ASCILITE
SHAPING THE FUTURE OF TERTIARY EDUCATION

SUSS
SINGAPORE UNIVERSITY OF SOCIAL SCIENCES

36TH INTERNATIONAL CONFERENCE ON INNOVATION, PRACTICE AND RESEARCH IN THE USE OF EDUCATIONAL TECHNOLOGIES IN TERTIARY EDUCATION

Personalised Learning. Diverse Goals. One Heart.

2 – 5 December 2019

Singapore University of Social Sciences (SUSS),
Performing Arts Theatre

ASCILITE 2019

Australasian Society for Computers in Learning in Tertiary Education

Singapore University of Social Sciences, Singapore
2 – 5 December 2019

Conference Proceedings

Personalised Learning.
Diverse Goals.
One Heart.

36th International Conference of Innovation, Practice and Research in the Use of Educational Technologies in Tertiary Education

Editors:

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ASCILITE 2019 – Personalised Learning. Diverse Goals. One Heart.

The ASCILITE 2019 Conference is ASCILITE's 36th International Conference of Innovation, Practice and Research in the Use of Educational Technologies in Tertiary Education. This year's conference was hosted by the Singapore University of Social Sciences (SUSS), and held at the University's campus, between 2 to 5 December 2019.

The theme of ASCILITE 2019 "Personalised Learning. Diverse Goals. One Heart." brings together the focus on the learner's needs in the use of technology and sound pedagogical practices. It recognises the diverse motivation behind each learner in the design of curriculum and the common goal in contributing to the betterment of the global society. Singapore, being the place for people of different ethnicity, culture and religion to pursue their passion and dreams, personifies the idea of "Diverse Goals" but "One Heart". This theme also coincides with the educational aspiration of SUSS, and Singapore at large, that regardless of students' goals, different backgrounds or life stages, it aims to equip them with the real-world knowledge and practice-oriented skills to excel, both in life and in their chosen career. Welcome to ASCILITE 2019 in the city state Singapore.

Conference Tracks

Conference submissions identifies the conceptual, applied, and theoretical research contributions on the following six conference tracks:

1. Visions and Explorations in Digital Learning, Pedagogies & Spaces
This exploratory theme encourages the sharing of new, emerging or tentative trials and experimentations of work that incorporates digital technologies into pedagogical instruction and learning, as well as learning spaces.

2. Practices and Challenges in Technology Enhanced Learning
This theme encourages contributions in the states of affairs, structures or collaborations needed, in order for technology enhanced learning to take root in a meaningful, scaled or sustainable manner. Personal reflections on obstacles, mistakes or lessons learnt in systems implementation are welcomed.

3. Nurturing Digital Competencies for Teaching, Learning, Work & Citizenship
This theme focuses on the attributes, attitudes, understandings, skills, dispositions and related digital competencies needed by educators and learners in formal and informal learning environments, including in Institutions of Higher Learning (IHLs) and at the workplace.

4. Data Analytics & Evidence to Improve Teaching & Learning
This theme is for the empirical, quantitative, interpretative or impact analysis of (a) digital learning issues or (b) the use of digital interventions to illuminate issues of teaching and learning.

5. Continuing Education: Learning Enrichment Throughout Life
This theme focuses on inclusive and lifelong learning initiatives or pedagogies related to upskilling and reskilling for work, as well as in the contexts of active and productive leisure, ageing, citizenship to meet local, regional and global learning needs.

6. Technology as a Catalyst for Social Impact
This theme focuses on how technology could be used for learning to create social changes and how educators and students alike can be motivated to use technology to make a difference in the society.

Conference Organisation

The Singapore University of Social Sciences' ASCILITE 2019 Conference Organising Committee, led by Professor Cheah Horn Mun, includes Associate Professor Rebekah Lim Wei Ying, Associate Professor Chui Yoon Ping, Dr Renee Tan Hui Ling, Mr Lee Chye Seng, Ms Chan Kah Mun, Mr David Toh Tian Kheng, Ms Katherine Lin Daomin, Ms Rebekah Lim Shi Yun, Ms Choong Fong Ling, and Ms Stephanie Tiu Ting Wei.

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Review Process

Full papers, Concise papers, Extended Abstracts (PechaKucha), and Posters submitted for the conference underwent a double-blind peer review process. A third blind peer review was conducted if opinions between the two reviewers was divided. This process allowed papers to be ranked and selected for inclusion in the conference. A further review was conducted by the ASCILITE 2019 Academic sub-committee for papers just above and below the anticipated cut line.

Panel discussion, Symposia, Debates, Experimental sessions, and Pre-Conference Workshop submissions underwent a single-blind peer reivew. Proposals that were at the cut-off line were also examined by the ASCILITE 2019 Academic sub-committee.

A total of 199 submissions were received for the 2019 conference, and all were either blind peer reviewed or double-blind peer reviewed. A further 13 non-peer reviewed submissions were added to the programme. The EasyChair Conference Management System was used for the submission and review process, for papers across the six conference themes.

Table 1: Summary of paper submissions and acceptances for ASCILITE 2019

Type	Submitted	Accepted	Rejected	Withdrawn
Double blind peer review				
Full paper	45	35	9	1
Concise paper	74	54	19	1
Poster	26	20	6	0
PechaKucha	32	23	8	1
Sub-total	**177**	**132**	**42**	**3**
Blind peer review				
Panels/ Symposia	5	5	0	0
Debates	2	1	1	0
Experimental sessions	9	7	1	1
Pre-Conference Workshops	6	5	0	1
Sub-total	**22**	**18**	**2**	**2**
Grand total (reviewed)	**199**	**150**	**44**	**5**
Non-Peer Review				
Keynotes	3	3	0	0
AJET sessions	2	2	0	0
SIG sessions	7	6	0	1
TELAS session	1	1	0	0
Innovation award presentations	1	1	0	0
Sub-total (non-reviewed)	**14**	**13**	**0**	**1**
Grand total (all)	**213**	**163**	**44**	**6**

Acknowledgements

The ASCILITE 2019 Conference Organising Committee would like to acknowledge and thank the ASCILITE Executive for their guidance and support, ensuring that this conference ran successfully. In particular, we would like to thank the ASCILITE President, Professor Dominique Parrish, Vice-President Dr Chris Campbell, Secretariat Mr Andre Colbert, Professor Sue Gregory, Mrs Hazel Jones, Dr Julie Willems, and our Executive member liaison, Mr Alan Soong.

List of Reviewers

The ASCILITE 2019 Conference Organising Committee and Conference Academic sub-committee wish to gratefully acknowledge the efforts of the international body of reviewers for contributions to ASCILITE 2019. Their work in reading and reviewing the 199 submissions was greatly appreciated

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Foreword

Whenever significant technological advances are made that have the potential for use in teaching and learning, the imagery of the human educator being replaced by one form of technology or another would inevitably make its appearance. While this ‘replacement’ has not quite taken roots, the role of the educator has certainly evolved as each introduction of relevant technology nudges and re-shapes teaching and learning practices. In fact, the response of the educator to effectively embrace available technologies represents one of the key challenges, and dare I say, ‘joy’, in our endeavours to make learning meaningful and integral to each learner.

If we cast our minds back to the impact technologies have on education, from the use of paper to the introduction of computing machines, it is not too difficult to recognise how each major adoption has significantly changed the way in which we interact and learn. However, the spread of these changes tended to be slow; that is, until the emergence of Information and Communication Technologies (ICT) redefines what pace of change means. Specifically, over a short period of time from the early 90s to the present, there are at least three recognisable paradigmatic shifts. First, the easy availability of information provided through the Internet largely means that the educator no longer has a monopoly on factual knowledge. In fact, the individual educator simply cannot compete with knowledge repositories embedded within technology and human networks made accessible through the Internet. Second, the interactivities brought about through Web 2.0 have shifted the interactions from between human and machine, to human and human through a machine. This has greatly increased the ability of the individual to connect with others beyond the space limited by geography. The impact on the way teaching and learning interactions need to be re-designed is palpable. Third, and perhaps the most challenging to date, is that the machines are now capable of learning about the learners, and through such knowledge can potentially customise learning at the individual level. The possibilities opened up by this capability is still under-explored. Within it lurks considerable dangers, and yet also tremendous possibilities that can definitively change teaching and learning interactions.

The theme of this conference recognises these possibilities, and also that it is not just about the use of technology in education. The social dimensions and impact of using technologies in teaching and learning are important aspects that need to be taken into account as we explore and deepen how technologies can support this most human of endeavours – learning.

On this sober and exhilarating note, welcome!

Professor Cheah Horn Mun
Chairperson, ASCILITE 2019 Conference Organising Committee
Assistant Provost and Dean (S R Nathan School of Human Development)
Singapore University of Social Sciences

Keynote Speakers

Emeritus Professor Mike Sharples
Emeritus Professor of Educational Technology Institute of Educational Technology, The Open University, UK

Mike Sharples is Emeritus Professor of Educational Technology in the Institute of Educational Technology at The Open University, UK and Honorary Visiting Professor at the Centre for Innovation in Higher Education, Anglia Ruskin University. His research involves human-centred design of new technologies and environments for learning. He inaugurated the mLearn conference series and was Founding President of the International Association for Mobile Learning. As Academic Lead for the FutureLearn company, he informed the design of its social learning approach. He leads the nQuire project with the BBC to develop a new platform for inquiry-led learning at scale. He founded the Innovating Pedagogy report series and is author of over 300 papers in the areas of educational technology, science education, human-centred design of personal technologies, artificial intelligence and cognitive science.

Professor Sandy Cook
Senior Associate Dean, Duke-NUS Medical School

Dr Sandy Cook received her PhD from Cornell University in Adult and Continuing Education. Her Master’s is in Research Methodology and her Bachelor’s in Experimental Psychology, both from Ohio State University. Prior to coming to Singapore, she was the Associate Dean for Curricular Affairs at University of Chicago, Pritzker School of Medicine. Dr. Cook joined Duke-NUS Medical School in June 2006, to facilitate the design and implementation of the Educational infrastructure for Duke-NUS Medical school. She facilitated the development of TeamLEAD, the local adaptation of Team-based Learning as the primary instructional strategy for Duke-NUS basic science year. She helped establish the Academic Medicine Education Institute (AM.EI) launched in 2012. AM.EI is a joint venture with Duke-NUS and SingHealth, designed to promote excellence in education for Health Professional Educators. Through AM.EI, she has taught hundreds of faculty from all levels of learning how to use TeamLEAD in their instructional programmes. In 2014, she was accepted into the NUS Teaching Academy Fellows and received the Master Scholar Award from the International Association of Medical Science Educators (IAMSE) in 2016. She is currently the Deputy Head of Office Education and Deputy Director of AM.EI.

Professor Koh Hian Chye
Professor and Director, Business Intelligence & Analytics, Singapore University of Social Sciences

Dr Koh Hian Chye is currently a Professor at the Singapore University of Social Sciences. He serves concurrently as Director of Business Intelligence & Analytics, which is responsible for the implementation of learning analytics in the University, among other things. He has more than thirty years of experience in data analysis and data mining, having served as a statistical/data mining consultant to SMEs, statutory boards, government agencies and large organisations. He has published in international journals and presented at international conferences in various areas in analytics. His main research and teaching interests are in data mining applications in business and education.

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Usability and user experience evaluation of Virtual Integrated Patient

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Most existing Virtual Patients utilize simplistic, predictable, and prescriptive approaches that limit deductive learning and the development of decision-making skills for medical students. We have designed a chat-based virtual patient for performing patient interviews, physical examinations, and investigations to help medical students develop reasoning skills. In this paper, we present results from a two-part study. In the first part, we conducted a usability evaluation with seven medical students and six clinicians. The objectives of the usability evaluation was to determine how VIP's user interface and its features affect the usability (efficiency, effectiveness and learnability) as well as the general subjective user experience associated with the use of system. Each participant completed a user experience, system usability scale, and a self-prepared survey form. A significant difference was seen between the results of students and tutors. Due to a lack of training data, the chatbot model predicted incorrect responses that led participants to feel frustrated. In the second part of study, we have retrained the chatbot model using the feedback and designed an error correction approach and engaged seven new medical students to test the chatbot intensively — a total of 2169 user interactions were performed with the chatbot. Of that, 77.4% were properly answered by the bot, 10.8 % were out-of-domain concepts, 8.6 % were unknown concepts (Li et al., 2018), 3.3 % were corrected using the error correction approach designed.

Keywords: virtual patient, medical education, usability evaluation

INTRODUCTION

A large percentage, 41-60% of medical graduates, feel clinically unprepared after university graduation (Cave et al., 2007; Goldacre et al., 2003; Ochsmann et al., 2011) due to the decreasing access of students to real patients. Training is designed based on a back-to-front approach where the student learns about the disease by analysing a diagnosed patient. There are relatively limited opportunities for the students to practice engaging with a patient, using a more natural perspective approach, beginning with a symptom, and concluding with diagnosis and management. Currently, medical schools use both mannequin-based and standardized patient simulation to overcome these limitations. However, the limitations of these approaches are that they can only involve a small number of students at one time, and the faculty have to conduct repeated sessions to cater to the cohort.

In the past two decades, medical education has placed increased reliance on simulation technologies, such as virtual patient (VP) simulations, to boost the growth of learner knowledge and to shape the acquisition of clinical skills for medical students and health professionals (Barry Issenberg et al., 2005). Most of the VPs have, however, been narrative based, using a linear or menu-driven model with preselected options, which are relatively simplistic, predictable, and prescriptive in their approaches limiting the opportunities of the student to engage the virtual patient in a more naturalistic way, to practice his/her decision-making skills. We have designed a virtual patient platform that allows a more natural and realistic way of interaction between students and the virtual integrated patient model. We believe that a well-designed VP, one that is easy and intuitive to use, will help students to remain engaged with exploratory learning, and eventually improve disease understanding and clinical reasoning skills. Therefore, a user-centred approach has been adopted for the development of the VP to ensure that the system is easy and enjoyable to use and meets the pedagogical goals. The system will be subjected to iterative user testing, evaluation and improvement design throughout the development lifecycle. This paper details the first user testing and a study conducted to improve the model performance.

In the next section, we introduce an overview of the design of the virtual integrated patient. Subsequently, the design of the usability study. In section 4, the results of the user study will be discussed. Following which, there would be a brief overview of an improvement study that was conducted to improve the system further. Through thorough exercises, the system learned a variety of new questions from experienced medical students.

DESIGN OF VIRTUAL INTEGRATED PATIENT

Figure 1. Student performing an interview with a virtual patient

Virtual Integrated Patient (VIP), generates realistic virtual patients which students can interact with using a free-text interface, through the process of interviewing (Figure 1), conducting a physical examination (e.g., to check the temperature, blood pressure, heart rate) and order of investigations (e.g., full blood count, x-ray, MRI, etc.). The patients generated are realistic because they come with randomly generated, rich and comprehensive case details, such as gender, age, ethnicity, presenting symptoms, family, social and medical history, drug history, travel history, and genetics. The engagements allow medical students to prospectively move from presenting symptom to eventual diagnosis, thus allowing the development of clinical reasoning skills.

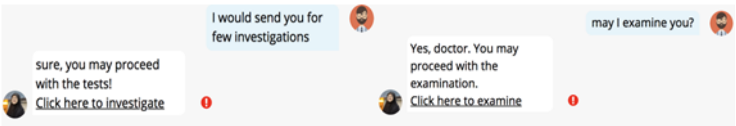

Figure 2. Taking patient consent to perform physical examination and investigation

In clinical practice, clinicians are trained to inform the patients or seek consent from the patients before they perform a physical examination or send patients for investigations. Similarly, on the VIP, students are reminded that they can only get access to perform a physical exam or to order investigations when they have informed the patient or have sought consent from the patient, as described in Figure 2.

The participant subsequently will be allowed to navigate to an examination interface by clicking on the link shown in the patient response within the chatbot. In the examination module, the participant clicks on any part of the human anatomical figure and types in the specific examination they wish to perform. As demonstrated in Figure 3, to check the patient temperature, participants have to input “temperature”. Similarly, to order an investigation, the participant has to inform the patient or seek consent from the patient before they input the specific investigation name.

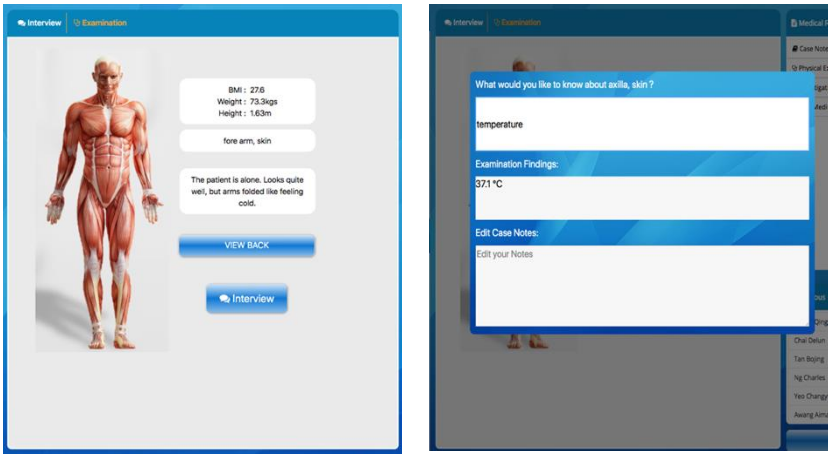

Figure 3. Physical exam: Click on human anatomical figure and search for a test name

Currently, the VIP provides feedback for the cost incurred to the patient based on investigations ordered and efficiency of the student's engagement with the VIP. The latter is calculated based on the number of interview questions asked, examinations, and investigations negotiated before a diagnosis is made. The norms for these assessments are empirically made at the moment but can be better calibrated as more data is harvested according to the seniority of the student. Clinicians are trained to start the interview by greeting the patient, verifying patient name, identity, and encouraged to ask for the patients' consent while asking any sensitive or personal information. The participant is assigned a penalty if they ignore any of these steps and rewarded for compliance. When the participant is ready to make a diagnosis, they simply indicate by clicking *Ready to Diagnose* button (Figure 1) and asked to re-enter brief case notes from the patient interview, physical examination, and investigations. They are then able to make a diagnosis and prescribe a treatment plan for the patient. Subsequently, the patient's actual diagnosis and treatment will be shown for the student to do personal reflection and review.

USABILITY EVALUATION

AIM OF USABILITY EVALUATION

Usability is defined as "*the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use*" (ISO 9241-11:2018). The objectives of the usability evaluation was to determine how VIPS's user interface and its features affect the usability (efficiency, effectiveness and learnability) as well as the general subjective user experience associated with the use of system.

This was achieved through a user-based evaluation, where the usability and user experience were evaluated using targeted end users of the system, which in this case were medical students. The study also aimed to seek feedback from clinicians (tutors) on the usefulness of the VIP platform as a tool for teaching and training for clinical reasoning skills.

PARTICIPANTS DEMOGRAPHICS

In Phase 1, a total of 13 participants (seven medical students and six clinicians) were recruited to evaluate the usability of VIP. All of them were Singapore citizens, and majority were Chinese (12/13). Eight out of 13 participants were male. Of 7 students, 6 were the second-year medical students, and one was a fourth-year medical student, and their ages ranged from 20 to 23 with an average age of 21. Of 6 clinicians, their ages ranged from 40 to 52 years old, with an average age of 46.5 years old, and their clinical working experience ranged from 15 to 27 years. All the participants are informed to sign a consent form before starting the study. There was an omission of a 4th-year participant during analysis to make a precise comparison between only second-year students and clinicians.

PROTOCOL

Each participant had to complete two patient cases that covered interviewing patient, examining, and ordering lab investigations. The participants were briefed on the aim of the study and viewed the tutorial before starting. Guided by the facilitator, participants were asked to think aloud while performing the tasks - what they are trying to achieve, how they think they will achieve them, unexpected systems responses, i.e. if something happened which they did not expect or if something they were expecting to happen did not happen. Each participant's interaction with the VIP were logged and video recorded. Thereafter, participants completed a user experience questionnaire, system usability scale, and a self-developed questionnaire. A semi-structured interview was conducted to follow-up on the observations during task performance (such as difficulties encountered, expressions of frustrations, etc) and capturing all participants' subjective feedback on the VIP system.

USER EXPERIENCE QUESTIONNAIRE

The User Experience Questionnaire (UEQ) contains 6 scales (e.g., attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty) with 26 items. The attractiveness scale has 6 items, and all other scales have 4 items. Each item is scaled from -3 to +3. Thus, -3 represents the most negative answer, 0 a neutral answer, and +3 the most positive answer (Schrepp, 2017).

SYSTEM USABILITY SCALE

The System Usability Scale (SUS) consists of 10 items to examine "usability" and "learnability" of a product. All items are measured on a 1 to 5 (1–Strongly disagree, 5–Strongly agree). Calculation of the SUS score is achieved by converting the 1 to 5 scale to a 0 to 4 scale. For items 1,3,5,7 and 9, the score contribution is the scale position minus 1. For item 2,4,6,8 and 10, the contribution is 5 minus the scale position. The overall SUS value is calculated by multiplying the sum of the scores by 2.5 (Brooke, 1996). Thus, the total score ranged from 0 to 100.

SELF DEVELOPED QUESTIONNAIRE

The self-developed questionnaire includes 15 questions to score patient responses, labels on menu items, and popup boxes, consistency of icons, colours used, navigation, organisation of items, performance metrics, physical examination and placeholders in input boxes. All questions are measured on a 1-5 scale (1–Strongly disagree, 5–Strongly agree).

RESULTS

In the UEQ, students rated all items positively and the mean score of each item ranged from 0.29 to 2.29, with especially high mean scores ($\geq$ 2.00) on items of enjoyable, valuable, interesting, good, practical and meet expectations. The students rated the low mean scores (< 1.00) on predictable, fast, and leading-edge. The scores of all items were rated lower in clinicians than students. The clinicians rated more negatively on some items, namely fast-slow (-1.33), pleasing-unlikable (-0.67), efficient- inefficient (-1.33) (Figure 4).

The mean scores of the scales of attractiveness, efficiency, and dependability were negative in clinicians (Figure 5). An Independent sample t-test between the students and clinicians showed that there were statistically significant differences in attractiveness, efficiency, perspicuity, dependability, and stimulation between them ($p < 0.05$) as shown in table 1 below.

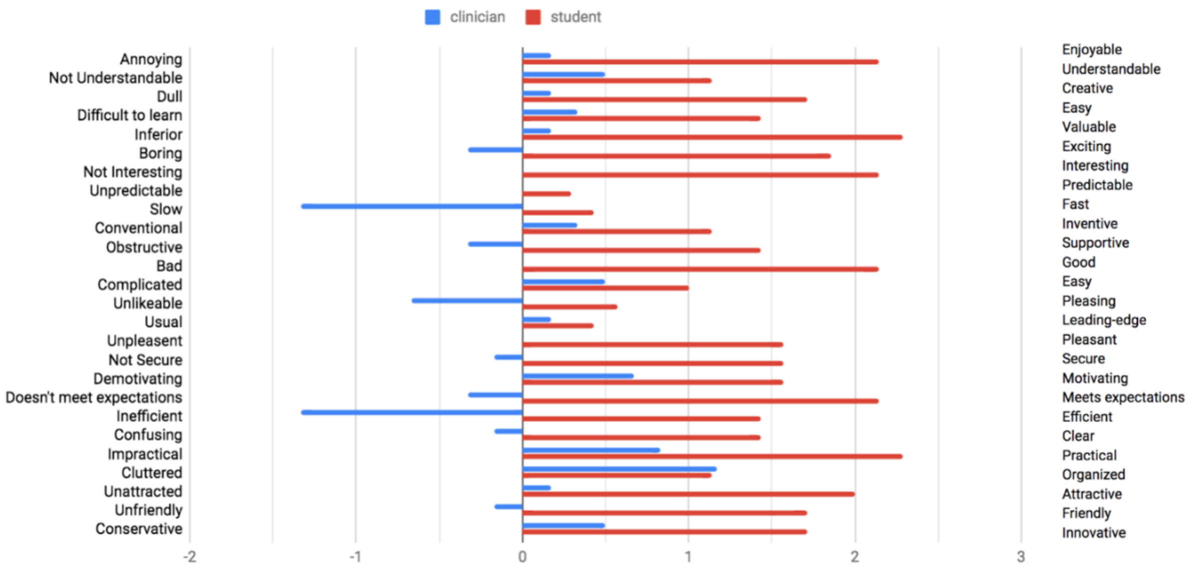

Figure 4. Mean scores of UEQ items between students and clinicians

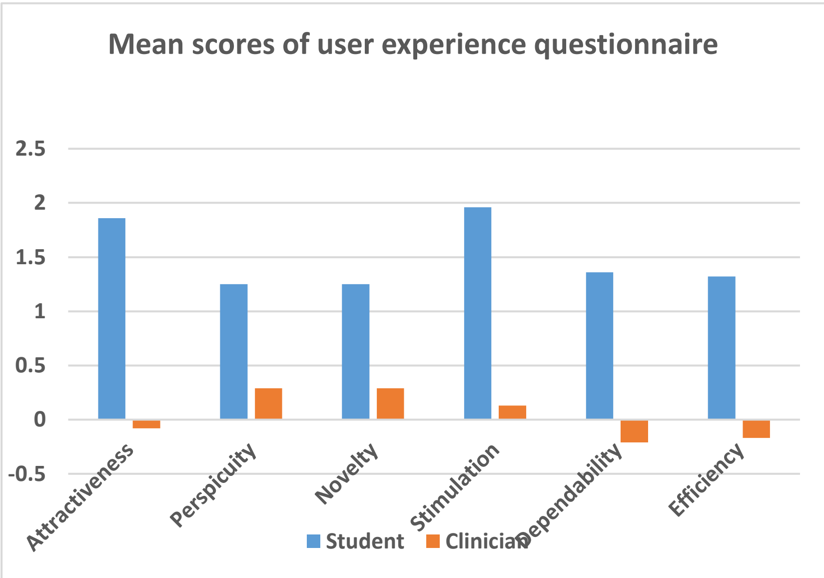

Figure 5. Mean scores of UEQ scales between students and clinicians

Table 1: Independent sample t-test on UEQ scales between students and clinician

	t	df	p-value
Attractiveness	5.698	11	0.000**
Efficiency	4.795	11	0.001**
Perspicuity	2.276	11	0.044*
Dependability	3.923	11	0.002**
Stimulation	5.229	11	0.000**
Novelty	1.983	11	0.073

In System Usability Scale (SUS), the mean score of each item ranged from 2.43 to 3.43 in students and 1.50 to 2.67 in clinicians. The students rated higher mean scores of all items than clinicians. When the comparison of the mean score of each item was performed, the students rated significantly higher scores on items of "I think that I would like to use this platform frequently", "I found the platform unnecessarily complex", "I thought the platform was easy to use", and "I found the various functions in this platform were well-integrated" than those in clinicians. The mean score of total SUS score was 71.43 in students and 53.75 in clinicians, and there was a statistically significant difference in the total mean SUS score between students and clinicians ($p < 0.05$) as shown in Table 2.

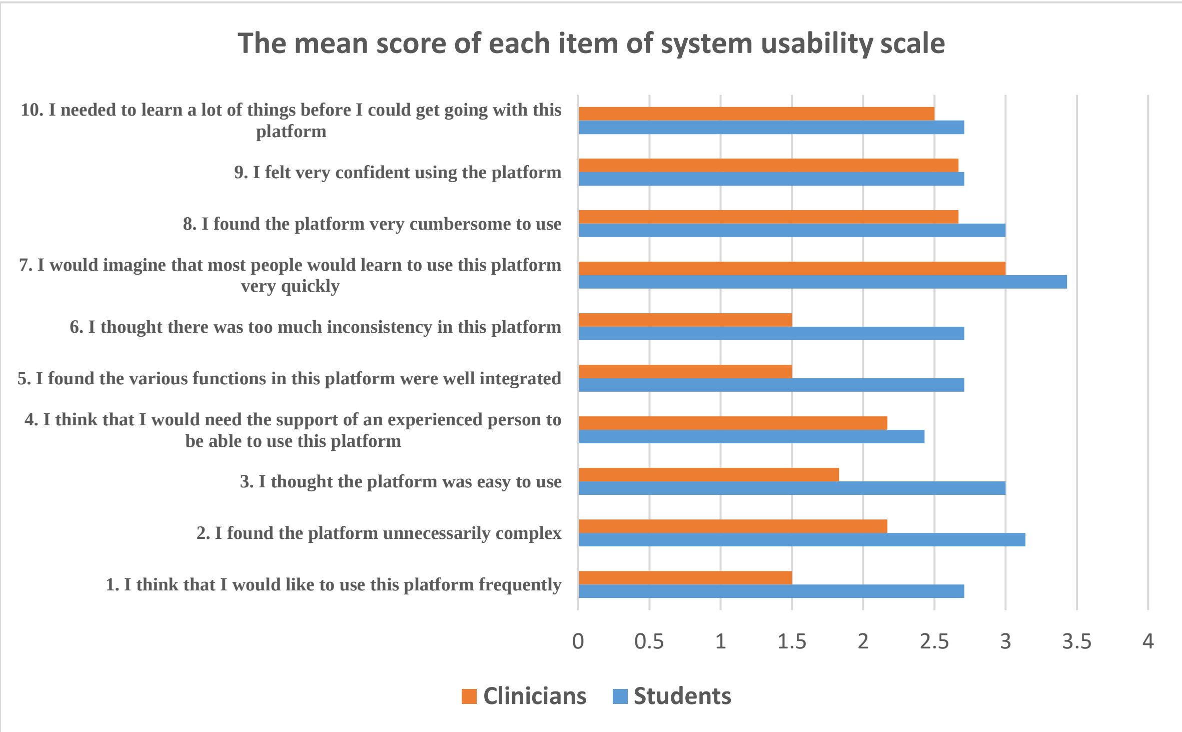

Figure 6. Mean scores of SUS items between students and clinicians

Table 2: Independent t-test on SUS scales between students and clinicians

Variables	t	df	P-value
1. I think that I would like to use this platform frequently	3.261	11	0.008**
2. I found the platform unnecessarily complex	3.029	11	0.011*
3. I thought the platform was easy to use	3.164	11	0.009**
4. I think that I would need the support of an experienced person to be able to use this platform	0.363	11	0.724
5. I found the various functions in this platform were well integrated	3.261	11	0.008**
6. I thought there was too much inconsistency in this platform	1.874	11	0.088
7. I would imagine that most people would learn to use this platform very quickly	1.326	11	0.212
8. I found the platform very cumbersome to use	1.088	11	0.300
9. I felt very confident using the platform	0.109	11	0.915
10. I needed to learn a lot of things before I could get going with this platform	0.355	11	0.729
SUS score	2.541	85	0.027*

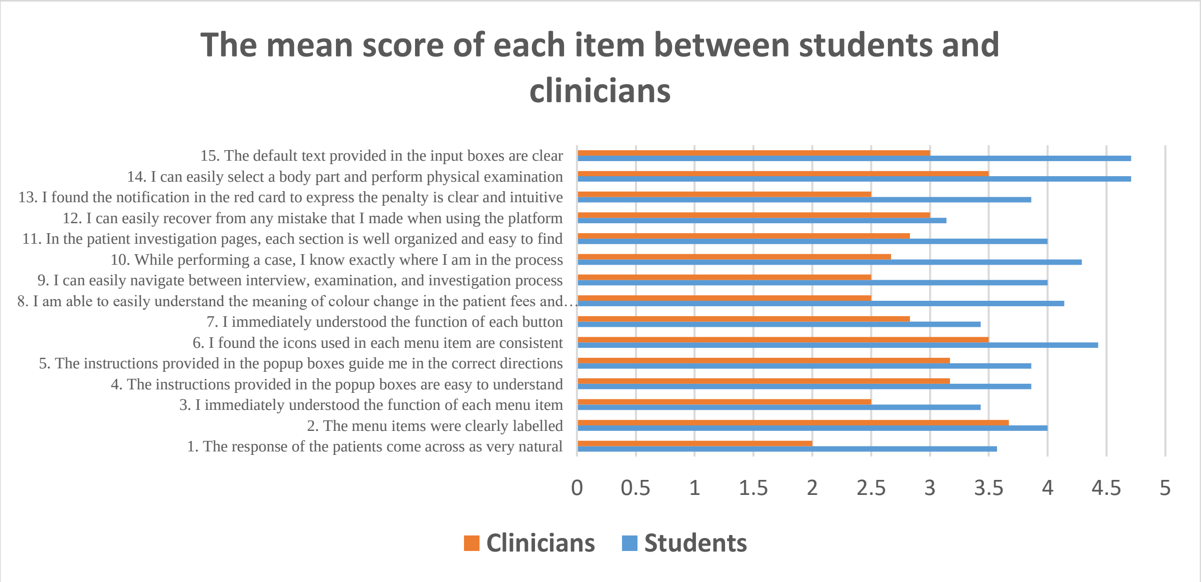

Figure 7. Mean scores of self-developed questionnaire items between students and clinicians

Table 3: Independent t-test on Self developed questionnaire between students and clinicians

Variables	t	df	P-value
1. The response of the patients come across as very natural	3.006	11	0.012*
2. The menu items were clearly labelled	0.734	11	0.504
3. I immediately understood the function of each menu item	1.419	11	0.184
4. The instructions provided in the popup boxes are easy to understand	1.322	11	0.213
5. The instructions provided in the popup boxes guide me in the correct directions	1.726	11	0.112
6. I found the icons used in each menu item are consistent	3.088	11	0.010*
7. I immediately understood the function of each button	0.930	11	0.372
8. I am able to easily understand the meaning of colour change in the patient fees and efficiency	2.422	11	0.034*
9. I can easily navigate between interview, examination, and investigation process	2.901	11	0.014*
10. While performing a case, I know exactly where I am in the process	3.712	11	0.010*
11. In the patient investigation pages, each section is well organized and easy to find	2.340	11	0.039*
12. I can easily recover from any mistake that I made when using the platform	0.196	11	0.848
13. I found the notification in the red card to express the penalty is clear and intuitive	2.302	11	0.042*
14. I can easily select a body part and perform physical examination	3.261	11	0.008**
15. The default text provided in the input boxes are clear	3.750	11	0.003**

Similar to the findings of the UEQ and SUS, the students rated higher scores on all 15 items than the clinicians in the self-developed questionnaire (Figure 7). An Independent t-test comparison between the students and the clinicians indicated that there was statistically significant difference in more than half of items ($p < 0.05$) as shown in Table 3.

The difference between the students' and tutors' usability score can be attributed to the differences in technical proficiency. Medical students comprise mainly of young adults who are more at-home with a chat-based interface, whereas the tutors are less familiar in engaging with online (virtual) patients. Medical students had more positive perceptions of the system as a learning tool and found the system to be engaging and simple to use. The tutors on the other hand found it less useful to them as they were trying to engage with the platform as a student. However, during the interview sessions, they conceded the system as a useful tool to support students' learning.

OBSERVATIONS FROM TASK PERFORMANCE AND FEEDBACK FROM SEMI-STRUCTURE INTERVIEW

Most participants had positive experiences using the platform. One of their positive experiences was that they felt that VIP was a good, fun and an easy and interesting platform to use, even though it could be further improved. Quite a number of participants liked the format and layout of the platform as they felt that it was simple and clear to learn and use. Some participants thought that VIP was a good platform to practice history-taking in a safe online environment without feeling stressed, as there were no limitations to the questions to be asked. Another positive experience, pointed out by one participant, was that the responses were quite practical and realistic. Thus, the participant felt that the platform was quite flexible. With the platform providing specific responses to each of the participants' questions, participants liked how the programme released one information at a time and further information must be probed by the participants themselves. In addition, for the lab investigations, the participants liked how the programme gave realistic results displaying descriptions of the investigations. The cases seemed more personalised, rather than generic, to the participants.

Despite the positive experiences, some participants also expressed some negative experiences when using the platform. The default model was not able to answer open-ended, long sentence and follow-up questions. Some participants had the conception that the platform was intended to replace the simulated patient or real patient and stated that the interview section was unrealistic. They also complained that they often felt frustrated from the inaccurate responses.

We classified the errors encountered in 3 different categories: unknown concept, out-of-domain and context errors. If the intent of the question asked by the student is already defined in the chatbot model but not predicted correctly, then it is classified as an unknown concept. If the model was not aware of any input, then it is classified as an out-of-domain concept (Li et al., 2018), and if the patient's response shown to the user doesn't follow the context of the current state of the conversation, then it is classified as a context error. Analysing the student logs, we found that 49.7% of the questions were predicted correctly, 18.3% were unknown concepts, 30% of out-of-domain concepts and 2% of issues were due to context. Due to the missing data in the system, the computer cannot provide appropriate responses to the participants' questions, which made the participants feel frustrated. A common issue also occurred when participants presented questions in different ways. In this case, although the system has the data relating to the question, the computer could not recognise the different presentations of the questions, which resulted in many unknown concepts. There were some mapping issues due to the context of the conversation and thus, the computer could not recognise the context questions or follow-up questions, which resulted in the generation of wrong answers.

In terms of interaction design, one of the major problems was navigating from history taking (interview) to physical examination. Participants were required to seek permission from the patients for physically examination in order for the system to move to the physical examination segment. However, most participants looked for a button to click to move to physical examination.

Another common problem encountered was most participants clicked on either the ear, forehead/face and mouth for the measurement of body temperature. However, the temperature was designed to be taken under the axilla. Participants found it difficult to navigate between the physical examination and the interview. When participants tried to order laboratory investigations, they also encountered some problems as there were some unregistered investigations in the system and also costing had an implementation problem where the system provided doubled costs when the student ordered the same investigation twice. Participants expressed their displeasure over some issues in the programme, such as the need to re-type or rewrite a brief of the patient case notes before diagnosing, as they found it tiring to cut and paste the words from the case notes.

REDESIGNING VIP

We have retrained the chatbot model using the usability study feedback. Following are few changes we have incorporated in the design.

1. Consider the student asked the patient *How long you have fever?* for which the platform is not been trained and so the program matched the response for the question *How long ?* as it was similar and the patient responded as *Since 3 days ago* which is for the symptom cough the patient may be suffering from. To avoid these inconsistencies, we have tailored the response more specific to the question i.e., *I got cough since 3 days ago.*

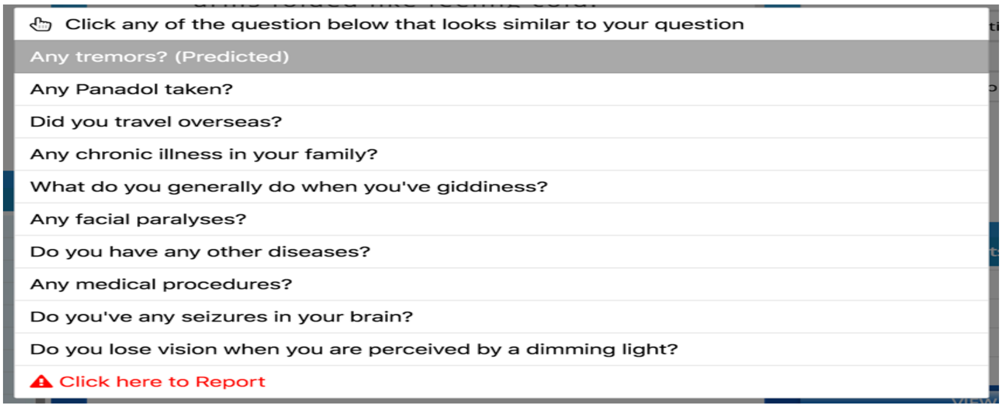

Figure 8. Nearby list of questions given to correct unknown concepts

2. We have used nearby predictions made by the natural language understanding model to correct unknown concepts. Whenever a user asks a question in the chat, the question is detected using a trained language model. Rasa NLU (Rasa Documentation) has been used to deploy the chatbot language model. Rasa NLU predicts a list of intents, each associated with a confidence level. By default a intent with high confidence level is chosen and a patient response for that intent is shown to the user. For example, If the question asked is *Did you take any panadol?* which is focussing on patient medications, then the chatbot incorrectly predicts a intent named *any tremors* with an confidence level 0.97, *medications intake* with an confidence level 0.94. So the intent shown to the user will be *I don't have any tremors* which is incorrect. We have provided a report option next to the patient response, on clicking this icon a nearby list of predictions made by the language model are shown in a popup as shown in figure 8. When user clicks on *Any Panadol taken?* the response *I haven't taken any Panadol* is shown to the user.

USER STUDY TO IMPROVE HISTORY TAKING

In phase 2 of the study, we focused mainly on thoroughly allowing the system to begin learning new questions that clinicians would often use. Ensuring the robustness of the system and allowing usage by people with different levels of medical experience. A total of 9 fourth year medical students were recruited to test the system. Students were instructed to be as thorough as they can be in this experiment. They were given instructions that they should cover only the interview portion, something learned in their second year and using it as a skeletal guideline in their "quest". The viewing of the tutorial was done at the beginning after their consent was taken. Each participant was tasked to complete 4 cases thoroughly. There was an improvement in the performance of the model after incorporating the feedback of the usability study. A total of 2169 user interactions were performed while interviewing the patients. Of them, 1678 (77.4%) were correctly predicted, 71 (3.3 %) unknown concepts can be corrected using the error correction approach described above, 186 (8.6 %) were the unknown concepts not be able to correct using the error correction approach, and 234 (10 %) were out-of-domain concepts.

CONCLUSION AND FUTURE WORK

Medical students feel clinically unprepared after graduation due to lack of access to real patients. Virtual integrated patient allows the student to interact with the patient more naturally and realistically. The VIP generates virtual patients that students can use to rehearse and practice skills to engage a patient through the interview, examinations, and ordering of investigations. The primary interface is through free text. We have evaluated this tool with seven medical students and six clinicians (tutors). Each participant completed three questionnaires (user experience questionnaire, system usability scale, and a self-developed questionnaire). In all the surveys, there was a significant difference between the students' and clinicians' scores. We also noticed that around 30% of the questions asked were new to the platform, resulting to frustration in participants. We incorporated the usability study feedback and designed an error correction for unknown concepts, and found an improvement in the performance of chatbot after engaging 9 new medical students to intensively test the history taking component of the website.

We believe that the VIP Interview chatbot can be further improved with increased participants interaction. We can use this tool to develop virtual populations of patients according to relevant demographics as well as even more complex patients with multiple clinical episodes, and clinical sequel necessitating follow-ups. We are building this platform to include more customisable features accommodating to the specific needs of different teaching environments, medical schools, and end-users.

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Learning business through digital simulation: An analysis of student reflections

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The use of digital simulations is becoming more prominent in higher education to provide students with authentic learning environments in which they can apply their knowledge as well as develop enterprise skills. These enterprise skills are those qualities necessary for successful employment after graduation. This paper investigated ten years of data gathered through student reflective assessments that identified their perceived learning from the completion of a course which contained an embedded digital simulation. Student reflections were analysed to determine the themes which defined their key learning from the course. Content analysis was undertaken using nVivo to determine the themes from the students' individual reflection assessment. Outcomes of the study revealed that students self-reported successful achievement of three of the four course learning outcomes. In addition, students identified improvement in their enterprise skills and better understanding of business practices for their future careers.

Keywords: business simulation; authentic assessment; content analysis; enterprise skills

Introduction

This paper investigates the final reflections of students who have completed the course Business Decision Making Simulation (BDMS). It uses content analysis to determine the learning achieved from the student perspective. The interest in this area stems from a ten-year involvement with teaching the third-year course using the Capstone business simulation developed by Capsim (www.capsim.org), combined with the implementation of an authentic assessment strategy for all courses taught by the authors.

Throughout their university studies, business students are introduced to a wide range of discipline-based theories pertinent to their future careers. However, it is considered in the literature to be just as important to show to future employers that they can apply these theories in a workplace setting that they will experience as graduates (James & Casidy, 2018, p. 401-402). One of the key pedagogical approaches to ensure not only the attainment of relevant theory but also the development of employability (or enterprise) skills, is the use of authentic assessment. This assists students in the transition from university to full time employment in their chosen discipline area. Tout, Pancini & McCormack (2014 p. 597) were adamant in that, 'theory is no longer able to govern practice; practice, while drawing on theory, now lights its own path based on precedent, analogy, experience, imagination and in situ practical judgement'.

Authentic assessment has been identified as containing eight key elements pertinent to the workplace environment. These elements are 'challenge, performance or product, transfer of knowledge, metacognition, accuracy, fidelity, discussion and collaboration' (Ashford-Rowe, Herrington & Brown 2014, p. 207). Herrington & Herrington (2007, p. 73) discussed the use of authentic assessment as a necessary alternative to traditional individualised tests and essays stating that

> …to provide authentic assessment of student learning, the learning environment needs to ensure that the assessment is seamlessly integrated with the activity and provide the opportunity for students to be effective performers with acquired knowledge, and to craft products or performances in collaboration with others.

The introduction of authentic learning environments and assessment have been gathering momentum over the last twenty years. One example, the use of digital simulations, has become widespread in higher education. They are dynamic tools which represent actions and roles from the students' future fields of employment, allowing the students to engage in the 'interactive, authentic and self-driven acquisition of knowledge' (Vlachopoulos & Makri, 2017, p. 4). Researchers have identified that all students enrolled in courses that use business simulations as a teaching tool become actively engaged in the learning activities particularly when the academic instructor provides guidance and feedback at regular intervals throughout the study period (Levant, Coulmont & Sandu, 2016; Asiri, Greasley & Bocij 2017; Buil, Catalán & Martinez 2019). In addition, it has been shown through student feedback, as well as pre- and post-simulation testing, that simulations assist students in the development of 'soft' or 'enterprise' skills (Morin, Tamberelli & Buhagiar (2019).

Literature Review

Simulation for learning

Salas, Wildman, and Piccalo (2009, p. 560) define business simulations as 'any artificial or synthetic environment that is created to manage an individual's (or team's) experiences with reality.' Business simulations provide opportunities for the 'active construction of meaning and knowledge' through pedagogies such as experiential, discovery and constructivist learning (Levant, Coulmont & Sandu, 2016, p. 371). Experiential learning is evidenced through the students engaging directly with the simulation providing experience dealing with consequences of the decisions they implement. Discovery learning is successful when students act on previous knowledge to discover new meaning of the concepts they have studied. Dellaportas and Hassall (2013) reinforce this by identifying that the creation of knowledge from experiencing a real or simulated environment is based on constructing meaning that is realistic to the learner.

Fearon et al. (2019) expand this concept with their discussion of heutagogic learning, which merges experiential and discovery learning pedagogies with student personal development. This type of learning is enhanced by the student's ability to critically reflect on the associations that can be made between the knowledge developed by combining the simulation, structured classroom learning and student self-development. However, due to the individuality of students, this reflective learning occurs at different stages throughout the simulation and tends to be greatly influenced by the students' level of motivation.

In addition to the ability of the students to be motivated to participate in the simulation, it must be noted, as stated by Scholtz and Hughes (2019), that the facilitator plays a large part in the success of any business simulation. Facilitator support necessary for the students to create appropriate levels of motivation to develop the soft skills includes:

1. Comprehensive support documentation and activities, which students are encouraged to complete before the simulation commences
2. Use of between one and eight practice rounds to provide students with formative feedback
3. Recap after each round of the simulation to repeat the theory behind the successes and failures (of the round)
4. Appropriate goal setting by the students, as a collective and individual, where 'students have to articulate their teams' vision, mission and goals' (Scholtz & Hughes 2019)
5. Firm understanding about the technology aspects of the simulation so appropriate support can be provided throughout.

It has been reported in recent literature that students do not engage in deep learning by sitting in lectures, memorising facts and regurgitating the answers in formats that do not relate to what their future working experience will require (eg LaDage et al, 2018; Matsushita, 2018). Experiential learning has been pushed to the forefront and challenges academic staff to reconsider their approach to teaching with comments such as "Organizing the course around exercises and mental challenges is much more effective than around lectures", says Udacity CEO Sebastian Thrun (Fowler 2013). Butler and Roediger (2011) identified that information becomes more entrenched when it is learnt through active rather than passive methods of learning. Therefore, the use of simulation exercises to replicate processes, projects or systems that students may experience in future employment situations is becoming more popular as academics work towards engaging students in a more active mode of learning (Hamzeh et al 2017).

Wolfe (2016) investigated the use of business simulations as a method of providing Assurance of Learning, one of the requirements that business schools need to include in their accreditation applications for the Association to Advance Collegiate Schools of Business (AACSB). He identified that whilst business simulations are a good method of providing this type of evidence, the simulation used and the method of embedding it into the course of study needs to be carefully managed. It is vital to ensure that all students are involved in the team activities and that every team member is given the opportunity to be hands on with the simulation, not progressing through the course on the back of other more active students. He went on to note that although some simulations provide a method of countering this by including individual exam style modules, this may not always test the acquisition of knowledge but rather an understanding of how the game works.

Evidence from the use of business simulations has shown development of enterprise or "soft" skills since they replicate actions from the workplace. Skills such as teamwork, critical thinking, problem solving, communication, cooperation, listening, and negotiation have been developed through the intense active learning approach which is inherent in these simulations (Levant, Coulmont & Sandu, 2016, p. 372). However, this development often remains out of reach in courses engineered specifically to teach these skills in a traditional environment (Tseng, Yi & Yeh 2019). Students use a digital version of the simulation and available digital resources both in the classroom and in their practice sessions outside of the formal classes to improve their capabilities as well as their digital literacy skills. According to a student involved in research undertaken by Narayanan and Turner (2019), only internship would provide a closer link to the soft skills required by a graduate in the "real world".

Using Capsim for BDMS

BDMS is a third-year undergraduate business elective using the Capstone business simulation developed by Capsim (www.capsim.org). The course learning objectives (Figure 1) identify that students will develop skills in business analysis, decision making, identifying factors for business success and working autonomously and collaboratively.

On completion of this course, students should be able to:

CO1. Analyse the competitive business environment
CO2. Apply complex business decision-making skills
CO3. Identify key factors in business success
CO4. Work autonomously and collaboratively

Figure 1: BUSS 3074 Course Learning Objectives

Capsim is a wholly online simulation that gives students the opportunity to run a manufacturing business in a team and compete against other businesses (student teams) for the same closed market. Student teams make decisions in the areas of Research & Development, Marketing, Production, Human Resources, Finance and Total Quality Management in order to manage a profitable and competitive business. Student teams participate in four practice and eight competition simulated years and then complete a cut-down version of the simulation as an individual. Decisions are made using results from the previous year's performance and there are numerous reports available online for the students to test the potential outcome of the decisions that they have made.

Student learning is assessed through their team performance (based on the team score in the balanced scorecard, team identified key performance indicators and a team presentation) as well as their performance in the individual simulation (based on balanced scorecard and responses to multiple choice questions, which show an understanding of their business' competitive situation at key points in the simulation). Finally, students submit an individual reflection reporting on the students' self-assessment of the learning they have achieved in the course. Self-assessment is reported as being one of four important processes to enhance the experiential learning and knowledge gain of the students (Teach & Patel, 2007). The assessment in this course asks students to reflect on the learning they have achieved in both a team and individual simulation environment as well as to consider any skills that they have developed.

Teach (2018) identified a brief, but incomplete list (Figure 2) of the cognitive and non-cognitive skills that students would be expected to learn from participating in a business simulation. Most business school undergraduate courses would include these skills and knowledge within their courses and as such it would be expected that students would be able to explain the concepts/terms. The implementation of these skills/concepts, however, is not normally taught in the curriculum (Teach 2018). It is for this reason that the use of business simulations is being incorporated into curriculum.

1. How forces outside of the firm's control may affect the firm's performance
2. How to understand marginal analysis
3. How to understand Opportunity costs
4. The importance of the many topics of forecasting and the costs of forecasting errors
5. What unintended consequences are
6. How product life cycles affect decisions
7. How variable costs turn into fixed costs as soon as commitments are made
8. The importance of product positioning
9. How to work in teams
10. How to differentiate important information from unimportant information
11. How to work under uncertainty
12. How to determine interactions among two or more decision variables
13. How to anticipate competitive responses
14. How to considering possible competitors' decisions when proposing strategies
15. How to analyze reports and financial results
16. How to assess risk
17. How to be innovative
18. How to be creative
19. How to create budgets
20. How to interpret useful statistics

Figure 2: Shortlist of what students might learn through participation in a business simulation (Teach 2018, p. 57)

Method

Ethics approval for this project was received as a result of negligible risk ethics application 034/2018. The application required independent de-identification of all student data from the reflective assignments and this was completed by two neutral staff members. This study takes a content analysis approach to analyse the individual reflections of students who have studied BDMS since 2013. 'Content analysis is a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use' (Krippendorff 2013, p. 24). Content analysis not only analyses the text but also considers the context in which the text has been written. Given that all the individual reflections have answered the same assignment question, the context of the analysis will remain consistent throughout the years that the study was completed. Analysis was undertaken by having all identifying features of the 249 submissions removed so that no student could be identified in the analysis. Papers were then loaded into nVivo 12 for coding and identification of common themes. This software was selected as it was available to staff in the University, and that the literature regarding qualitative research often refers to the fact that the 'systematic and rigorous preparation and analysis of qualitative data is usually time consuming and labour intensive' (Zamawe, 2015, p.13). The software was identified as the best possible option to assist in the reporting of the data for the following reasons:

- Simple structure using nodes
- Ability of researchers to focus on underlying themes
- Easier retrieval of results through efficient coding
- Ability to easily reorganise coding and node structures (Zamawe, 2015, p.14)

Nodes (or themes) are created to aggregate the information from the source documents. As data is coded against a node the software identifies the total number of files relating to the node and the total number of references. References are considered any segment of a file coded to a node and as such a file may contribute multiple references for a node (eg team) but could also be coded across multiple nodes (eg team, decision and work).
After some initial software learning and frustration in the use of nVivo, the following section reports initial results from the coding of the student reflections.

Data and Analysis

Although one of the authors had marked all the reflections from 2013-2018 giving some idea of the types of codes to be expected, using the software for the first time led to a lengthy decision-making process regarding the codes to be considered for this research. Finally, two coding methods were trialed in nVivo: manual coding in the first file and automatic coding of nodes in the second one. The manual coding process completed the coding of 12% of the source files (31 of the 249). This process took over five hours of continuous work. The autocoding process completed coding of 100% of the source files in three (3) minutes. Tables 1 and 2 show the first order codes created in the initial process.

Table 1: First order codes created through manual coding

Name	Files	Reference
Ambition	1	1
Business operations	12	13
Communication	6	6
Competitors	6	6
Conflict resolution	2	2
Decision making	13	19
Department connectedness	13	17
Diversity	1	1
Future career	8	9
Leadership	1	1
Learn from mistakes	5	5
Link to real world	1	1
New knowledge	14	20
Personal attributes	6	7
Problem solving	3	3
Risks	1	1
Strategic management	10	10
Teamwork	25	46
Using prior knowledge	15	17
Working in business	2	3

Table 2: First order codes created through auto coding

Name	Files	References	Number of subcodes
Business	142	289	155
Decision	215	809	203
Group	168	432	151
Individual	153	287	67
Making	158	335	59
Market	103	191	118
Members	193	416	115
Product	115	206	117
Rounds	153	347	85
Simulation	112	219	81
Team	233	945	262
Team members	143	251	53
Work	135	236	101

Each of the primary first order codes created through auto coding contained numerous subcodes as can be seen in Table 2 above. Most of the subcodes were created from identifying a key word either before or after the main code and therefore there was generally only one file and one reference for each of these subcodes. From the codes developed through the auto coding process, a second pass was made to clearly identify those codes that were directly relevant to this study, ie what students learnt through taking the simulation-based course. A series of second-order themes (Table 3) were developed based on the original manual codes as these better reflected the understanding of the author in terms of the data contributing to this study. This was undertaken using the approach suggested by a colleague based on research from Gioia, Corley & Hamilton (2013). At this point data coding was concentrated in the second file based on the auto coded data to achieve the best possible set of data for reporting.

Table 3: Second order themes created from the auto coded data

Name	Files	References	Number of Subcodes
Business operations	71	114	6
Commitment	10	10	0
Competitors	10	10	1
Decision making	41	58	4
Engagement	1	1	0
Enterprise skills	87	172	8
Future career	23	23	0
Knowledge	67	99	5
Mistakes	13	14	2

The themes were finally interrogated to identify the key achievements in student learning through the simulation course and to reflect on how these themes can inform future teaching methods for the author.

Discussion

The themes generated from the coding of the papers have identified eight main areas the students saw as key learnings from taking BDMS. Reviewing the course learning objectives, the themes generated from the student identified learning match with three of these objectives. Although there is no apparent thematic match to course learning objective 3 (Identify key factors in business success), there were comments in the student papers which discussed the success of the simulation. This however was not considered by the students as something that they learnt and as such was not included in the coding at this time.

Table 4: Comparison of Course learning objectives with generated themes

Course Learning Objectives	Student Learning Themes
Analyse the competitive business environment	Competitors
Apply complex business decision-making skills	Decision Making
Identify key factors in business success	*No match after second order coding*
Work autonomously and collaboratively	Enterprise Skills (subtheme Teamwork)

Students identified these learning areas with comments such as:

> *The use of a competitor analysis as an assignment felt real and was a great way to practically demonstrate our understanding of the course content and theory without regurgitating slabs of text. (Student 209)*
>
> *I found that individually, decision making are (sic) more effective and quick to make, while in a team it can take up time to come to a conclusion and stick to that decision… Sometimes making decision individually can be overwhelming due to only one person making the decisions, this could increase the stress levels of them and accidently make the wrong decisions or decisions which are not useful. (Student 003)*
>
> *With working in teams in future I think that if I have an issue about something I should put more effort into coming up with logical reasoning for why I think there is an issue and try harder to explain this to my team members. (Student 012)*
>
> *I have worked in many teams before, both academically and professionally, and walked away from this group assignment both a better team member and a better leader of people. (Student 016)*

In addition to the themes that matched the expected course learning for the student there were other themes which the students saw as significant to the university learning and for their future career.

Table 5: Additional Learning Themes – Student identified

Theme	Subtheme	Sub-subtheme
Business operations	Business decision making	
	Business departments	Department interconnectedness
		Effects of decisions
	Investment	
	Planning	
	Strategy	
Commitment		
Competitors	Competitor analysis	
Engagement		
Enterprise Skills	Communication	
	Conflict resolution	
	Leadership	
	Personal attributes	
	Problem solving	
	Time management	
	Working in diverse context	
Future Career		
Knowledge	Apply existing knowledge	
	Lack of knowledge	
	New knowledge	
	Relying on knowledge	
	Theory not always the best	
Mistakes	Impact of mistakes	
	Learning from mistakes	

The theme of knowledge is an interesting one with many students identifying the ability to apply existing knowledge as a key learning in their taking of this course.

> *Lastly the use of balance sheets and income statements finally became tangible and useful for the first time in my accounting course, to see the projected outcomes and how they would affect each statement was a little exciting and gave a great summary as to our teams decisions regarding things like material, marketing and production of a product and whether that product would produce a profit or loss and how much it was adding to or taking away from our company. (Student 176)*

The ability to learn new knowledge without the actual inclusion of any specific new theory in this course was to the author a very interesting outcome. Students identified that the new knowledge came from working in teams and having their teammates provide them assistance in the areas which were not their discipline specialty. This is particularly true of students who reflected that they were not studying a finance or accounting degree but were able to learn significant amounts around the financial areas and the understanding of financial statements and ratios in this course. This, to the author, is an excellent outcome as in other courses it is not often the case that students help co-create the knowledge for themselves; it is normally disseminated from the lecturer or course coordinator. This outcome is supported by the research undertaken by Lohmann et al (2018, p. 11) who commented that 'overwhelmingly, students found that the teamwork enhanced their learning and problem-solving'.

> *I learned a lot about the business world, including: competitor analysis, demand, forecasting and finance (I know about stocks now!). (Student 230)*
>
> *But overall, I think we have nice performance on the team, and I am not good at finance part which I got help by the teammate a lot, so I know more about the way to manage a company in a unique way. (Student 062)*

Fearon et al (2019) identified a clear link between student involvement in business simulations and the development of employability or enterprise skills coinciding with the outcomes reported by the students from this study. The theme of enterprise skills, which was derived through the nVivo analysis, matches with the UniSA Business School's recently developed Enterprise Skills program (UniSA 2018). UniSA is a leader in the field of graduate quality development being the first University in Australia to embed these qualities into their programs back in 1991. The Enterprise Skills program is a step forward from UniSA's graduate qualities with considerable research and collaboration being undertaken with industry partners to determine the skills that are needed by today's graduates. The fact that students acknowledged that these learnings were being achieved from within this course and that they relate to their future career (another theme identified) are an excellent outcome from this study.

In a face-to-face environment, even though the simulation is undertaken using digital resources, communication became a key for students key learning for students and this was an unintended outcome as it is not part of the key learning outcomes for the course. It is obvious from their reflections that students found the ability to work together helped with the improvement in their communication skills particularly those skills of listening and patience.

> *We have been taught how to communicate, listen and incorporate others ideas and in business decision making simulation course we got the opportunity to work and make decision within groups. (Student 234)*

> *I think that listening to others ideas is something that I need to work on because I know at times I can be controlling and like to have things done my way, but when working in a team it is important to consider and listen to everyone's ideas. (Student 004)*

Appendix 1 presents the major themes identified through the research with primary statements from the study that support the themes.

Conclusion

This paper has identified that the inclusion of authentic learning environments, in this instance the use of a business simulation, has achieved significant learning for the students from their perspective. One of the key outcomes is the success of the development of enterprise skills such as communication, teamwork, decision making, problem solving, conflict management and leadership. This supports claims from research, for example Ornellas, Falkner & Stalbrandt (2019, p. 118) who report that authentic learning tasks and assessments enhance the development of transferrable skills.

Students self-reported achievement of three of the four course learning objectives whilst additionally noting learning in several other areas, notably applying existing knowledge, new knowledge from peers and learning about business practices for their future careers.

This paper will now lead to further analysis of the complete data set with additional themes to be identified, not purely around student learning, as well as conducting research into any links between student self-reported learning and the results achieved in the group and individual simulations.

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Appendix 1 – Student statements supporting themes

Table 6: Summary of major themes and student supporting statements

Theme	Supporting statements
Business Operations	*This course is a good real-life subject to teach you a lot of things to be aware of when it comes to making real-life decisions in the workplace, even though I do not want to start a business myself, I would like to work as a business analyst and this subject has taught me a lot of things to be aware of as to what matters, analysing competitors and the products to work, focus on, the age and reliability.(Student 066)*
Department Interconnectedness	I learnt a lot from this course, even though I am already in a managerial position I gained more knowledge regarding how certain decisions can affect the other parts of the business and not just the manufacturing business unit. (Student 016) *I would definitely say most of my learning centred around the functions of a business, and how different decisions affected different areas of the profitability of the business in different ways. (Student 017)*
Business decision making	I believe this course has prepared me for what the business world will be like outside of university, including all of the decisions that come with running your own business. (Student 208)
Competitor analysis	*I also learnt how important it is to survey what the competitors are doing and form strategies based on likely decisions made by them. (Student 008)*
Communication	By participating in this class and being put in a group for this project, I have learned how to communicate effectively with other team members under business situations. (Student 144)
Conflict resolution	*Conflict resolution is another useful skill that I have learnt when working as a team. (Student 172)*
Leadership	…as a management student I need to learn to work and deal with all colleagues and students and what I have learnt by doing this course is that leadership skills needs to be applied across all situations. (Student 185)
Personal attributes	*You have an advantage by participating in capsim, because you could learn if you are a risk-taker, team player, if you like the business setting, and if you can handle the pressure that comes with running a business. (Student 151)*
Problem solving	Moving forward, I have taken from this course the ability to develop my analytical skills, forecasting skills and enhanced my strategic planning understanding. (Student 237)
Time management	*Due to the course being intensive and all rounds running to a time schedule I also learned how to make quick informed decisions and improve my current time management skills. (Student 213)*
Working in diverse context	I believe that the success of the group largely was dependent on diversity; I enjoyed working in my team because there was a researcher that had a realist point of view a HR/marketing person who had an optimist point of view and me a figures person who has a reasonable/conservative point of view. (Student 007)
Apply existing knowledge	*From this course I was able to use the marketing theories that I have learnt, such as; always targeting a broader market, not targeting a particular market as it will exclude potential buyers. (Student 005)* There were a lot of terms that I knew from previous courses but did not really understand in a business setting. (Student 024)
Lack of knowledge	*It was remiss of me to exclude myself in some decision making processes on the ground that I do not have the necessary knowledge in the relevant area such as finance. (Student 002)*
New knowledge	Outside of theories and academic learning, I learnt a lot about conducting business with others, the importance of individual team members strengths as well as the need for individual motivation along with team motivation to succeed. (Student 136)
Impact of mistakes	*The key area I learned the most in is how a small mistake or rushed decision can cause a huge impact across a whole business. (Student 032)*
Learning from mistakes	In some situations I decided to take a step back from decision making and allow mistakes to be made, this then meant that the other team members were able to learn from the mistakes. (Student 008)

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The challenge of learning analytics implementation: lessons learned

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Despite broad interest in learning analytics across the Australian Higher Education sector, there remains few examples of institution-wide implementations. Learning analytics implementation is currently under-theorised with little knowledge of the complexities that mediate the systemic uptake required for an institution-wide implementation. It has been established that approaches to learning analytics that are exclusively top-down or bottom-up, are insufficient for successful implementation across an enterprise. Drawing upon an award-winning and institution-wide learning analytics intervention that has been used across almost 5,000 unit offerings, this paper formulates an initial set of theory informed design principles that can help learning analytics practitioners mediate the complexities of institution-wide implementation.

Keywords: learning analytics, complexity, action design research, sensemaking, situation awareness, feral information systems, design principles, emergence

Introduction

Despite sector-wide interest in learning analytics, there are currently few institution-wide deployments at scale (Dawson et al., 2018; Ferguson et al., 2014). The deficit of whole-of-institution implementations continues to deny the sector a comprehensive understanding of the complexity of issues that mediate systemic uptake of learning analytics across an enterprise (Dawson, Mirriahi, & Gasevic, 2015). The same deficit applies to the theories and methodological approaches required for learning analytics implementation in real-world environments. Knowing what works, or otherwise, and why, provides potentially valuable generalisations or abstractions that can inform future learning analytics implementations. A team at a regional Australian university has been researching and experimenting with learning analytics for over 10 years and has developed an institution-wide learning analytics system. For deidentification purposes, the system that was developed will be called System X throughout this study. System X was developed by the team during 2014, has been used in 63% of the university's offerings, and has facilitated communications with almost 90% of the university's higher education students. While System X is a rare example of an institution-wide learning analytics implementation, its life beyond implementation has been beset with organisation-related challenges. Reflecting upon the design, development and operation phases of a learning analytics implementation like System X can provide valuable insights, which can contribute to a theory of implementation (Marabelli & Galliers, 2017; Sanders & George, 2017). This is especially important for learning analytics where successful, institution-wide implementations are currently rare.

Learning analytics is a field of research and practice that is relatively new and still evolving (Colvin, Dawson, Wade, & Gasevic, 2017). While there are many examples of theory-informed, empirical research around learning analytics, there is a shortfall of theoretical knowledge for how learning analytics can be operationalised in a given situation (Wise & Shaffer, 2015). Theory provides the learning analytics practitioners with guidance on the variables to include in their models, how to interpret their results, how to make the results actionable and how to evaluate their work (Wise & Shaffer, 2015). The current shortfall of theory in the learning analytics literature around design and action prohibits the broad recipes and principles that can help solve problems in specific contexts (Colvin et al., 2015). Theories for design and action are needed to provide "explicit prescriptions for how to design and develop an artefact, whether it is a technological product or a managerial intervention" (Gregor & Jones, 2007, p. 313). In addition to the absence of theory around implementation, there is a proliferation of commercially available learning analytics tools that are marketed as institution-wide solutions to complex problems related to learning and teaching (Dawson et al., 2015). In a vacuum of theoretical knowledge that affords informed scepticism, organisations are naturally drawn to solutions marketed as learning analytics (Dawson et al., 2018).

The problem of learning analytics adoption at the organisational level needs to be considered in relation to how these organisations operate, how they conceptualise learning analytics, and the problems they are looking for learning analytics to solve. A recent study identified two classes of universities based on their approach to learning analytics adoption; those that followed an instrumental approach, and those that followed an emergent approach

(Dawson et al., 2018). Instrumental approaches were identified by top-down leadership, large-scale projects with a heavy focus on technological considerations, and were associated with limited staff uptake (Dawson et al., 2018). Emergent approaches were identified by bottom up, strongly consultative processes that proved highly resistant to being scaled to the organisational level (Dawson et al., 2018). While System X's adoption was predominately based on an emergent approach, it was successfully scaled to the institutional level within an organisation with a stated preference for instrumental approaches to technology adoption.

This paper aims to use the journey of System X's development and operation to unpack the theories, methods and heuristics that contributed across its lifecycle to date. It is hoped that the insight into the organisational realities associated with a learning analytics implementation can help universities address the deficit of institution-wide implementations, and help bridge the growing divide between learning analytics research and practice (Colvin et al., 2017; Dawson et al., 2015). This paper develops a design principles that can help learning analytics practitioners within universities employ emergent approaches to learning analytics implementation that can scale to the institutional level. In essence, these principles form a nascent design theory (Gregor, 2006), a type of theory that can be used to guide implementation across a variety of contexts, and can contribute to our theoretical understanding of learning analytics implementation. This paper aims to answer the following research question: What theoretically derived design principles can help practitioners employ an emergent approach to learning analytics implementation?

Methodology

This paper aims to retrospectively analyse an example of the emergent development of learning analytics that scaled to the institutional level. It applies a methodological approach based on Action Design Research (ADR) to determine the theoretical elements that contributed to the design, development and operation of the IT artefact. ADR is a design research method that conceptualises the research process as containing the inseparable and inherently intertwined activities of building the information technology (IT) artefact, intervening in the organisation, and evaluating it concurrently (Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011). ADR is not intended to solve problems as might a software engineer, but to generate design knowledge and reflections by building and evaluating IT artefacts in authentic organisational settings (Sein et al., 2011). ADR removes the sharp distinction between IT artefact development and its use by organisational stakeholders that is often assumed with design research and design thinking (Sein et al., 2011). ADR reflects the premise that IT artefacts are shaped by the organisational context during their development and operation (Sein et al., 2011). Organisational specific structures such as hardware, software, process and policies impact upon, and are subtly ensconced in the development and operation of an IT artefact. That ADR encapsulates the IT artefact within a real-world organisational context establishes an obvious link with learning analytics whereby a primary challenge is how it can be implemented across an organisation. ADR suggests that technological rigor often comes at the expense of organisational relevance and acknowledges that IT artefacts emerge from interactions within the organisational context (Sein et al., 2011).

ADR consists of four broad, non-linear stages. The impetus for the first stage, Problem Formulation, is an identified problem perceived in practice by the researchers, that represents a research opportunity based on existing theories or technologies. The problem is viewed as a knowledge creation opportunity at the intersection of the technological and organisational domains. The second stage of ADR is the building, intervention and evaluation (BIE) stage whereby the problem framing and theoretical elements from stage one provide a platform for generating an IT artefact within an organisational context. The mutual influence of the developing IT artefact and the real-world organisational context is iteratively and concurrently built and evaluated, generating reflections and learnings. The third stage of ADR parallels the first two stages and moves conceptually from building a solution in a specific context, to applying what has been learned to the broader class of problems. Concentrated effort is conducted on what emerges from the evaluation and research processes, ensuring that contributions to knowledge are identified. ADR refers to this process as guided emergence, whereby the external, intentional intervention is brought together with the organic evolution that results from real-world operation (Sein et al., 2011). The fourth and final stage of ADR is the formalised learning that developed from the research process and can be represented by generalised outcomes or principles (Sein et al., 2011).

The intention of the ADR process is not necessarily to solve the problem in its entirety, but to generate knowledge that can be applied to a broader range of problems that the specific problem exemplifies. For this study, the broader class of problem relates to how an emergent approach can be taken with learning analytics implementation, and still scale to the organisational level. This study is using ADR to retrospectively analyse System X. System X's journey has been divided into three chronological sections; explorations, formal development, and operation. Each of these three sections is described according to ADR in terms of each section's problem formulation, BIE, and reflections. Project plans, designer reflections, designer blog posts, project logs, emails and other empirical data sources are drawn upon to inform these sections. Following these three sections, this study will reflect on the theoretical elements that emerge. These theoretical elements and reflections will inform the main contribution of this study, a set of theoretically aligned design principles for learning analytics implementation.

Exploration and serendipity: 2008 – 2014

Problem formulation
While System X was established as a formal university project that officially began in 2014, its genesis was in the five years prior. During this time, the designers were conducting research around learning analytics, exploring patterns found in institutional datasets, and were exploring how these patterns could help understand and respond to learning and teaching related problems (Beer, 2008). How these patterns and data could help with student attrition and student engagement were specific problems the designers were investigating at the time, given a sector wide trend of increasing online enrolments and its negative impact on student retention (Beer, 2010b; Beer, Clark, & Jones, 2010). The designers were part of the central learning and teaching support unit who were tasked with supporting teaching staff with their learning and teaching. This provided the designers with broad perspectives on the problem based on their daily interactions with the teachers. Their perspectives were further informed by their technical knowledge, their experience with local information systems, and their knowledge of institutional policies and processes.

BIE
The System X designers conducted a number of investigations between 2008 and 2014, investigations that included the development of experimental IT artefacts that were applied in real-world contexts (Beer, 2009b, 2009c, 2010a). These investigations were often centered upon patterns found within the data, patterns that required further exploration to determine their usefulness and how they could be applied. A simple and early example was the development of a small artefact that retrospectively showed teachers how online students interacted with their unit sites compared with the grades their students received (Beer, 2009a). In each case the designers worked with teaching staff using informal cycles of evaluation centered upon the interventions. Together with the teachers, the designers were learning what worked, what did not work, and gathering knowledge and experience about why. Variations in student behaviours, the diversity of pedagogical contexts, the different mental models of the teachers, along with large variations in teacher's technical and teaching experience, made it difficult for the designers to distil which data would be useful across all contexts. As the BIE cycles progressed, a common theme emerged from the feedback from academic staff. They wanted simple indicators of student activity in their teaching contexts, and the ability to monitor student activity to determine if the actions the teachers were taking during the term was impacting upon student activity and results (Beer, 2009d). In addition, teachers wanted the data to help them with a range of questions they had about their students depending on their teaching context. These questions included: which students have accessed the LMS site and when; how often are they accessing the LMS site; which students have failed this unit previously; what is their GPA and so on?

During this period, the team's supervisor, a Pro Vice Chancellor (PVC), was coordinating a large undergraduate science unit and asked if the learning analytics activities the designers were engaged with could help with their unit's relatively high failure rate. Using the learnings from the previous BIE cycles, the designers provided the unit coordinator with weekly lists of all students in the unit, arranged by an algorithmically developed estimate of success (EOS). The EOS was a simple algorithm that combined each student's academic history (GPA, prior fails, grades received, withdraw fails) with their current level of Moodle activity as indicated by clicks, and was modeled using previous offerings of this and other units. The unit coordinator used this list to proactively contact students who were showing as being at risk of failing. This process, along with other instructional design changes, contributed to a 7% reduction in the failure rate of the unit over the next two offerings, on top of a small rise in the student satisfaction surveys. The unit coordinator's direct contextual experience and their influential position with the university led to the establishment of a formal, centrally-funded project to develop the concept into an system that could be used by all unit coordinators.

Reflections and learnings
The organisational position of the designers afforded a perspective that was situated between university-wide learning and teaching policies, processes and management, and the learning and teaching coalface. Their roles, their history with technology at the institution, their interest in learning analytics, who they worked for and no small degree of serendipity associated with legacy access to institutional datasets, meant that the designers had access to data, and had the technical skills to manipulate it and represent it in different ways as the situation required. The trial-and-error cycles of development, and the close proximity the designers had with the teachers, led to an understanding of what data could help with what problem, and how it might help. The multiple

perspectives of the designers allowed them to consider the problem in a different manner than would be afforded by a single perspective, such as a software developer for example. The circumstance whereby the team's supervisor held an influential position with the university, and was also teaching a unit with a specific problem, was happenstance, yet pivotal in the establishment of a formal university project to expand on the initial concept.

The rise of the feral system: formal development - 2014

Problem formulation

At the prompting of the PVC, a formal university project began with the associated funding being allocated at the end of 2013. A project initiation document was prepared by the designers where the stated purpose of the overall project was to "help address student attrition by strengthening and focusing the interactions between academics and students" (Reed, Fleming, Beer, & Clark, 2013, p. 3). The broader project had multiple sub-components, one of which was System X, the learning analytics focused project. System X was aimed at helping with "the early identification of students who may be at-risk along with more effective targeting of student support for such students" (Reed et al., 2013, p. 6). A further requirement was added by the PVC who specified that the system needed to be very easy to use with little to no training or guidance required. While earlier explorations provided the designers with some understanding of what was required at the unit level, moving beyond a small scale intervention to an institution-wide IT artefact required a more formal approach due to the required investment in infrastructure, integration with other university systems, and consultation with other university departments. As such, the practical problems faced by the designers during this time was how to scale System X from a handful of units to a university-wide system, and how System X could be integrated with established university systems. These are problems represented in the wider learning analytics literature whereby the transition from small, local learning analytics experimentation, to institutional-wide implementation is known to be difficult (Ferguson et al., 2014).

BIE

The formal development of System X began with the allocation of funding and the fulltime secondment of the three designers. The team of designers consisted of two teaching academics and a graphic designer, who all had web development skills. System X was unusual in the context of information systems procurement, in that it was developed in-house and outside of the information technology (IT) department. The conceptual shift from a small-scale experiment to the institutional scale, while superficially a technical exercise due to the learnings already developed from previous BIE cycles, required cycles of iteration beyond just technical iterations. For example, as staff used and became more experienced with System X, the designers noticed that the feedback staff were providing changed from functionality-related commentary to requests for additional features. As an example of this, an iteration of System X released early in 2014 provided unit coordinators with a mail-merge feature that allowed them to send personalised emails to groups of students. Feedback from unit coordinators suggested that an indication of changes in student behaviour after the email would be useful in terms of assessing the need for a follow up. This indicator was added to the Moodle weekly activity timeline in System X and meant that they could quickly identify changes in student behaviour after the email "nudge". The gradual shift in teacher feedback as they used System X was found to align with previous research that showed staff usage of education systems in general became more refined as they gained experience with the system (Malikowski, Thompson, & Theis, 2006). The iterative approach taken by the designers catered for the reciprocal evolution of both the technology and the human users of the information provided.

Formal and informal consultations, and conversations with schools and discipline teams, contributed to System X's evolutions. Over 20 open discussions were conducted with various departments of the university during the first half of 2014. Each of the ideas presented in these forums were collected by the designers with the intention of incorporating as many as possible in the available time. This was reflected in the underlying modular design of System X where it was designed with an expectation of frequent change. However, the governance requirements associated with a funded institution-wide project often conflicted with the approach the designers employed. Detailed plans, that included specific feature release dates and other detailed outcomes were required upfront, prior to the building process. In the case of System X, the project management framework used by the institution discouraged an evolutionary approach where the next stage of the project was uncertain, dependent on cycles of feedback from the teachers, and not predetermination. For a concept like learning analytics that was very new at that time, the absence of institution-wide implementation examples or recipes required an evolutionary and learning approach. From a methodological perspective, the design phase of System X differed from the exploration phase in that much of the effort became directed to the IT artefact to achieve the required scale and to still support adaptation. However, it could be argued that the approach was more focused on the education intervention as opposed to the IT artefact, as the end-users were still integral to the ongoing design process, and there is evidence of reciprocal shaping whereby the end-users and the IT artefact continued to be shaped by each other.

Reflections and learning
The iterative approach taken with the development of System X supported the emergent development of the intervention where the intervention consisted of both the IT artefact and the end users. The approach allowed the IT artefact and the end users to coevolve as the design was implemented into a complex organisational context. So while the overall project superficially conformed to the mandated top-down, plan-driven approach, the underlying development process was conducted with change and evolution in mind. Adopting a modular design from the outset afforded the ability for the IT artefact to change based on user feedback. The iterative and evolutionary approach also contributed to the problem of scale. Aside from the addition of several hundred units with variables that included pedagogical contexts, student cohorts and teachers, the technical design needed to be flexible enough to enable frequent change. The technical components required to support a flexible, iterative approach and often conflicted with traditional enterprise implementation norms. So while the consultative approach and modular design allowed the IT artefact to adapt with the teachers as they became more experienced with the system, the design was different to IT procurement and architecture norms.

Maintenance and operation: 2015 – 2019

Problem formulation
The formal System X development project finished at the end of 2014 with the designers returning to their substantive positions in the central learning and teaching support unit, signaling the end of the development phase and the start of its maintenance phase. While the team's supervisor had informally indicated System X would continue to be maintained by the designers moving forward, the supervisor's retirement created a new set of unanticipated problems. The idea of an institutional IT system operating outside of the central IT department was unconventional, and associated with a myopic assumption of risk. How System X could continue to operate, never mind evolve, without senior-level advocacy, in an increasingly lean and homogeneous IT environment, became the core problem associated with this phase. This is a problem that links with a broader problem noted in the research literature, associated with issues that arise with systems that are developed outside of central IT departments, systems that are often referred to as shadow systems or feral systems (Behrens & Sedera, 2004; Spierings, Kerr, & Houghton, 2014, 2016).

BIE
While System X was unable to secure funding or workload allocation for maintenance, the designers continued to keep the system operating in its current form in addition to their normal duties. This included a number of non-trivial adaptations that were required to cater for upstream changes that impacted upon System X's data ingestion processes. However, from an ADR perspective, the BIE cycle was severely constrained with the lack of allocated resources, a situation that contrasted with the design intent. Despite this, System X had developed into a tool that continued to prove useful for many teaching staff. At the time of writing System X has been used to view 63% (4,924) of the university's higher education offerings while 39% (3,016) of these offerings used the personalised email (nudge) facility. These nudges were delivered to 89.7% (49,089) of the university's higher education students over this period and usage continues to grow. For example, there were 108,523 nudges delivered in 2014 by 231 teaching staff whereas across 2018, 315,192 nudges were delivered by 429 teachers. A sentiment analysis of 1,208,762 nudge texts has shown that 61% of the nudges were worded positively, 30% used neutral language and 9% were deemed to be negatively worded. This aligns with the design intent whereby System X was not developed as a reliable predictive instrument, but as a tool of positive communication between teachers and students, with a focus on the students most at risk. While the usage of System X continues to grow, its long-term sustainability remains uncertain due to negative perceptions associated with its unorthodox implementation approach.

System X was unable to secure funding for maintenance beyond the end of the development phase. That it was an IT system outside of central IT control, proved to be an irreconcilable hurdle when funding was being sought for basic maintenance. Exacerbating the problem, was tension with the IT department who were concerned with what they considered to be an enterprise system, operating within the organisation, and outside of their direct control. A senior member of the IT department was quoted as saying "*we don't want another repeat of...System X*", referring to the approach taken in System X's development. Ironically, the development approach taken by the design team had previously been recognised with a national learning and teaching award (Australian Office for Learning and Teaching, 2016). The IT department's targets and performance indicators generated a different ontological perspective of System X to that of the designers and the teachers; a different perspective that encapsulates different assumptions about how such work gets done (Ellis & Goodyear, 2019). This demonstrates how an exclusive focus on IT considerations can be incompatible with learning approaches and problem solving in complex environments, when an IT artefact is involved (Macfadyen & Dawson, 2012). While teacher usage of System X continues to grow, the lack of resourcing and investment has prevented its evolution beyond what was available at the end of the design phase, a situation that contrasts with the design intent where a fundamental premise was adaptation and change.

Reflections and learning

Arguably, the approach the designers had taken with the development of System X approximated an emergent BIE cycle when framed with ADR. The primary focus was on solving a problem at the intersection of the users, their learning and teaching context, and the IT artefact. However, from the perspective of normal IT procurement and implementation, the primary consideration is on technical matters relating to the IT artefact (Macfadyen & Dawson, 2012). This created an organisational tension around the IT artefact, a tension that still exists at the time of writing. As learning, teaching and technology become further entwined and interdependent, this creates a problem whereby the focus on the IT artefact, coupled with rigid approaches to implementation, can become divorced from the problem context and the context of the human users, a situation that inherently limits the ability of organisations to adapt to emerging and complex challenges. Imposing one-size-fits-all approaches into changing and increasingly complex learning and teaching contexts makes exploration and implementation of hybrid concepts like learning analytics exceedingly difficult. Learning what works, why and how with learning analytics is unlikely to emerge from rigid, plan-based approaches to implementation. However, the notion that a well-used and reliable system can be considered feral, is represented in the research literature, and was a critical and unanticipated oversight by the design team.

Formalisation of learning

The following section reflects on the design, development and operational phases of System X from a theoretical perspective. This section is an attempt to derive formal learnings from the System X phases into theoretical elements that can be translated into design principles that support emergent approaches to learning analytics implementation.

Bottom-up, middle-out and meso-level practitioners

System X was designed and developed by academic staff, whose roles involved the provision of learning and teaching support to teachers, as well as contributing to policy, processes and learning and teaching systems. The teachers were embedded in the process of System X's development, which helped ensure the process was grounded in the teachers' lived-experience (Beer & Jones, 2014). The designers were able to help the teachers adapt to the new technology, and could also adapt the technology based on its real-world use by the teachers. The designers' roles and position between the top-down and bottom-up allowed them to balance the requirements of the end-users (teachers) and the socio-material requirements of the organisation. This aligns with a theoretical construct known as meso-level practitioners (MLP). Much of the work of implementation with learning and teaching related innovation happens at the meso-level, which sits between small-scale local interactions, and the large scale policy and institutional processes (Hannon, 2013). MLP are well situated to mediate the tension between learning and teaching practice and the ambiguities associated with real-world technology change (Hannon, 2013). For learning analytics implementation, MLP is a theoretical perspective that can help balance the tension between the top-down and the bottom-up; emergent and instrumental. However, the MLP concept requires a blurring of the sharp distinction between traditional organisational boundaries.

Shadow systems

The problems that arose for System X as an institutional-wide system, relate to how it was developed outside of normal IT procurement processes and that it was perceived singularly as an IT system. The lack of funding for maintenance and the tension that developed with the IT department had detrimental impacts on the system. IT systems that are not under the control of an organisation's IT department are often referred to as shadow systems (Spierings et al., 2014; Zimmermann, Rentrop, & Felden, 2014). These are systems that sit outside of the control of IT management and often develop as work-arounds for the deficiencies with existing institutional systems (Spierings et al., 2014; Zimmermann et al., 2014). There are two perspectives on shadow systems in an enterprise environment: On one hand, they introduce innovation into an organisation and allow for flexibility in specific contexts; On the other hand, they increase heterogeneity and complexity (Spierings et al., 2014, 2016; Zimmermann et al., 2014). However, most contemporary universities follow a strategic approach to deciding what work gets done (Jones & Clark, 2014) and shadow systems are generally considered to be an undesirable phenomenon in these environments (Behrens & Sedera, 2004). While shadow systems are often viewed unfavourably, it has been argued that their presence is an indication of a gap between required business workflow and what the sanctioned systems are providing (Spierings et al., 2016). Managers or supervisors can often insulate the shadow systems from the enterprise system proponents who seek to close or suppress the shadow systems (Spierings et al., 2016). With the loss of a key advocate from a senior leadership position, System X was increasingly perceived as a shadow system, as it sat outside centralised IT management. Emergent approaches to learning analytics implementation requires a shared organisational conceptualisation of the process as applied research, rather than a purely IT implementation process.

Complex adaptive systems (CAS)
The evolutionary approach taken in System X's development acknowledged and supported the adaptation of the agents involved. The cyclical approach facilitated the reciprocal shaping of the IT artefact and the teachers, within an organisational context. Plan-based approaches assume that there is sufficient knowledge about how to integrate the technology so that a recipe-based approach can be applied (Hannon, 2013). In the case of an emerging field like learning analytics and in the absence of a critical mass of successful examples, there are currently no recipes to support a deterministic approach. Further to this, top-down and mechanical approaches assume that the system and its agents are stable and unchanging, an assumption that is fundamentally flawed in systems that involve humans (Beer, Jones, & Clark, 2012; Snowden & Boone, 2007). Reconceptualising learning and teaching as a complex system (Beer et al., 2012) or more recently, applying principles of complexity leadership theory (Siemens, Dawson, & Eshleman, 2018), have been presented as theoretical foundations that can guide non-deterministic and emergent learning analytics implementation. Complexity contends that systems involving agents, such as humans, are always changing disproportionately with the non-linear interactions between agents (Boustani et al., 2010; deMattos, Ribeiro Soriano, Miller, & Park, 2012; Plsek & Greenhalgh, 2001). For learning analytics implementation, complex adaptive systems (CAS) theory provides a conceptualisation of the system that describes the interdependency and mutability of the agents and actors operating within the system (Beer et al., 2012; Beer & Lawson, 2016; Dawson et al., 2018). The application of a CAS lens to learning analytics implementation provides a theoretical base for an emergent approach in a socio-technical system that is complexly and unpredictably entangled with other socio-technical systems.

Situation Awareness (SA)
The System X designers struggled to distill the types of data that the teachers required from the incredible volume of data available. Like most organisations, universities are collecting vast volumes of diverse data from their operations. The humans in these environments are exposed to increasing volumes of data which has created a gap between the volume of data being produced and the data that the human needs to achieve their goals (Endsley, 2001). Situation awareness (SA) is a theory that helps to define the data that the human operator needs at a particular time (Endsley, 1995). Visibility over the elements interacting within their environment is crucial for decision-making, particularly as the complexity of our operating environments increases (Endsley, 1995). In essence, situation awareness is the operators internal model of the current state of their environment (Endsley, 2001). In the case of System X and although the designers had access to vast quantities of diverse data that could be provided to the teachers, situation awareness theory suggested limiting the data to key metrics related to the teachers' tasks, and that teachers needed the ability to filter the available information. It is vitally important that learning analytics be tethered to the learning design, and consequently the goals and expectations of the users (Wise, 2014). For learning analytics implementation in data rich university environments, situation awareness provides a theoretical framework and design principles for filtering, focusing and centering the information on the goals of the human operators (Endsley, 2016).

Sensemaking (SM)
System X included the ability for the teachers to take action based on the information they were provided, along with an indicator that could help assess the subsequent impact of the action. Taking action and monitoring for a resultant change is a key property of a theoretical construct known as sensemaking. Sensemaking is the interplay of action and interpretation (Weick, Sutcliffe, & Obstfeld, 2005). The most basic question in sensemaking is "what's going on here?", closely followed by "what do I do next?" (Weick et al., 2005). Sensemaking is about the continual redrafting of an emerging story through cycles of action and interpretation (Weick et al., 2005). In other words, it is not enough to provide teachers with just situation awareness, it needs to be coupled with the ability for them to take action (Jones, Beer, & Clark, 2013). The ability for teachers to take action based on learning analytics data, can often be overlooked in the face of increasingly sophisticated and attractive data analysis and visualisation tools. However, sensemaking is a critical diagnostic process that allows us to develop plausible interpretations when faced with ambiguous cues (Weick, 2012). These plausible interpretations are coupled with actions where the results further refine our understanding in a cyclical process. As learning environments and student lives become more complex and busy, our ability to make sense of situations based on what can only ever be fragmented information, is becoming increasingly important. This would suggest that the provision of near real-time information that augments the humans operators, coupled with the ability to take action, is a more appropriate starting point than detailed statistical analysis and sophisticated predictive modeling (Liu, Bartimote-

Aufflick, Pardo, & Bridgeman, 2017). For learning analytics implementation, sensemaking provides a theoretical framework for the taking of action based on near real-time and incomplete information.

Design Principles

Design principles are intended to be reusable, evidence-based heuristics that can inform future development and implementation decisions across contexts (Herrington, McKenney, Reeves, & Oliver, 2007). However, learning analytics is a diverse field and its purpose will be driven by the context in which it is applied. Variations in pedagogical intent, learning design, available organisational technology, staff capability and capacity will influence the design, development and operation of the learning analytics systems (Wise, 2014). Similar to the learning analytics concept, design principles for learning analytics implementation cannot be everything for everyone. Instead, this study is proposing a set of initial design principles for meso-level practitioners engaged in learning analytics implementation, where the design principles are empirically derived and theory-informed.

The following principles are intended as an initial starting point for meso-level practitioners engaging in learning analytics implementation in higher education and represent the embarkation point of a longer journey. The concept of meso-level practitioners and the following design principles can potentially help bridge the divide between the current polarized approach that learning analytics implementations tend to take. These design principles offer a model of compromise that may help bridge these seemingly incompatible approaches to learning analytics implementation. Applying these principles in real-world contexts will refute or refine the principles and determine their applicability across multiple contexts. The application of these principles will also provide guidance on another under-theorised area of learning analytics, how to design the actual learning analytics artefact.

Table 1. Design principles

Principle	Description	Theory
Balance top-down and bottom up	Learning analytics implementation requires an emergent approach that balances top-down and bottom-up requirements and considerations. Balancing the ambiguities of the teachers' lived experience with the organisational requirement for homogenization is the role of the meso-level practitioner.	MLP
Balance the socio-technical	Meaningful learning analytics requires equitable and contextual consideration of both the users and the technology. Recognise that effective learning analytics results from the complex interplay between humans, technology and context.	MLP
Consider learning analytics implementation to be applied research	Learning analytics implementation is a process of discovering what works, or otherwise, and why, in specific contexts. The objective is not to build an IT system, but to iteratively and methodically develop knowledge about what information the users require.	Shadow Systems, SA
Allow for emergence	Outcomes from the learning analytics process emerge from complex interactions between humans, technology and information. Design for, expect and facilitate change.	CAS
Apply informed skepticism	Detailed plans, deterministic approaches and assumptions of certainty are incompatible with the complexities of learning analytics implementation.	CAS
Centre the learning analytics information around tasks and goals	Filter information to just what is needed to support specific tasks and goals in specific contexts. Resist the urge to provide additional information just because you can, or it is easy to do.	SA
Link learning analytics with action	Provide affordances for action. Information and action are inseparable. Understanding in complex environments results from the combination of information and the taking of action.	SM
Apply purpose-specific, theory-informed evidence-based practice	The purpose of specific learning analytics implementations will have related theoretical underpinnings that can help inform the implementation. Theory provides the implementation with guidance on a range of important functions including variable selection, model selection, data selection, result discrimination, result interpretation, actionable results and generalisability of results (Wise & Shaffer, 2015).	General

Conclusion

The experience provided by System X comes at an opportune time for Higher Education with many universities looking to learning analytics to help solve complex problems. In many, if not most of these cases, overly simplistic conceptualisations and mechanical approaches to implementation will limit the potential benefits in the longer term. Reconceptualising learning analytics implementation as cross-institutional applied research can help bridge the growing divide between learning analytics research and real-world practice, and lead to meaningful learning analytics implementations. Learning analytics is a relatively new concept in Australian Higher Education and the reality of real-world implementation is proving to be difficult and complex. Reframing our ontological conceptualisations of learning analytics implementation from the design of IT products, to the co-design of a service that integrates IT and people, is a vast and under-acknowledged challenge that has been recognised more broadly (Ellis & Goodyear, 2019). The design principles developed by this study provide an initial starting point that can help universities develop more meaningful learning analytics implementations through emergent development approaches.

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In the Village: Enabling transformative and student led engagement with social science making through the design of technology rich learning spaces

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Learning through making has emerged as a critical form of pedagogy in the digital era of higher education, supporting active learning, students as co-creators and co-designers of their own learning and accessible forms of experiential education. Much of the existing literature and practice in making focuses on how to embed maker pedagogy within STEM fields and arts and media practice. This paper will explore the unique nature of making in social science education and role of technology rich spaces that were designed and deployed at the London School of Economics and Political Science in the United Kingdom played in supporting students to engage in social science making connected to assessment, teaching and as ways of navigating their own pathways through and inside their own village of learning spaces.

Keywords: Learning spaces, making, social science education

Introduction

Making has emerged as a form of critical pedagogy that supports active and participatory learning in higher education environments through the construction and sharing of something produced or created, often located in technology rich spaces (Blikstein, 2018; Bullock & Sator, 2015; Cohen, Huprich, Jones, & Smith, 2017). Many universities are investing in makerspaces and digital labs, supported by technology-led pedagogical innovations that can be used to connect students within and between disciplines, facilitating making and inspiring creative approaches to thinking by using digital technologies (such as 3D printers and drones) and more traditional maker forms and tools (such as Lego, DIY art or crafting) (Barrett et al., 2015; Moorefield-Lang, 2014; Thomas, 2018). The commonalities between the development and design of makerspaces and making as a form of teaching, learning and assessment are well explored in the literature on STEM education, both at University level and within secondary and primary schools (Barniskis, 2014; Barton, Tan, & Greenberg, 2016; Kalil, 2013). In the social science education literature, making as a form of pedagogy is a nascent concept often aligned with the pedagogical notions of student co-construction and students as producers (SAP) as opposed to the more constructivist, physical or experiential approaches inherent in STEM education (Gerodetti & Nixon, 2014; Neary, 2014). Whilst much of the technology located within makerspaces in academic libraries (such as workstations, audio and vide editing and gaming) can be used for social science making, the pedagogical focus has been on the role of that technology to better engage in tinkering and experimentation, transitions from consumer to producer and the development of technical skills in using devices such as 3D printers (Burke, 2015). How do spaces for learning and teaching in social science education support making pedagogies over and above the support of technological interventions and facilitation? Can the opportunities afforded by making pedagogies (and the spaces the are located and immersed in) go beyond the use of media and technology to facilitate creativity and tinkering to engage with an expanded understanding of making, one that is located within social science curricula and learning outcomes?

Located within the context of scaling and sustaining an award-winning portfolio of SAP projects at the London School of Economics and Political Science in the United Kingdom, this paper exposes some of the complexities of using spaces, technology and social media to support and enhance student and staff capabilities to engage in the definition and deployment of social science making pedagogies. It will use case studies of two spaces that (in part) work towards defining the requirements and conditions supporting social science making as a pedagogical practice as well as explore how singular spaces such as makerspaces present challenged notions of permission, belonging and facilitation in the context of some of the abstract notions underpinning social science making pedagogies and how collective, integrated spaces (the village) might better engage students with the organic, exploratory and contested activities of making.

Locating making as a practice

Making is a relatively generic term that has multiple meanings across several disciplines and fields of study (including arts and media, science, education and sociology). Lande (2013) argues that making is a connected series of acts ranging from building to the process of turning parts into an object, aligning making (as a process) with the sense of creativity and fun it engenders for the maker. Britton (2012) adds to this by arguing that institutions can support learning by '….creating playful information-based spaces [that] allow the learner to explore and engage with content on the learner's terms instead of on the instructor's terms.' Several writers have extended the conceptual definition of making to include cognitive processes such as thinking, analysing and creativity (e.g. Bratich & Brush, 2011; Gauntlett, 2013; Orton-Johnson, 2014; Ratto & Boler, 2014), whilst others have located making within more traditional activities such as construction, production, prototyping and tinkering (Bevan, 2017; Lock, da Rosa dos Santos, Hollohan, & Becker, 2018). Making has also been described as an attitudinal state linking practices and skills to wider notions of citizenship, participation and engagement (Ratto & Boler, 2014). Orton-Johnson (2014) makes the case that making is essentially a socially networked and connected practice that informs the wider engagement of the community through participating as a citizen. Making something extends the role of the maker past that of a consumer, affording them the opportunity to engage 'passionately' with the field or form (Dougherty, 2012).

The social capacity afforded by making has been significantly enhanced by technology and social media. The application of these technologies to facilitate and support the formation of DIY communities has blurred the lines between DIY making and social media practices such as the sharing and making of user-generated content (Lingel & Naaman, 2012). Henry Jenkins in his extensive writing on modern making culture argues that made culture is not a singular act, ending with the production of an artefact or shareable product. Across a number of studies on participatory culture (Jenkins & Ito, 2015; Jenkins, Purushotma, Weigel, Clinton, & Robison, 2009) he argues that DIY making is an inherently social process that includes social practices such as the sharing of culture, lived experiences, play and bricolage. Even in the context of the physical acts of making, he argues that sociality in the form of networked and connected engagement, for example the remixing and repurposing of existing cultural forms, defines making in the digital age:

> …the power of participation comes not from destroying commercial culture but from writing over it, modding it, amending it, expanding it, adding greater diversity of perspective, and then recirculating it, feeding it back into the mainstream media. (Jenkins, 2006, p. 257)

By including making practices such as re-mixing, modifying, amending and re-purposing into DIY making, Jenkins incorporates social processes that draw directly on the creative work of others (not just the replication of those works) to make something new.(Jenkins, 2006, 2009; Jenkins, Ford, & Green, 2013). This extension of making to include challenging, reinterpreting, re-using physically (objects and media) and conceptually (perspective and ideation)

Students as producers at the London School of Economics

The London School of Economics and Political Science (LSE) is one of the world's leading social science institutions with undergraduate and postgraduate programs specialising in disciplines across the spectrum of social science education from management and accounting, through government and politics and anthropology and sociology (with mathematics, statistics and philosophy in between). Before 2015, much of the teaching and learning at the School was delivered in traditional lecture/tutorial format and assessed through high stakes final examinations. As part of the Schools strategy for enhancing the student teaching and learning experience, a program of pedagogical interventions that engaged students actively in learning and provided opportunities for them to work together was launched in 2015/16. The aim of this program was to encourage students to build connections with colleagues and to enhance their capacities to both challenge and repurpose the knowledge they were learning. A critical component of this was program was the Students as Producers (SAP) initiative which was designed to transform the student experience from one that was primarily didactic to one that prepared the learner for the challenges of work and practice and engaged them actively in their own learning. Students were supported through learning and engaged through assessment to acquire and apply skills in communication, collaboration, problem solving and digital literacy to specific discipline-based contexts. These skills enhanced their capability to learn and inhabit the identity of emerging professionals and practitioners located within their discipline, through face-to face teaching and assessment supported by an authentic experience rooted in social science making practices. SAP was a multi-faceted project that had four main streams of activity, each designed to deliver the objective of enhancing learning, teaching and assessment through student co-creation in different ways;

1. **Pedagogical innovations in making**. Using a series of grants, the School supported twenty projects between 2014-2018 that included transforming assessment using methodological approaches such as documentary film making and media production, telling urban stories in Geography, podcasts for

students, the development of an undergraduate student led research journal and supported PHD students to make games for and with their undergraduate colleagues.

2. **Digital Storytelling.** This stream of activity generated student produced media across variety of platforms, both inside and outside the classroom, including projects to support the digital literacy of new students, and help students develop better digital and professional identities through posters, undergraduate research, blog posts, YouTube videos and participatory events. This stream supported the LSE2020 project where the stories and learning experiences of nearly 300 students were collected and shared via video (made by and for alumni and students).

3. **Creative hub**. The School built a hub of students and young professionals to work with programme teams and students to enhance their Moodle presence, to build skills around media making and design, and to work to enhance the quality of our learning spaces through interactive artworks, linked to technology and learning.

4. **Students as researchers**. The School developed a number of research projects that used students or recent graduates as research leads in projects ranging from learning analytics, student voice and satisfaction projects, program evaluation and learning spaces research. These projects were shared publicly and presented by these students at the School and at conferences

This paper will focus primarily on the first two streams of activity (although some of the data used emerged from activities undertaken in the other two streams). In the context of scaling the original small cohort pilots into larger units of study hat impacted more students, we began to think about the importance of spaces to support at a practical level how we scaled these projects. For example, one pilot project supported 20 students to make documentary films. We were able to hack office space to become makeshift editing, collaboration and sound studios using a combination of furniture, some professional equipment and domestic technological infrastructure. When the project doubled in size, these spaces were insufficient, and their pedagogical limitations were exposed. The spaces also only addressed the direct media-making requirements of the project, and forced students to find other spaces to do the rest of the making and learning required to complete the assessments (planning, rehearsing, interviewing, collaboration and problem-solving). Most of the learning spaces at the School were designed as study rooms, generally individual with a limited amount of collaborative 'group study' space. They were not technology rich but were densely utilised, especially at assessment crunch points. One of the design intentions of a School-wide evaluation and redesign of learning and teaching spaces was to support and enhance the capacity for our students to engage in social science making collaboratively and to identify ways through which our students could share their making with others.

Defining social science making and the critical role of space

From a practical level, the School was faced with a shortage of spaces to make and show media, to record film and sound in controlled environments and to work collectively on making projects, both from the teaching side and the student engagement perspective. There were only limited spaces in the library primarily for students to engage with each other to debate and discuss social science challenges or pernicious questions. Students were not actively encouraged to work in groups or form communities in many of their units of study and the physical learning spaces reflected this dominant pedagogy, dominated by single seat desks, bean bags and quiet study environments which made finding collaborative and creative physical spaces difficult, This moved much of the interaction required for these units into virtual spaces such as Google Docs, WhatsApp and Facebook, all of which were in the direct control of the students themselves (Liote & Axe, 2016). It also left the University owned virtual spaces such as Moodle and library systems to serve as facilitators of academic compliance (assessment submission, referencing etc).

Pedagogically, the challenge of supporting and encouraging making in our spaces was a more abstract one. We first had to address the question; how was making represented in the teaching of social sciences, which is often theoretical, conceptual or socially constructivist? Making as a pedagogy can be demonstrable and visible within physical activities such as constructing prototypes, art, craft, artefacts etc (Hynes & Hynes, 2018) or in the form of coding for gaming, robotics or machine learning (Hsu, Baldwin, & Ching, 2017). These types of making whilst capable of being applied to learning social science disciplines do not reside naturally within their epistemological frames. As we engaged in evaluations of the pedagogical impacts of the SAP projects, different forms of making began to emerge. Located within the more intellectual aspects of social science education, our students learnt through making at a conceptual and ontological level. At a practical level, they were engaged in making documentary films as part of their assessment in visual international politics, which were shared with the community of and cultures they were chronicling through various media sharing social media. Through tour evaluation of the SAP projects we began to observe different forms of making that were manifest in processes such as debate between competing positions on critical problems, theory development and challenge, digital storytelling and student-led ethnography and collaborative problem solving. Supporting how students engaged in these forms of making outside the classroom and in the time and spaces they used for self-study, groupwork and assessment presented challenges, such as the increasing inappropriateness of the dominance of single seat study spaces and quiet areas. The challenge for the School was to design learning spaces that facilitated, both physically and technologically, these emergent forms of social science making so that students felt they were provided with the support and encouragement to engage and participate collaboratively.

Experiment 1 - The Rotunda Learning Spaces

Picture 1: Rotunda Learning Spaces – Clement House LSE, London, UK

Occupying a previously underutilised void space in a stairwell in the busiest teaching building of the School (Clement House), the Rotunda Learning Spaces (RLS) project is comprised of six learning spaces, designed for between 4-8 students each. The RLS had to be discipline agnostic, supporting the learning practices of students studying in multiple disciplines, all of which densely used this building. The spaces were commissioned on a very small budget with no architectural design input. From the earliest stage of ideation, the RLS were envisaged to be pilot spaces for different modes of learning not supported at the School. Picture 1 shows two examples of the six new spaces. The first (left) included small group work and theory development which was supported by moving laptop desks, interactive whiteboards and moveable seats. Another example (right) was the multimedia making space, with fixed computers designed for both casual use but also in the medium term, for use as editing computers for video. These two spaces were supported by four other pods of collaborative furniture, writable surfaces and power, located within bright, lush, open and well-light spaces all thematically aligned to global cities. On two lower floors, large TV screens were installed in high traffic areas outside classrooms to share student made media, documentaries and animations with students waiting between classes.

It was not an explicit design outcome to support the kinds of social science making that we had begun to observe in our SAP projects (although the TV screens were added to support dissemination of these projects more widely). In order to better uderts and whether the spaces were delivering on the design intention, we conducted a post-occupancy evaluation of the spaces, comprising of 174 combined responses collected through surveys and structured short interviews with students using the spaces and 67 observations of the learning spaces. The RLS were very popular with students (over 80% of students said they used the spaces regularly) and were recognised as unique spaces for study that were a positive and welcoming site for learning. We observed that, despite the fact that they could be used for the same single student study that represent the dominant pedagogy across the School, they were often hacked by the students. Chairs were moved into circles or groups (Wilson, Roger, & Ney, 2017). The whiteboards were always filled with equations, problem solving diagrams or allocations of group work. Some students wanted to use more of these collaborative making tools but did know if they had ‘permission’ to do, as whiteboards were perceived as the tools of teachers. Equally some of the more complex technological tools for collaboration (such as interactive whiteboards) needed both permission and explicit instructions on how to use them. It was interesting to note that whilst we ran several instruction sessions for the spaces, they were generally poorly attended. Our analysis indicated that students wanted a sense of ownership to make in the space or to break it for their purposes and felt that because it was a teaching building that they did not have that permission. The sense of public visibility that rose from having your making shared by leaving it on the board, or allowing your documentary being shown to passing students or by leaving books or papers on the table, or copies of their edited media on the desktop was perhaps a way of students stamping ownership on the spaces in non-identifiable ways.

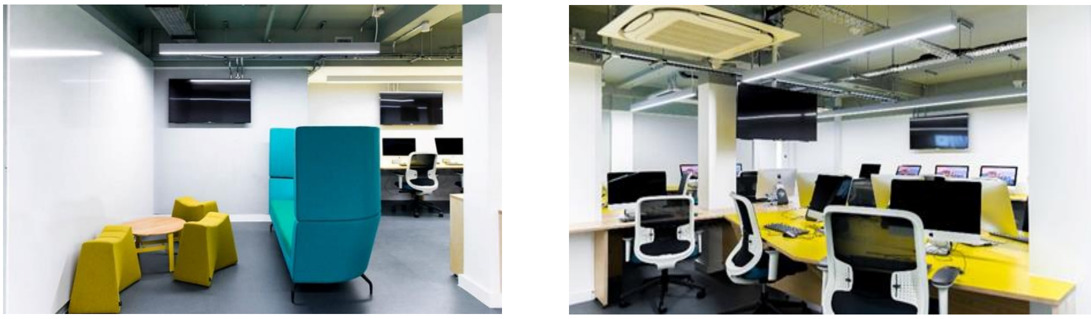
Whilst the occupancy levels of the spaces were extremely high (between 80-90% during peak traffic times), the students were only observed in conversation in less than 15% of those times (which could also be a conformation bias issue in that because they were being observed, they chose to ‘behave’). The behavioural aspects of the dissonance of experience and usage was a critical insight for the design team. We wanted to try and support collaborative practices outside of closed group study rooms and to signal permission that these spaces could be used for those purposes using technology and furniture. Student however seemed bound by behavioural tropes (such as being quiet in spaces) that had evolved through experience and mirroring the behaviours of others around them. Even though this building was one of the most trafficked sites on campus with thousands of students entering and exiting rooms on the hour, the students still engaged in quiet, contemplative refuge in these sites, even when working together, sometimes resorting to whispered or more intimate engagement (hence the chairs being moved together and the relatively low level of satisfaction with usability of the furniture that could not be moved more closely together).

What was present in many of observations was that when making was happening it was discourse driven, learning centred and initiated by the student. We did not tell them to start making, nor did the spaces give explicit instruction to engage in making (in the main they happened later at night or after we had been there undertaking observations). The students used the space to engage in the making practices that helped their learning. Making in this context was both individual and collective. It was in part aligned with problem identification and with the making of a solution. It left the design team with some significant further challenges for the next project. How could the School overcome the dominant (almost expected) behaviours of learning in University owned spaces in order to signal that collaboration and making is encouraged?

Picture 2: Students engaging in making in the Rotunda Learning Spaces (shared via Instagram)

Experiment 2 - The Hive Studio

In 2016, the design team was asked to develop and design a technology rich space in an underutilised computer room in a windowless basement. We approached the design process with a clear intention to develop a space where making was more explicitly facilitated and actively encouraged. We also wanted to change the nature of computer rooms spaces which from two previous projects where we had observed to be quiet spaces which could generate tension and sometimes outright conflict between students who ‘camped’ at computers even when away from the keyboard or who actively chastised other students who made noise. This is a common behavioural trope in many quiet study spaces such as libraries (Bedwell & Banks, 2013; Regalado & Smale, 2015). The starting point for this design was to provide more spaces for social science making and to encourage students to unlearn the learned behaviours of studying in quiet and individual spaces. The end result was the Hive Studio, the School’s first ‘loud’ computer room, where talking and sounds from media making and collaboration were encouraged and not behaviourally frowned upon. Learning from the RLS, we actively signalled that talking and group work was ‘allowed’ in the space both using technology and putting the lounge and whiteboards in the centre of the room.



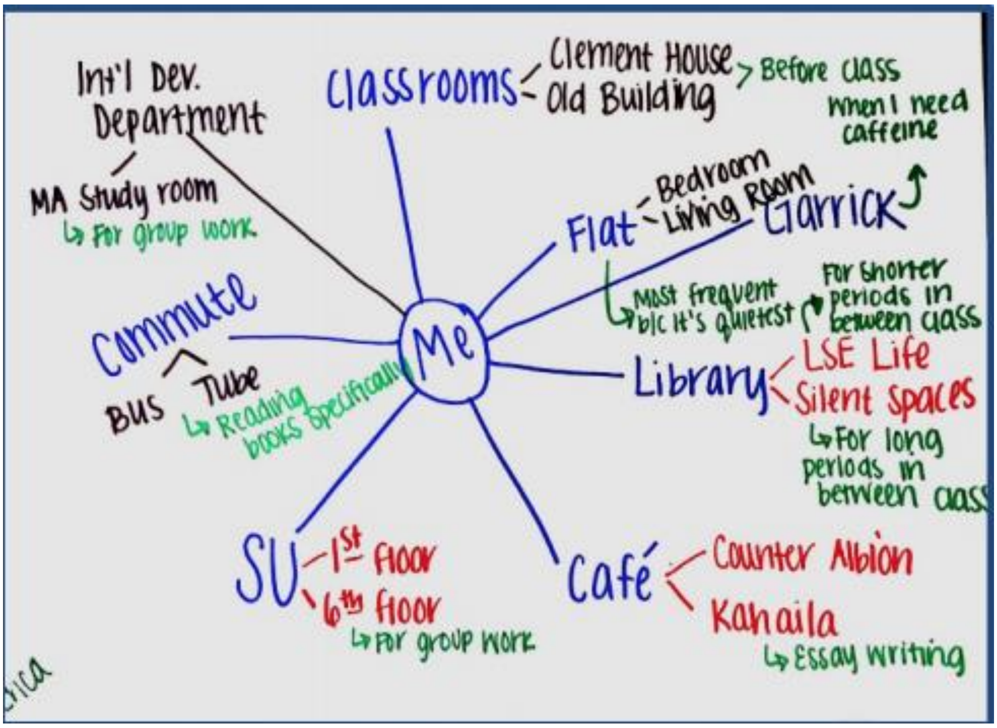
Picture 3 – The Hive Studio, showing collaborative screen sharing (left) and writable problem-solving booth (right)

The space featured multiple ways of supporting social science making, from the capacity to make and edit media on high-spec editing Macs, through to screen sharing in pods of computer (see Picture 3 – left). The space also supported more physical ways of making through in the form of problem-solving booths inside and outside the room. There were writable surfaces everywhere in the space, including behind the computers. Aesthetically, we drew on the design of co-working spaces (lights, exposed industrial ceiling etc) to signal to students that this was not a normal computer room. The colours of the furniture and room thematically linked the room and the kind of activity we were foreshadowing by calling the space ‘The Hive Studio”. In the early post-occupancy observations, we did not see evidence that the loud nature was being subverted, however as with the RLS the technology that was introduced was underutilised, resulting from either a reticence to use it or a lack of understanding that it was there or how it was used. That permission to use the tools of making was less difficult to give around the writable surfaces as the addition of magnetic marker holders seemed sufficient to enable students to use these tools. The same could not be said for kit like the collaborative screens.

Conclusion – Navigating the Village

These experiments represent just two examples of nearly twenty spaces designed by the design team at the LSE over the last four years that have challenged the dominant learning pedagogy of singular and individualised study, aligned with a commensurate strategic approach to assessment diversification across the School. These experiments in the design and delivery of learning spaces were deliberately open in how they defined making, but more prescriptive in their intention to shifts the ways in which students studied on the campus. Most of the experiences described in the literature on makerspaces in universities argued that these spaces centralised and located making with technology or tool rich environments. Putting the makerspace in the library can signal to students that making is an intrinsic part of the study process, located exclusive of the discipline specificity of classrooms and department spaces (Moorefield-Lang, 2014; Shapiro, 2016).

One of the key insights that emerged from the RLS project was that students occupied a suite of spaces in and around the School for different study, social and learning practices, some of which were physical and others of which hybridised physical and virtual spaces (such as the use of the Virtual Learning Environment or social media). The RLS and Hive Studio spaces were part of their journey in and around the campus, stopping at different sites for convenience, for purpose, for availability or for habitual reasons. During the RLS interviews we were able to map these spaces across an undefined study period for the students who participated. *Picture 4* shows how one student mapped this village approach to their use of spaces, which shows how they travelled between their home, their commute, and into their time spent on or around the campus. These village maps showed that students, when faced with critical assessment, study or even learning challenges, developed strategic and pragmatic approaches to how they responded to those challenges. They used technology to bridge gaps in both access and capability, they identified conditions and environments within spaces to support a range of activities and most critically, the taught themselves how to engage in learning through making. What was also apparent in that students did more than do their University work in these spaces. They socialised, they maintained their networks and connections and they engaged in reading and watching behaviours not related to being a student at the LSE.



Picture 4: Mapping learning spaces across the School (Wilson et al., 2017)

Technology (and specifically their own technology such as mobile devices, laptops and social media accounts and platforms) were critical navigators and enablers of learning within their own self-styled village, bringing making and connections into virtual and physical spaces alike. One student described how she navigated her learning journey (which touched on some of the aspects of social science making) using technology:

> For my studies I use my smartphone. For the majority of it it's my laptop. I look at readings on my laptop. I take notes on my laptop. Sometimes side by side I'll have the readings, the pages I'm taking notes on concurrently so I can switch back and forth very easily. If I want supplemental information, I can very easily Google up certain things I might have questions about or articles I might immediately relate to any theoretical concepts that I am studying or practical studies that I'm looking at the supporter, or how to degrade it. I also use Facebook when I see a particularly interesting concept that either makes me mad, is quite controversial or I really agree with or something that I'm trying to puzzle out. So, I will reach out to social media and ask my friends, okay what do you think about this? Do you agree with this? Where do you think this might be wrong or where do you think it's strengths are or how controversial the statements are, how they are wrong in all the wrong ways
>
> (Student from the LSE2020 project (cited in Liote & Axe, 2016)

The disaggregation of learning across many spaces located in the bounds of the village of one challenges some of the notions of the importance of developing a sticky campus where students stay within the borders of the University to generate a vibe and buzz of a busy, humming common. But as student numbers continue to grow, density of site usage increases and timetables are spread more widely across longer hours in a week, the span of the village spreads further and further. Social science making does not have to happen in a makerspace or a study room. It can happen on social media, with files shared through the cloud, facilitated using web conferencing and messaging apps. For the modern University the challenge of maintaining and improving both the technological infrastructure as well as the expensive physical spaces demanded by students is a prescient and strategic one. For the LSE, they have addressed this challenge head-on by locating making (students as creators and producers) at the centre of their LSE Education for Global Impact approach (Fung, 2018). These activities have now been located in the heart of the campus in the Centre Buildings project, which have embraced a learning commons approach built on the insights that came from the RLS and the Hive Studio, which The Guardian in their review of the building described as *'…it's a sort of studious and cleaned-up Naples, a unique multi-storey fusion of civic and academic space. It's a hive, an anthill, a rookery… insert your zoological metaphor here'* (Moore, 2019). These changes in part recognise that social science making is a complex part of teaching and learning at the School that represents both the studious and busy nature of the work, but also that like a Hive some of the work happens outside of the space, which can eventually be the hub that brings all the activity and making together in one shareable and visible location.

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At the heart of a diverse technology: Applying a realist evaluation methodology to a university live streaming programme

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Researching web-based lecture technologies in higher education is a complex undertaking (Morris, Swinnerton, & Coop, 2019), making experimental trials and summative evaluations impractical. The implications of existing literature in this area are therefore uncertain (Kay, 2012; O'Callaghan, Neumann, Jones, & Creed, 2017). In this paper we report on the use of an alternative research design, realistic evaluation (King, Dawson, Rothberg, & Batmaz, 2017; Pawson and Tilley, 1997), to gain insight into the impact of a university lecture live-streaming initiative. The initiative provided synchronous and asynchronous access to video of 129 weekly lectures using two different platforms. Surveys of 306 students and 49 staff, a focus group of five students, and an exploratory study of trace data of 359 students indicated that student access to the videos was lower and more idiosyncratic than expected. The ability to identify useful content, appropriate instructional methods, and participation by peers were reported to encourage students to become involved. Our results confirm the importance of specific contexts and forms of behaviour in encouraging beneficial lecture video use. We also show time of initial view to be a promising way to study students' strategies for using lecture video content.

Keywords: realistic evaluation, learning analytics, web-based lecture technologies

Introduction

Realist evaluation, as described by Pawson and Tilley (1997), adopts the critical realist paradigm (Carlsson, 2012) to propose a theory-based model for evaluating social initiatives or programmes. 'Theory' is defined by Pawson and Tilley as a set of beliefs about the conditions and processes/mechanisms likely to produce a regular observable effect; they argue that theories underlie the design of all social initiatives and can be tested and refined through evaluation. Rather than aiming to establish generalisable *post-hoc* causal explanations, realist research designs in evaluation studies seek to engage and inform policymakers by identifying *how*, *why* and *for whom* initiatives bring about change. Realist evaluation as an approach was quickly embraced by researchers working in fields such as health and medical education (Ogrinc & Bataldan, 2009; Marchal, van Belle, van Olmen, Hoeree, & Kegels, 2012; Hewitt, Sims, & Harris, 2013). More recently, the use of realist evaluation has also been advocated for educational technology research (Sorinola, Thistlethwaite, Davies, & Peile, 2015; Stohr & Adawi, 2018; McFaul & Fitzgerald, 2019) because of its potential to address the practical complexities of educational ecosystems (Ellis & Goodyear, 2019). Using this approach, our goal here is to show that effective, impactful evaluation of complex activity is not only achievable but well within reach for educational technology programme teams, as long as specific behaviours and specific contexts are placed at the heart of the enterprise.

In our study, a realist evaluation approach was adopted to establish how and in what circumstances a lecture live-streaming initiative at a large, research-intensive Australian higher education institution, Monash University, brought about beneficial changes. The research team included staff responsible for designing and implementing lecture live-streaming; only the first phase of evaluation is reported. The study was motivated by a desire to explore the efficacy of realist evaluation in the context of a complex educational technology initiative. Realist evaluation uses diverse methods to explore the specific social conditions and forms of behaviour that are associated with the success of a particular initiative; it seeks to improve specificity of understanding and ability to predict outcomes across multiple studies. Accordingly, both in conducting the research and for the purposes of reporting our findings in this paper, the research team followed the cycle of activity described in Pawson and Tilley (1997, chapter 4): investigate the initial design or "specification" of the initiative; generate theories and hypotheses; design and conduct observations; refine theories and discuss implications.

The rationale for our chosen approach has two key elements. Firstly, there is a need to improve the evaluations that are currently undertaken of educational technology initiatives in higher education (Nordmann, Calder, Bishop, Irwin, & Comber, 2018). The need is discussed at length in Selwyn (2014) and King, Dawson, Rothberg, & Batmaz (2016). Whilst there is already a substantial body of literature relating to web-based lecture technologies (WBLT), its conclusions are mixed and their implications are uncertain (Kay, 2012; O'Callaghan, Neumann, Jones, & Creed, 2017). We do not necessarily agree with the conclusion of Nordmann and colleagues that this is a situation best remedied through further empirical work, coupled with rigorous meta-evaluation or further research synthesis. Instead, we suggest that members of the research team and our equivalents in other institutes are faced with a classic evaluator's dilemma: a plethora of evidence and apparently conflicting findings on one hand, and a pressing need to measure the value of initiatives on the other (Pawson & Tilley, 1997). Data collection about WBLT is a highly complex undertaking (Morris, Swinnerton, & Coop, 2019) and institutional and practical constraints restrict the feasibility of experimental trials and full-scale summative and/or independent evaluations (O'Callaghan et al., 2017). In this context, we consider that more research by itself may not help; it could even intensify the difficulty. What is most likely to be required in our view is a re-think of educational technology evaluation and its relationship to research. Our study is intended as a contribution towards that goal.

Secondly, there is an often-stated view that theory has not kept pace with the use of educational technology (King, Dawson, Rothberg, & Batmaz, 2017; Morris et al., 2019). One possible reason for this is that educational change involves interdependent changes in behaviour (student and staff), in curricula and in technical systems, motivated by the beliefs and values that prevail in a particular educational community (Fullan, 2016). Fullan's work suggests that theories of technology are unlikely by themselves to offer a worthwhile explanation as to what is happening in universities.

We therefore concur with Whitworth's (2012) call for frameworks of evaluation that permit attention to the political and institutional context of educational technology initiatives. The approach of realist evaluation provides one such framework, offering a promising alternative model for integrating research within the development and evaluation of technology initiatives that is grounded in critical realism.

We begin by considering the findings of King et al. (2017), as this research team also adopted a realist evaluation approach in a recent and comparable study of a lecture video initiative at a research-intensive university in the United Kingdom. Modelling their work closely on Pawson and Tilley (1997), King et al. concentrated on explaining observed regularities in the use of lecture video via theory development. The authors use the term "theory" in the same way as Pawson and Tilley to mean "propositions about how mechanisms are fired in contexts to produce outcomes" (1997, Chapter 4) refined in a cyclical way via data collection and analysis over multiple studies. In other words, they attempted to develop ideas about the use of lecture video and the technical performance of the video platform, so as to reliably explain – and therefore ultimately predict – video access patterns, as well as informing future research.

We summarise the theories resulting from the work of King et al. (2017) as follows:

i. Students are encouraged to utilise video capture of scheduled teaching when this opportunity appears aligned to their study objectives and personal preferences for learning, and also when the video is accessible and of acceptable quality.
ii. In departments where the use of video capture of scheduled teaching is embedded, students become familiar with its use, although this familiarity can lead to disillusionment or avoidance if students do not acquire the skills to use video effectively or regard its use as an unsuitable vehicle for learning.
iii. In units where video capture of scheduled teaching has been relatively successful, staff report that they are encouraged to use the technology by student demand and for equity reasons.

We accept, though not entirely without reservation, the use of lecture video access patterns by King et al. (2017) as a proxy for the "outcomes" of a lecture video initiative. However, Pawson and Tilley (1997) stipulate that an empirically observed pattern will be affected by *specific forms of behaviour* in *specific contexts*. We therefore sought to develop a realist research design for lecture video that considers when and how, as opposed to simply how often, video is accessed. Critically, the initiative that is the basis of research reported in this paper provided students with the opportunity for synchronous (live-stream) access to lecture video alongside the more familiar offering of recorded lectures. Consequently, the full range of possible access times could be investigated. We believe ours is the first use of a context-sensitive realist design in the study of web-based lecture technologies (WBLT). Our research therefore constitutes a distinctive contribution to the emerging literature on realist approaches to the study of higher education technology initiatives.

Initial investigations: live-streaming at Monash University

Up to and including 2017, video capture of scheduled teaching activities was made available to students in some Monash University units at the request of the academic or the department. From time to time, individual disciplines also made class video capture footage available synchronously in order to experiment with the potential offered by live-streaming.

A major initiative known as Monash LIVE commenced at the start of 2018. This involved the creation of a scheduling option for students to attend lectures via live-streaming in units with a relatively high number of students enrolled. Ninety-one units (76 undergraduate and 15 postgraduate units) provided a scheduled live-streaming option to students as part of the LIVE initiative during the first major teaching period of that year. 129 average weekly scheduled teaching activities were live-streamed, representing 3.66% of the total number of lectures on Monash's Australian campuses. Two different video platforms were made available, described here as platform A and platform B; 14 lecture rooms were upgraded with new audio-visual equipment to support lecture live-streaming. At the same time, a separate project was undertaken to clarify and update the nomenclature, timetable codes and definitions used to describe scheduled teaching activities.

The research team searched in papers from the initiative steering committee, scheduling data (in 2017, 2018 and 2019) and information provided to students and staff, comparing the specification of Monash LIVE with that of the initiative described in King et al. (2017). Both initiatives used policy change and student demand to introduce WBLT across the institution, formalising and standardising existing localised practices. While the other initiative expected that students would learn more effectively from lectures when recordings were made available for review and revision, Monash LIVE anticipated that pressure on lecture venues would be reduced when the possibility was created for students to attend and participate in lectures synchronously online. Both initiatives expected widespread take-up by students; in the case of Monash LIVE there was an additional expectation that students and staff would quickly become familiar with interacting using text questions and comments during the time period scheduled for the lecture.

Further to the theories about lecture video use identified by King et al. (2017), we identified two additional initial theories specifically associated with Monash LIVE. These were:

iv. Students and staff quickly become accustomed to large-cohort interactive synchronous whole-class teaching that spans in-person and remote attendance.
v. The presence of a member of staff with the role of 'moderator', working alongside the lecturer to monitor and respond to text questions and comments from live-streaming students, mitigates the practical challenges of online interaction.

We proceeded to develop a research design that would allow us to refine both sets of theories and to better understand the explanatory potential of context-sensitive data within the overall framework of a realist approach.

Designing and conducting observations of Monash LIVE

Our research relates only to the first phase of the Monash LIVE initiative in the first main teaching period of 2018. Because there is little consensus and considerable fragmentation in existing WBLT literature (see above), we chose not to develop lines of enquiry for the study through a literature review. Some theory has been established, but not, so far, informed by observations in specific contexts. In a theory-poor environment, Pawson and Tilley's matrix of realist designs (1997, chapter 4, table 4.1) recommends the use of exploratory strategies, typically those involving concurrent quantitative and qualitative data collection. For this reason, we used multiple methods to gather and compare data about the specific contexts and uses of WBLT in the Monash LIVE initiative. We surveyed 306 students and 49 staff, held a focus group (n = 5), and carried out a pilot study of trace data of video usage by 359 students in one first year unit. Next, we compared the results with those in the existing literature in order to refine theories i. - v. Our study concluded with a review of major findings and their implications, reflection on the efficacy of the approach taken, and consideration of next steps.

Two research questions informed these activities:

a) What insights can a context-sensitive realist evaluation methodology provide, through improved theory, that might support better programme design and/or institutional practice in a WBLT initiative based on live-streaming?

b) What can the findings of a) suggest about the benefits and limitations of realist evaluation as a means of assessing the impact of educational technology initiatives?
We invited all students in the 91 LIVE units, including those not enrolled in the live-streaming lecture option, to complete a survey. Student survey items were adapted from those reported in Richardson, Dunn, McDonald, and Oprescu (2014). Three underlying constructs were identified: overall opinion of the initiative, benefits to learning, and technical usability. The development of the student survey is reported in detail in Bryant, Francis, Ryan, Wood, and Zhang (2019).

A total of 596 students responded, of whom 306 provided complete responses. The scale was a seven-point Likert scale where 1 = “strongly disagree” and 7 = “strongly agree”. Respondents typically held a positive overall view of live-streaming (M = 5.48, SD = 1.44 for the “overall opinion” construct), regarded the benefit to learning as moderate (M = 4.21, SD = 1.45) and reported a positive overall view of usability (M = 5.01, SD = 1.26). Respondents who provided an email address were invited to attend a focus group to further explore the survey questions. A transcript of the focus group and free-text comments from the staff survey were coded by two members of the team independently and an aggregated set of codes produced, with the aim of representing all sentiments related to the three constructs measured in the survey.

There were 50 complete responses to the staff survey, adapted from the survey reported in Buchanan, Sainter, and Saunders (2013). The scale was an five-point Likert scale where 1 = “strongly disagree” and 5 = “strongly agree”. One response related to a previous teaching period and was removed. The overall perception of live-streaming was, on average, neutral: M = 3.00, SD = 1.26 for the item “Overall I was satisfied with the experience of using live streaming software”. Most respondents utilised the open comment fields. Accordingly, and because of the small sample size, we analysed free-text rather than numerical responses.

Students in the focus group indicated that when they were able to identify video that was likely to be valuable for the purpose of study and view that content in a setting that promoted concentration, they placed a high value on the use of the platforms for learning. For example, a student reported intentionally leaving campus so as to be able to view part of a lecture in a quiet location. We suggest that this sentiment may explain the typically high opinion of the initiative reported by respondents to the student survey. Staff indicated that where live-streaming was valued, this was either on equity grounds (to provide a degree of access to those students unable to attend in person, as suggested by King et al., 2017 in theory c.) or because it could support the goals of a specific unit or stage of the course.

One factor mitigating against the perceived benefit to learning for students was the absence of live video of the lecturer, reducing the ability to pick up non-verbal cues such as gestures or use of the pointer. Where internet, software or hardware problems restricted access, this also affected perceived educational value. No students in the focus group and few students in the survey (M = 2.31 for the relevant item) identified their own skill level or difficulty with using the platform as a barrier. Factors that staff reported as reducing the perceived value of the initiative were scepticism about its aims, insufficient training and support, and insufficient time to prepare. The complexity of using live-streaming as part of large-class lecturing was also reported by some staff as having reduced its effectiveness.

Both student and staff respondents reported that synchronous access and participation had depended heavily for their usefulness on the instructional methods employed and students’ responses to them. Students identified instructional choices they saw as tokenistic and low engagement from peers as factors likely to discourage synchronous participation. Staff stated that the level of student engagement in live-streaming, which some believed had increased the likelihood of absence, was low and insufficient to justify the time required to implement the initiative within their unit. Latency (time delay) – built in to the platform and/or the result of buffering – was identified in the staff free-text comments as an inhibitor of synchronous platform use. The use of moderators was reported as inconsistent. A total of 20 of the 49 respondents to the staff survey stated either that no moderator was assigned, or that the moderator did not have an active role because of low synchronous engagement by students.
The intention had been that synchronous use of platform A would be the norm, with students and staff moving to platform B only in the event of technical problems. This was not what occurred in practice. Some scheduled teaching activities occurred in venues where only platform B was available. Also, students in the focus group reported idiosyncratic patterns of technology access, with personal schedules, preference and experience of platform performance all playing a role in influencing when content was accessed and how.

Time of access was investigated further in a small-scale exploratory study of a single unit using trace data from platform A. This unit, a first year psychology unit with two weekly lectures (25 videos in total), was chosen because the lecture videos, comprising introductory overviews of a range of topics such as developmental and biological psychology, were formally and stylistically similar. We analysed students' first views (the time when the first view of each video occurred in relation to the time of the lecture). 996 students enrolled in the unit before semester, with 243 and 95 respectively selecting the live-stream option for the two lectures. 359 students (36.04%) viewed video content. We classified first views as to whether they occurred at the time of the lecture; within one day; within one week; within two weeks; or more than two weeks later. The data were then subject to latent class analysis for the purpose of exploring strategies enacted by students when using live-streaming systems; a three class solution was selected as the candidate model. The composition of the three classes was: 302 students in class 1 (84.12%), 11 students in class 2 (3.06%), and 46 students in class 3 (12.81%).

Table 1. Descriptive Statistics for the Three Class Solution

Class	Live Streaming		Within 1 Day		Within 1 Week		Within Two Weeks		Greater than Two Weeks	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
1	.77	.90	.15	.37	.58	.79	.09	.29	.10	.40
2	6.55	2.11	.36	.67	.73	1.19	.18	.41	.27	.65
3	.20	.54	.89	.99	3.26	2.13	1.33	1.25	1.65	2.41

Table 1 provides the mean and standard deviation values for each of the five variables created from the trace data (time of the lecture; within one day; within one week; within two weeks; or more than two weeks later) across the three identified classes. For example, Class 1 demonstrated limited engagement with the recorded lecture videos based on mean values (e.g., .77 views, on average, for initially live streaming a lecture). Initial viewing behaviour for Class 2, on average, appeared to consist of live-streaming (M = 6.55), whilst all other viewing behaviour occurred less frequently (e.g., M = .18 for within two weeks). Class 3's initial viewing behaviour, based on the presented mean values, generally took place within one week (M = 3.26) or more of the lecture being recorded (M = 1.33 and 1.65 for within two weeks and greater than two weeks, respectively).

This study of trace data supported our emerging understanding that, in contrast to the intention of the Monash LIVE initiative, students' first views of video content were often not synchronous. Instead, we found support for distinct patterns of use. Only a small minority of students, the smallest class (Class 2) followed the guidance provided by Monash LIVE in that their typical first view was under live-streaming conditions. A larger group (Class 3) had first-view behaviour that could be characterised as 'strategic', being one day or more after the time of the lecture on average. We also showed that students made only moderate overall use of the video content available to them in this unit, with mean first views of videos being below 7 in each time category for each of the three latent classes. It should be remembered that our trace data study investigated first views, not duration of view or number of repeat viewings, and only within a single unit and platform.

Theoretical development and comparison with existing literature

We refined the initial theories as follows:

vi. Students quickly become accustomed to a new model of incorporating video content into their units.
vii. Students are more likely to access video content when it is clearly identifiable as useful for study. In this situation, they will typically seek out an optimal time and physical location to view the content.
viii. Specific instructional methods and the perceived engagement of peers are factors that, in combination, encourage students to participate synchronously.
ix. Perceived high student engagement in live-streaming, equity of access, course and/or unit alignment, and low latency are important factors in encouraging staff to utilise the technology.

Theories vi. - ix. offer several clarifications and improvements to the theory taken from the earlier study of King et al. (2017). The earlier theories i. and ii. proposed that students tend rapidly to develop a superficial acquaintance with WBLT as part of their technical and social environment – as something 'ready-at-hand' – without either fully understanding or accepting their educational purpose in the context of their degree course, sometimes in turn leading to disaffection. Our results indeed indicate low to moderate student use of WBLT based on staff perception as shown in the free-text survey data, and moderate use in one specific context as indicated in the trace data pilot study. However, we found no evidence that the absence of widespread, wholehearted student access to lecture video at the time of the lecture or subsequently was caused by a general phenomenon of alienation or disillusionment with the technology. Instead, the results both of the student focus group and the staff survey support the team's initial expectation that student motivation to access video is closely associated with specific contexts and forms of behaviour 'in-play' at the time of access. The trace data demonstrates that student first-view behaviours in the selected unit followed several distinct patterns. Theories vi., vii. and viii. reflect these findings, while theory ix. develops the earlier theory iii. about factors influencing staff to use WBLT.

We next investigated whether findings from the extensive broader literature on WBLT could assist with theory development. Several previous studies that utilise system data have found WBLT use by students to be lower than expected. King et al. (2017) found that individual videos were watched by 14% of the student cohort on average across the institution; at unit level, Edwards and Clinton (2019) and Elliott and Neal (2016) both report that a minority of the total number of students enrolled viewed lecture video content when very short views are removed from the data. By contrast, Morris et al. (2019) reported that the proportion of students across the whole institute viewing WBLT at least once reached 81% at the end of a four-year period. Although we did not regard these results as theory-refining in themselves, we noted that our finding of moderate video access by students was a common theme in the literature.

Many previous studies also show that students attribute a high overall value to WBLT, although few specifically consider synchronous access (Chapin, 2018). Self-reported student perceptions of the educational value of WBLT in previous studies strongly support the indication in our results that students see these technologies as providing different affordances to those of in-person lecture attendance. For example, students have reported that they value being able to pause and skip backwards to interrogate complex concepts as well as skipping forward to access specific content strategically (Chapin, 2018; Cilesiz, 2015; Karnad, 2013; Nordmann, 2018; O'Callaghan et al., 2017). Dommett, Gardner, and van Tilburg (2019) found that WBLT access reduced anxiety for the students in their study; a reduction in stress and efficient use of study time is also proposed by Danielson, Preast, Bender, and Hassall (2014) as the most plausible explanation for the positive relationship between number of views and standardized test scores in the lecture-based units they studied. The interviews reported in Cilesiz (2015) indicate that students may progressively become acculturated into the use of WBLT for study. We found these studies to be of significant explanatory value in relation to our theoretical framework; we reflect on their importance in the section below.

We believe that ours is the first study to consider time of first access as a possible indicator of different student behaviour patterns. However, there is other existing evidence that student use of WBLT is variable across the student cohort (Bos, Groeneveld, van Bruggen, & Brand-Gruwel, 2016; Edwards & Clinton, 2019; Leadbeater, Shuttleworth, Couperthwaite, & Nightingale, 2013; Williams, Birch, & Hancock, 2012). Brooks, Erickson, Greer, and Gutwin (2014) found evidence at individual unit level of accesses by different groups of students across different weeks in a teaching period. Danielson et al. (2014) and Nordmann et al. (2018) both found that student access within a department varied by the type of unit, although neither study separates instructional method from unit design. Owston, Lupshenyuk, and Wideman (2011) concluded – based on self-reported use and unit marks – that lower achieving students were more likely to be helped by WBLT, although it seems equally plausible that students who failed to make effective use of the videos may have earned lower marks.

Staff reservations about the introduction of WBLT are reported in Dona, Gregory, and Pechenkina (2017), Freed, Bertram, and McLaughlin (2014), Morris et al. (2019), and Taplin, Kerr, and Brown, (2014). However, very little attention has been paid in existing literature to the goals of staff in using the technologies or staff alignment with higher level institutional strategic aims related to their use. This gap is addressed by the theories we present above.

Few previous studies have explored patterns of viewing behaviour by students in detail using system data – for example, by considering which elements of the video were viewed and what type of action (e.g. rewind or skip forward) led to the view. This remains a gap in the literature and an area for further investigation.

Discussion and implications

In relation to our research questions:

a) What insights can a context-sensitive realist evaluation methodology provide, through improved theory, that might support better programme design and/or institutional practice in a WBLT initiative based on live-streaming?

The evaluation of the first phase of the Monash LIVE initiative allowed us significantly and usefully to refine theories presented by King and colleagues (2017). Although the students we surveyed attributed a high value to live-streaming overall, our focus group found evidence that students do not think about WBLT in the same way as they think about in-person lecture attendance. Instead, value was placed on the ability to identify relevant content and view this in a setting that promoted learning, using the specific affordances of video. Worthwhile synchronous access to and participation in WBLT were associated by students with a combination of appropriate instructional methods and a high level of engagement amongst peers. Our pilot study of trace data supported the findings of the student focus group and confirmed that multiple distinct patterns of first view prevailed in the unit studied, which was a first year introductory science unit. We hypothesise that within a particular initiative, patterns in viewing behaviour are likely to vary according to the design of a unit, the instructional methods adopted and students' existing acculturation into the use of video, and recommend these as areas for future research in the realist paradigm. For staff, student engagement, equity of student access, alignment with course and/or unit aims and low-latency video were reported as encouraging (and their absence inhibiting) efforts to use the technologies synchronously.

Our research design employed a student focus group, qualitative analysis of staff survey responses and study of trace data within a single unit to improve understanding of the specific conditions for students' successful use of video. These methodological choices permitted details of the time of first view, physical location, instructional conditions and video type to be considered as part of theory formation, in a way that would not have been possible had the team relied on aggregated survey data and/or video accesses. Time of initial view was shown to be a promising way to investigate students' strategies for using WBLT. Overall, although there are strong indications in our evaluation that the intention of the initiative for large-scale synchronous engagement was not enacted in practice, our results confirm the importance of specific contexts and forms of behaviour in encouraging beneficial lecture video use.

In the light of these insights, we intend to refine the design of the initiative in various ways. Using the outcomes of a separate project to clarify timetable codes and definitions for different scheduled activity types, the team plans to change the guidance to staff to clarify why, under what circumstances and in which venues live-streaming is made available to students. A series of hardware and software improvements will be undertaken to minimise latency and in-venue technical difficulty. In-venue visual indicators where there is no video stream or the microphone is muted, and the option for academic teams to provide live video of the lecturer, will be provided. Staff will be surveyed at the beginning of the teaching period so that they are able to self-identify a requirement for more training or technical support.

In the next stage of the evaluation, we plan to test and improve theory vii. above by identifying contexts through, and mechanisms by which, students are able to identify video content as potentially valuable for study, and use this information to inform unit design. Our intention is also to investigate contexts in which synchronous engagement is moderate or high and those in which it is less so, exploring specific instructional methods that may encourage students to take part in real-time so as to further refine theories vii. and ix. Finally, we plan to continue to investigate the different strategies adopted by students when using WBLT, expanding our study of trace data across both platforms and refining our survey using items from Danielson et al. (2014).

b) What can the findings of a) suggest about the benefits and limitations of realist evaluation as a means of assessing the impact of educational technology initiatives?

We believe the use of realist evaluation has provided us with three key advantages in carrying out the research reported in this paper. Firstly, our chosen design sought to understand the beliefs that had informed the design of this specific initiative, find out to what extent they were justified, and propose refinements or alternatives. There was no intention to establish the general benefits of lecture live-streaming in higher education or to compare live-streaming as an innovation with existing practices of in-person lecture attendance. We were thus able to avoid formidable theoretical and methodological challenges that we expect would be associated with these alternative research approaches. Secondly, this type of design encouraged us to concentrate on specific conditions in which WBLT were used and how these might compare with those of previously reported studies. We were therefore able to add to the research reported in King et al. (2017), for example by exploring a context that involved synchronous use of WBLT. Thirdly, unlike experimental designs, the realist model was *feasible* within the practical constraints governing Monash LIVE. Rarely, in our experience, is there time at the start of such initiatives to develop an approach to evaluation or to carry out a review of literature that might otherwise usefully inform practice. Although we would reserve judgement for future phases of our work, on our current indications we believe this type of research design may have much to offer to research teams working in similar settings, allowing them to get 'to the heart' of diverse technologies within the resources available to them.

One possible limitation on the evidence to date is the extent to which a realist evaluation research design is able to provide a satisfactory account of the experiences of people whose lives are affected by a social initiative. We avoided some of the language associated with realist accounts of the use of technology by individuals, finding it reductive and hard to apply. For example, was the focus group student's choice to leave campus to watch a lecture an example of a "mechanism" or a "context"? Studying "what works" also carries with it a theoretical difficulty of its own. As shown by Biesta (2007), the questions need to be asked: works for whom, and works to do what? Difficulties associated with these questions arose in our research. At times there was a need more clearly to distinguish the benefits of the technology for an individual from the accomplishment of the goals of the programme or the institution, and more fully to investigate different possible ways in which the technology might "work for" or assist learning. Finally, the methodological pluralism of realist designs as described by Pawson and Tilley (2007) carries with it some risk of a lack of rigour. For instance, selection bias may have influenced the results of our surveys, as some staff and students chose not to respond. Had we concentrated exclusively on surveys, we may have found ways to reduce this possibility. We recommend that future research with a similar design takes all three potential limitations into account.

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Solving ill-structured problems mediated by online-discussion forums: Mass customisation of learning

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To foster students' learning of critical-thinking skills, we incorporated ill-structured problems in a Human Diseases module for third-year Life Sciences students. Using a problem-solving rubric and working in groups of three, students attempted to solve problems presented to them. We mediated their discussions by asynchronous online discussion forums (AODFs) as part of mass customisation of learning for 40 students where personalised learning was constrained by structure of the module. We examined the quality of students' discussion, focusing on the feedback group members provided to one another, using an interpreted Structure of Observed Learning Outcomes (SOLO) taxonomy to code students' feedback. Our analysis indicated that the students were able to provide uni-structural and multi-structural level in relation to solving an ill-structured problem, even though they are not used to solving ill-structured problems. This indicated that in a mid-size class, while personalised-learning is not always easy, it is possible to mass customise learning for students using common ill-structured problems in a class by mediating problem-solving using student discussions as feedback. However, more can be done to scaffold peer feedback on solving ill-structured problems so that the level of collaborative-learning can be improved in a mass customised model that approaches personalised learning.

Keywords: ill-structured problems; asynchronous online discussion forum; feedback; mass customisation.

Introduction

Real-world problems are often ill-structured problems that have ambiguous information and no standard solutions (Jonassen, 1997). University students, therefore, need opportunities to develop problem-solving skills, apply content knowledge in a rational and relevant manner to solve real-world problems. After graduation, they would be equipped with relevant problem-solving skills that would enable them to contribute productively to society.

However, intentional design of ill-structured problems is not a routine part of curriculum design. In addition, unlike experts, novices such as undergraduates generally do not possess the skills to apply domain-general problem-solving strategies in relation to domain-specific knowledge to solve these problems (Glaser, 1995). Students who are novices at solving such problems can benefit from having a framework (Jonassen, 1997) and support to help them develop problem-solving skills.

In our third-year Molecular Basis of Human Diseases module at NUS, we designed ill-structured problems based on Jonassen's framework (Jonassen, 1997) to provide opportunities for students to learn ill-structured problem-solving skills. The framework describes iterative steps to approach an open-ended problem, beginning with the definition of a problem scope, examining possible solutions based on the evidence available, consider alternative solutions and testing out the solution. Based on previous studies, asynchronous online discussion forums (AODFs) have been found to be effective for students learning in a collaborative manner (Hrastinski, 2009). Accordingly, we organised our students into groups of three to work collaboratively on ill-structured problems at AODFs.

The use of ill-structured problems that are open-ended can form the basis of mass customisation (Schuwer & Kusters, 2014) as an approximation of personalised learning in our curriculum design, where the ill-structured problems posed can be common problems all students have to solve. However, given the open-structure of the problems, there are potentially different solutions. Instructors can leverage peer discussions within groups of students as a means of mass customised learning among students providing feedback to one another. In our conceptualisation of mass customisation, we envisioned that as the discussions among different groups are different, the responses from students among the same group would be focused on group-specific issues and points raised, and hence, provide a customised learning experience for students within each group. In this exploratory study, our research questions in this study revolved around whether students were able to provide feedback to group mates while trying to solve an ill-structured problem collaboratively and if so, what the quality of the feedback was.

Theoretical framework

Problems designed for students to support learning can range from the well-structured ones that mostly test defined concepts within a fixed scenario and a prescribed, perfect solution, to less-structured ones that rely on a range of domain knowledge, have elements of uncertainty about the information available with regard to the problem and have multiple solutions (Jonassen, 2011). Ill-structured problems reflect the characteristics of real scientific issues that scientists deal with in their authentic research work (Aikenhead, 1996; Schwab, 1960) and hence potentially can provide students the opportunity to practise the use of content knowledge and critical-thinking skills within a relevant context.

However, as students might not be equipped to solve open-ended problems, scaffolding needs to be provided. Indeed, from a previous study, we noted that students in our module had difficulties defining the scope of ill-structured problems among other difficulties (Yeong, 2015). Accordingly, we have included scaffolds in subsequent semesters to help students solve ill-structured problems and noted some benefits (Yeong, Foo, & Tan, 2018). Scaffolding refers to appropriate assistance given to novices so that they could solve a problem which is otherwise beyond their means (Wood, Bruner, & Ross, 1976). Previous studies revealed that scaffolds in the form of question prompts could be useful for providing students with the cognitive and metacognitive knowledge that are required to solve ill-structured problems (e.g., see Davis & Linn, 2000; Land, 2000). Of particular relevance is the use of procedural facilitation scaffolds (Guzdial & Turns, 2000) that could help students formulate contributions to the discussion, such as planning the steps of solving a problem. Our scaffolds included the use of questions prompt and message labels on the steps of the ill-structured problem-solving framework (Jonassen, 2011).

Students could further gain from feedback that might help them move from their current state to the desired state (Hattie & Timperley, 2007). In mid- to large-class sizes, prompt feedback provided by instructors might not always be possible. Hence, in addition to merely providing summative feedback from the instructors, we leveraged on group discussions as a form of close to immediate feedback students can receive from their peers. This draws upon the social constructivist theory wherein the ill-structured problem helps create the zone of proximal development (Vygotsky, 1980) and peers provide the scaffolding for student learning so students can develop beyond their initial capabilities. Students as peers working cooperatively together might also have an influence on one another, in terms of the standards expected as well as motivation (Topping, 2005). Moreover, peer as a teacher helping others might have benefits for learning (Whitman, 1988).

As far as personalised learning where learning needs and preferences are tailored to the specific interests of different learners (U.S. Department of Education, Office of Educational Technology, Washington D.C., 2010) is concerned, it was not possible to cater to personalised learning within the constraints of a regular module in our degree programme. Nonetheless, we subscribe to the idea that a continuum exists in the approaches towards tailoring instructional design (Schuwer & Kusters, 2014). In our discussion forums where students attempt to solve ill-structured problems, the open nature of the questions allowed for diverse approaches and solutions (Jonassen, 2011). Other than scaffold and instructor's feedback, comments from groupmates served as immediate feedback for peer learning that would be targeted in response to posts by students themselves. This was conceptualised as the mass customisation of learning (Schuwer & Kusters, 2014).

In this paper, we examined students' posts in AODFs, with a focus on the feedback that students provided for their peers. In particular, we evaluated the quality of students' feedback within a discussion group as a form of mass customisation of learning, given that targeted comment provided by group members served as feedback for members' solutions to the problem and served as an approximation of personalised learning. In our exploratory study described here, we used the SOLO taxonomy (Boulton-Lewis, 1995) to categorise the posts as a proxy for the quality of students' feedback to one another.

The SOLO taxonomy is organised in a hierarchical manner, where students might start at demonstrating little knowledge or competence (pre-structural level) in the subject matter. As students develop, they learn to deal with one relevant aspect (uni-structural level) and subsequently, several relevant aspects (multi-structural level) of the topic. At the more advanced levels, students could demonstrate the ability to integrate different aspects of knowledge into a structure (relational) and even generalise their knowledge to a new domain (extended abstract). The assumption we have made here for our analysis is that the better the ability of the student to provide feedback at the more advanced SOLO levels, the better the quality of the feedback. This is based on evaluating whether the students had been targeting the scope, information or solutions related to the problem posed, as they provided feedback to one another. The feedback could, therefore, range from not connecting their comments to the problem at-hand to extending their comments beyond links to the problem posed to a broader view.

Materials and Method

Module information and recruitment for the study

The elective module was on Molecular Basis of Human Diseases and spanned 13 weeks. The class was made up of 45 undergraduates mostly in their third year of the Life sciences degree programme. An ill-structured problem was incorporated in the end-of-semester summative assessment to assess if students were able to solve the problem on an individual basis. Scaffolds such as question prompts (Ge & Land, 2003) or message labels (Cho & Jonassen, 2002) were used to help students work through two problem-solving assignments. These scaffolds were provided together with the assignments.

One of the ill-structured problem posed was whether students would support the use of gene-editing technologies in embryos. Students were allowed to discuss this topic without any constraints, with issues surrounding techniques of gene editing, as well as ethical, and legal issues were all opened to them. The second problem posed was whether students agreed that a putative tumour suppressor gene was tightly correlated with colon cancer, with limited data set provided and students allowed to select relevant data to support their stand. Depending on the data they selected, students could support or refute the assertion. For each of the problem, students had about 4 weeks to discuss at the AODFs and submit an essay detailing their arguments. The two assignments were run sequentially, with a gap of about four weeks between them.

Coding of students' forum posts

After the semester, we used thematic analysis of students' posts in the AODFs to evaluate students' problem-solving skills and approaches, focusing on the levels of feedback provided by groupmates to one another. At the first level of coding, we used the ill-structured problem-solving framework (Jonassen, 2011) to categorise students' posts into (1) scoping the problem, (2) providing or consolidating relevant information (3) proposing solution and (4) counter-proposing solution (Yeong et al., 2018). Within these steps for solving an ill-structured problem, we also examined feedback among groupmates to understand better about how peers could provide timely and targeted responses to one another's posts. The use of Jonassen's framework was to examine if the learning outcome of solving ill-structured problems was achieved by our students using such an instructional design. As alluded to above, such a problem-solving skill is necessary for our Life Sciences students who might face open-ended problems in their subsequent studies and careers.

We used the SOLO taxonomy (Boulton-Lewis, 1995) to categorise the posts as a proxy for the quality of posts. The feedback fell into categories in the problem-solving steps adapted from (Jonassen, 2011) such as defining the scope of the problem (referred to as "feedback_scope"), information provided surrounding the problem (referred to as "feedback_information") and solution to the problem (referred to as "feedback_solution"). Feedback from both assignments was coded for the SOLO taxonomy and descriptive statistics were generated for a summary of the analyses. We used the SOLO taxonomy to further analyse the quality of students' feedback as these could be rather broad, given that the discussion forums took on different threads from one another. Nonetheless, given that the SOLO taxonomy was based on a hierarchical structure, it provided us a means to focus on the domain competency level of the students from the basic to bringing together different concepts. It also allowed us to examine relevance of students' feedback to the topics under discussion, and also their ability to go beyond concepts and issues discussed in class to implications to the field or a broader societal impact.

Results and Discussion

Students' posts that were categorised as feedback for other group members were coded using the SOLO taxonomy to ascertain the quality of students' comments to one another. We interpreted the SOLO taxonomy in the context of solving an ill-structured problem as shown in Table 1. This allowed us to evaluate the quality of the feedback in relation to how students approach the ill-structured problems. As the students were tasked to provide possible solutions to the problems posed, whether students were able to provide targeted feedback to one another such as directing their feedback to the problem-solving framework was an important criterion. In our observations, we noted that students' feedback ranged from uni-structural to extended abstract as seen in the examples highlighted in Table 1.

In our context, a feedback was judged to be pre-structural if the post failed to make connections directly to the problems posed. These could be short sentences that did not contain information that enabled us to detect any attempts by students to relate their feedback to the problems posed, indicating a limitation in the feedback in terms of being constructive towards solving the problem (Table 1). This was to distinguish the feedback from others that explicitly related at least one issue or topic to the problems.

At other levels of the SOLO taxonomy, the feedback by students demonstrated the ability to make explicit links in their feedback to the ill-structured problem they had to solve. Depending on the number of relevant issues they were able to make connections with, the feedback was classified as uni-structural (typically focussed on a narrow aspect) or relational (more complex feedback with different ideas integrated together that were connected to the problems). There were several examples of feedback that went beyond the problem and were coded as extended abstract. These were those that alluded to more generalised issues that

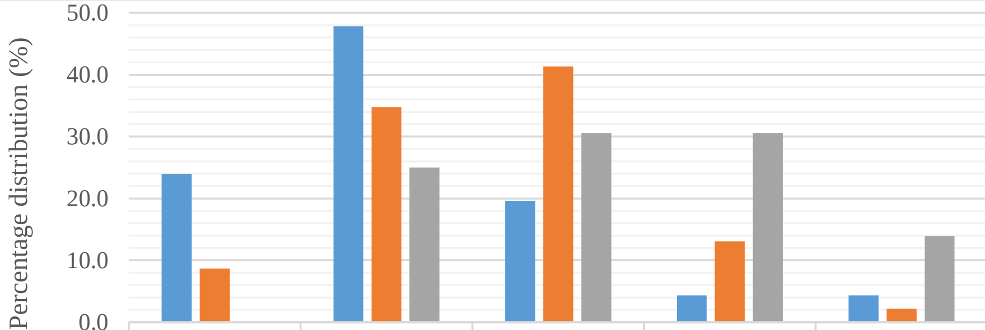
Table 1: Interpreted SOLO taxonomy and samples of students' AODF posts

SOLO taxonomy Levels	**Interpreted categories description**	**Attributes of students' feedback**	**Examples of students' posts**
Pre-structural	At this level, students could not relate to the problem statement at all. The students' feedback failed to connect to the problem statement.	Students forum responses were typically characterised by the general replies without directly addressing the problem question. There was limited information provided and no link to the problem question.	*I think this article is really similar to Article 1, which is great I guess! Forum B3, student #23*
Uni-structural	At the uni-structural level, one aspect of the task was highlighted by the student and the students' understanding was disconnected without obvious connections to the problem statement. Here the students feedback focused on one or a few relevant aspects that have discussed limited concepts about the problem question. Many of the discussions were taken from the articles provided and at the surface level with minimal discussion.	Here the students feedback responses were characterised by information provided with limited or no proper explanation. Students demonstrated a partial understanding of the problem question and one or few aspects were highlighted picked up. Since the discussions were not really complete, the feedback was not completely helpful.	*CHFR & mitotic progression from the article 1* *Dma1p, an orthologue of CHFR, plays a role in regulating mitotic events such as spindle assembly and septum formation. Dma1p and Dma2p have been linked to the positioning of mitotic spindles. There were no clear connections of CHFR functions to the antephase checkpoint, but it is said to delay mitotic entry in cells. Forum B11,student #35*
Multi-structural	At this, students attempted to analyse several aspects related to the problem statement, but their relationships to each other and exact connections were not discussed completely. However, such qualitative Multi-structural discussions included a range of	Here the students' feedback included elaborations on the concepts from various aspects of the problem questions. Not all the student's discussions were connected well to one other. However, most of the students tried to make the connections, but overall there were struggles to understand completely on the true significance of their ideas.	*A study was performed: Among 61 primary colon cancer samples studied, hypermethylation of the MLH1 and CHFR promoter was found in 31% of the tumors. In 68% of all primary cancers with MLH1 promoter hypermethylation, hypermethylation of CHFR promoter was also observed. This suggests there could be*

	discrete facts related to the problem statement. Here the quality of various ideas on the problem statement was increased, but they were alienated from other students' perspectives.		*a direction towards forming a solution targeted at the loss of mismatch repair (MMR) caused by hypermethylation of MLH1 and the loss of CHFR as a mitotic spindle checkpoint. Forum B10, student #13*
Relational	At the relational level, peer discussions were at the deep learning stage, concepts were linked and integrated in order to contribute to a more coherent understanding of the problem statement. At the relational level, peer feedback from the students helped to integrate their ideas into a whole, recognizing relationships and connecting the relevant information to each other. This level was characterised by an adequate understanding of a subject and problem question.	Students at this level could use their understanding to apply their ideas/discussions to new situations. Students argued among each other's discussion, stood on their views and integrated the relevant details to bring the concrete facts together.	*Hence, I would say there is no correlation between chromosomal instability and no / low CHFR expression. As you said, CHFR is perhaps a tumor suppressor gene especially used in the colon. Methylation of the promoter region leads to less CHFR expression and therefore less tumor suppression what cancerous tumors allows to develop easier (there are still physical reactions to stop growth of cancer tissue, i.e. from the immune system). So, the question how to reconcile the CHFR promoter methylation and tumor growth, you have already answered. And because there is no correlation between CIN and no/ low CHFR expression, I'm not able to explain you how to reconcile these 2 components. Forum B11, student #18*
Extended Abstract	At the extended abstract level, the understanding at the relational level was re-thought at another conceptual level, resulting in metacognitive analysis of the problem statement. Students analysed the problem statement in a different view and used it as the basis for prediction, generalization, reflection and creation of new understanding. Students extracted the underlying principles and structures behind the ideas discussed. Multiple possibilities were considered and refined to	Students responses at the extended abstract level went a step further than relational answers, beyond what had been learned from peer discussions. There were indications of reasoning, anticipating possibilities, and multiple connections made. There were instances of generalisation of principles to new situations and considerations beyond the problem statement.	*CHFR hypermethylation can be a benchmark that helps identify patients with high risk of the disease recurrence and have implications for clinical management of colon cancer (following curative surgical resection in their study), and that it may serve as a potential prognostic biomarker. Forum B8, student #24*

	relate to the problem statement.		

The chart in Figure 1 shows the percentage distribution of various categories of feedback among the SOLO taxonomy. Majority of the feedback_scope was at the lower levels of the SOLO taxonomy, with 24% at the pre-structural level and 48% at the uni-structural level. In comparison, for the feedback_information, there was a lower percentage at the pre-structural level (9%) with a majority of them at the multi-structural level (41%). With regards to the feedback_solution that students provided for one another, there were none at the pre-structural level and a fairly-even distribution across uni-structural, multi-structural and relational. Among the different categories of feedback, the feedback on the solution was highest at the extended abstract level (14%).



	Pre-structural	Uni-structural	Multi-structural	Relational	Extended Abstract
Feedback_Scope	23.9	47.8	19.6	4.3	4.3
Feedback_Information	8.7	34.8	41.3	13.0	2.2
Feedback_Solution	0.0	25.0	30.6	30.6	13.9

Figure 1: Percentage distribution of different categories of feedback provided by students to peers according to the SOLO taxonomy

The distribution suggests that the feedback by students in response to group mates' posts on problem scope was less well-developed that feedback on information or solution. This correlated with our previous observations that defining the scope of an ill-structured problem is an issue for students (Yeong, 2015). Consequently, the students might also have problems with helping one another with constructive comments on how to define the scope of the ill-structured problems. Nonetheless, there was at least 20% of the feedback on the scope that was at the multi-structural level, indicating that there were students who were capable of providing useful feedback on the problem scope in attempting to solve the problems.

The better performance of students in providing feedback on information could be due to the fact that the information provided was mostly domain-related and students were able to rely on their knowledge as science students. The link back from information might be less opened than the scope to the problem posed. In providing feedback to solutions proposed by group mates, the more evenly distributed feedback across the across uni-structural, multi-structural and relational could be the fact that different solutions are possible and related to the openness of the problem, students might not all be good at making links to the problems. However, there were no pre-structural feedback and the highest level of extended abstract among the feedback on solutions, suggesting that perhaps with various possible solutions provided, students were likely able to make links to broader issues using prior knowledge.

The observation that 31% of feedback that was multi-structural and 15% relational in nature provided us some confidence that students were able to make relevant comments to one another (Table 2). In relation to customization of learning (Schuwer & Kusters, 2014), students involved at the group level were able at some level, to provide targeted and specific to other members. This fitted our idea of using group-specific discussions to drive the learning of common topics but with scope for students to contribute their own ideas and feedback to one another that might not be possible within the time-frame of an in-class discussion led by on instructor. The peer-feedback by students within groups, therefore, served as a good complement to the feedback provided by instructors, who might be engaged with other modules in parallel and normally provided broader comments for each group without necessarily going into specifics that have already been dealt with by students themselves. The instructor nonetheless catered comments and feedback to the group-specific topics that were raised by the students, again fitting into our aim of customizing learning experiences for students.

SOLO taxonomy	Percentage Frequency
Pre-structural	11.7
Uni-structural	36.7
Multi-structural	30.5
Relational	14.8
Extended Abstract	6.3
Total	**100**

Table 2: Percentage distribution of all feedback categories according to the SOLO taxonomy

Conclusions

Given that students are not all experienced in solving ill-structured problems, we anticipated that there might be problems with the level of feedback that students might provide their peers. This is because our scaffolds for solving ill-structured problems were related to steps for solving the problems. However, from the exploratory study, we noted that students were able to provide feedback that included SOLO levels at the uni-structural and multi-structural, with a small percentage of the relational and extended abstract. One reason for this could be that students were still having difficulties with solving ill-structured problems. We could, therefore, strengthen our scaffolding on ill-structured problem-solving skills. Moreover, the observation could indicate that students might not have sufficient skills to provide peer feedback, as this was not part of the instructional design.

Nonetheless, the finding that students were able to provide feedback at more advanced levels of SOLO implied that there could be a way to scaffold students in terms of feedback for peers to improve the proportion of higher-level feedback. For instance, training students to be better at providing constructive feedback (Gielen, Peeters, Dochy, Onghena, & Struyven, 2010) might help improve collaborative-learning. Additionally, there needs to be a continued focus also on defining the knowledge surrounding problem scope as peers who are not familiar with the skill might have difficulties in supporting one another. Additional studies could be conducted such as interviews with students to find out how some students are able to make feedback at the advanced SOLO levels including the relational and extended abstract. Based on this information, we could design ways to support other students so that they might also attain such SOLO categories.

Future studies will focus on the improvements to our problem-solving scaffolds as well as scaffolds to support student collaboration. This should enable us to provide a learning environment that would cater to a more open structure of learning for students at different levels but with the similar outcome of learning about problem-solving skills. In terms of using AODFs as a platform for mediating student discussions as they solve an ill-structured problem, the instructors were able to observe the level and quality of feedback that students provided to one another as students make explicit their problem-solving approaches (Andresen, 2009). Moreover, collaborative-learning among students have been shown to be beneficial to knowledge construction (Schellens & Valcke, 2006). Hence the use of ill-structured problems together with an appropriate technological platform as a mediating tool have afforded us the means to provide mass customization of learning as students work collaboratively on the problem.

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Skills, practice and challenges in the adoption of learning technologies in training and adult education

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Training and Adult Education is critical to Singapore's effort to compete in the global economy and respond to its major economic and social challenges. iN.LEARN 2020, a key SkillsFuture initiative was introduced to catalyse the adoption of blended learning, through the use of technology-enabled learning and workplace learning, to enhance learning accessibility and relevancy. This paper reports the first nationwide survey that investigates the training and adult education landscape in Singapore. The findings provide baseline information of the current status of the use of learning technology in training and adult education and highlight issues and challenges in the adoption of learning technologies. A considerable proportion of training providers (47%) and adult educators (77%) reported using learning technologies in their training related work, however, use of learning technology may not linked to better learner experience or deep learning. Cost and lack of expertise are main obstacles to effective adoption of learning technologies. It provides implications to training organisations and adult educators to review their current programmes and skills, and to better design and implement technology enhanced learning. It also has implications for building partnerships among government agencies, enterprises and training providers and professionals to favourably exploit cutting-edge technology to support learning and performance.

Keywords: technology enhanced learning, learning technologies, pedagogical innovation, training and adult education, adult educators, training providers, skills

Introduction

Learning in traditional settings is making way for more digital and interactive approaches. Varied formats and individualised learning provided on e-platforms and at the workplace provide learners the flexibility to learn the way they prefer (Hodgkin, 2009). In educational institutions and corporate training, technology enhanced learning has become increasingly important (Zhang & Cheng, 2012; Garrison & Kanuka 2004). For the purpose of this study, technology enhanced learning refers to any learning that leverages on technology, including for example, e-learning, online learning, learning on simulators, mobile phones, augmented reality or virtual reality.

Many have argued the effectiveness of technology enhanced learning and some are concerned that technology enhanced learning may just be a fad in training and education (Hofmann, 2006). Nonetheless, the adoption of technology enhanced learning has been undeniably increasing by businesses and educators because of its flexibility, cost-effectiveness, and relevancy. FELTAG (Further Education Learning Technology Action Group) advocated that learning technology facilitates personalize training, providing autonomy to learners (Hutchinson, 2016). In training and adult education, autonomy is especially essential as it provides adult learners with flexibility to choose their preferred time and pace for learning to accommodate other commitments from work and family (Graham, 2006). In addition, what makes blended learning attractive is also because of its potential and promise in providing authentic learning environment (Herrington, Reeves and Oliver, 2010; Institute for Adult Learning, 2016). Well designed and implemented, it could improve learner engagement and participation which would lead to better learning outcomes (Hewett, 2016; Badawi, 2009). For business, blended learning can extend the reach of training in terms of access and flexibility with variety of formats and elements to ensure that all learning styles (visual, auditory, kinaesthetic) would be met whichever works for the employees to keep them stimulated in learning, and allow them easy access to learning anytime, anywhere (Korr, Derwin, Greene & Sokoloff, 2012; Osguthorpe & Graham, 2003; Singh, 2013).

Singapore is in its digital journey with its Smart Nation initiative to drive the nation to be the leading digital economy as detailed in three national plans namely, the Digital Economy Framework for Action, the Digital Government Blueprint, and the Digital Readiness Blueprint. Within the Digital Economy Framework lies the Industry Transformation Maps that facilitate guidance to companies and the workforce across sectors in adopting and stressing technology and innovation to transform enterprises and improve productivity. In line with the nationwide digital journey, the Training and Adult Education (TAE) sector of Singapore launched the iN.LEARN

2020[1] (SkillsFuture, 2017) as a national strategy to catalyse the adoption of technology-enabled training and adult education. Blended learning offers the potential to create new and innovative educational solutions and improved learning experience; however, how this can be achieved is usually not straightforward. Despite an intensive search of available literature on the Internet, there is a paucity of publications on blended learning in the training and adult education in Singapore. The lack of readily available research and exemplars of blended learning adoption in the TAE sector could be seen to be impeding the adoption of blended learning and the implementation of iN.LEARN 2020.

Methodology

We use data from the first nationwide survey of the TAE landscape study (Chen, Ramos and Cheng, forthcoming). It was conducted by the Institute for Adult Learning conducted in 2017-2018, with a total response from 326 training providers, 535 adult educators, 252 training and management professionals, and 138 human resource developers. This is the first formal study on the TAE sector that hopes to uncover the profiles of the training providers and TAE professionals, their business model, the programme offerings, approaches and forms of delivery used, how technology is used to advance their business operations and training delivery. This paper will focus only on the use of learning technologies. Specifically, it aims to address the following questions:

RQ1: What is the current status of the use of learning technology by the training providers and adult educators in Singapore?
RQ2: To what extent are the skills of adult educators and training management professionals proficient to perform their current work in technology enabled learning?
RQ3: What are the challenges in the use of learning technologies reported by training providers and adult educators?

Results

Key finding 1: A considerable proportion of training providers (47%) and adult educators (77%) reported using learning technologies in their training related work, however, current use of learning technology may not be linked to better learner experience or deep learning.

As mentioned earlier, iN.LEARN 2020 promotes adoption of blended learning with a strong technology component, we therefore asked the current use of learning technologies by the training providers and adult educators in the study. A considerable proportion of training providers (47%, n=153) and adult educators (77%, n=411) reported using learning technologies in their training programmes and services in the last 12 months. We also asked what tools they have used and Table 1 lists the learning technology tools used by training providers and adult educators.

Table 1: Learning technology tools used by training providers and adult educators

	Percentage of Training Providers that used …	Percentage of Adult educators that used …
Audio-visual training aids (e.g. Smart boards)	35.9%, *n* = 117	66.2%, *n* = 354
Recorded video of training activities, contents (e.g. lectures, seminars, discussions)	31.6%, *n* = 103	57.8%, *n* = 309
Collaboration platforms (e.g. Google docs)	25.8%, *n* = 84	42.1%, *n* = 225
Learning management systems (e.g. Moodle, Canvas, LearningSpace, AsknLearn)	25.5%, *n* = 83	35.3%, *n* = 189
Web-based forums, online chats, online community of practice, polling	23.3%, *n* = 76	33.8%, *n* = 181
Web-based seminars/presentations (e.g. Blackboard Collaborate, Adobe Connect, virtual classrooms)	22.7%, *n* = 74	32.5%, *n* = 174

[1] iN.LEARN 2020 is a key SkillsFuture initiative, which is introduced to catalyse the adoption of blended learning, through the use of technology-enabled learning and workplace learning, to enhance learning accessibility and relevancy.

E-assessment (e.g. online quizzes)	21.5%, *n* = 70	32%, *n* = 171
Web-based chats, conferencing	21.2%, *n* = 69	26.9%, *n* = 144
Mobile applications for adult learning (e.g. Gnowbe, AcuiZen)	17.8%, *n* = 58	22.1%, *n* = 118
Gamifications	16.6%, *n* = 54	21.1%, *n* = 113
Simulations (e.g. augmented reality, virtual reality)	14.1%, *n* = 46	20.9%, *n* = 112
E-portfolios	14.1%, *n* = 46	20.7%, *n* = 111
Others	2.6%, *n* = 4	2%, *n* = 2

As can be seen from the table, the top learning tools used by the training providers and adult educators were similar: audio-visual training aids, recorded videos of training activities or content, and collaboration platforms. The use of learning technology seemed to be primarily asynchronous, i.e. one-way knowledge transfer, such as creating audio-visual training aids with Smartboard and recorded videos; but less frequently to connect learners to learner or context. For example, less than 15% of training providers and adult educators reported using simulations such as augmented reality or virtual reality. Given that most tools used were mainly for one-way knowledge transmission and the frequency of use was not high (~3 “Occasionally” out of a scale of 6 “Always”), the results could imply that current use of learning technologies in training might be more content-driven; but less dialogical or contextual, which may not lead to better learner experience or deep learning.

Key finding 2: Technology enhanced learning was identified as one of the emerging skills to support the organisation’s business needs, however, adult educators and training management professionals perceived their skills in technology enhanced and blended learning to be lower than classroom facilitation and are top needs for continuing professional development.

About 72% of the training providers invested on technology and automation in the last 12 months. They also indicated willingness to invest in technological and automation enhancements in the next 12 months (Chen, Cheng and Heng, 2019). Over 60% of training providers foresee pedagogical innovation and technology enhanced learning as emerging and critical skills that adult educators and training management professionals need to be equipped with in order to support the organisation’s business needs. However, the adult educators and training management professionals self-reported that they were least skilled in this areas. Figure 1 shows that over 90% of adult educators reported they were proficient in classroom based learning, however, the percentage that were proficient in technology enhanced learning and blended learning dropped to around 75%.

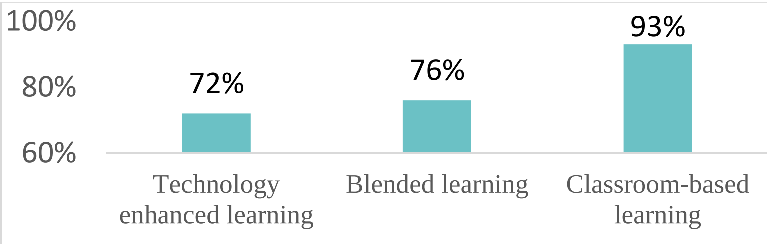

Figure 1: Percentage of adult educators who are proficient in the skills

Similarly, for training management professionals, the percentage that reported proficient in learning technology management and digital skills were lowest as compared to other skills that were critical to their work. See figure 2 below.

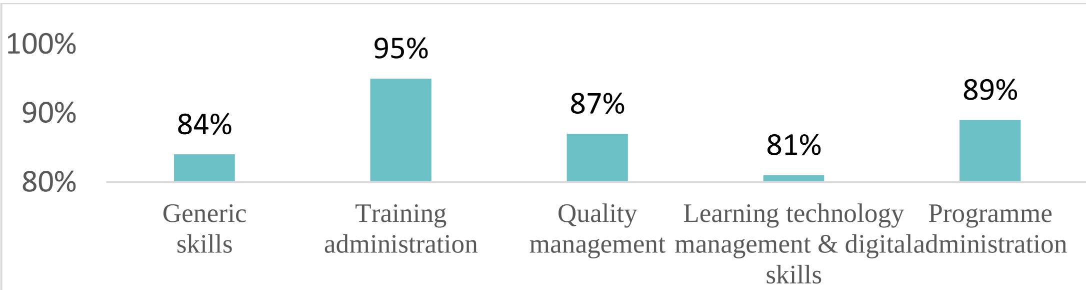

Figure 2: Percentage of training management professionals who are proficient in the skills

The survey also asked the areas that adult educators and training management professionals needed continuing professional development (CPD). Top CPD needs reported by adult educators were: learning analytics, curriculum design and development for technology enhanced learning, curriculum design and development for blended-learning. And top CPD needs reported by training management professionals were: learning technology & system management, digital literacy, curriculum and programme management. The findings show that technology enhanced learning is a key trend in the TAE sector and adult educators and training management professionals are aware of the gaps in their skills in this area. There is a need for quality CPD provision in this area to help them meet the changing demand in their work.

Key finding 3: About 1 in 3 training providers (31%, n=102) are still doing classroom-based training only; thinking that their current mode of training delivery can meet the clients' needs. Cost and lack of expertise were main reasons reported by training providers for not adopting learning technologies.

About 1 in 3 Training providers (31%, n=102) are still doing classroom-based training only. About 53% (n=173) of training providers did not use learning technologies at all in the last 12 months. The top reasons for not using learning technology included: current mode of training delivery was enough to achieve the learning outcomes (47.4%, n = 73), learning technologies were too costly and would not reap the returns on investment in the next 2-3 years (33.8%, n = 52), and lack of expertise to design and manage high quality technology enhanced programmes (31.2%, n = 48), see Table 2.

Table 2: Reasons for not adopting learning technologies

Reasons for not adopting learning technologies reported by training providers	
Current mode of training delivery can meet the learning outcomes effectively	47.4%, *n* = 73
Too costly and will not reap the returns on investment in the next 2 to 3 years	33.8%, *n* = 52
Lack of expertise to kick start	31.2%, *n* = 48
Lack of financial resources to kick start	29.9%, *n* = 46
No need as my clients prefer traditional mode of delivery such as classroom training	26.6%, *n* = 41
No resources to explore what learning technologies are available in the market	26.6%, *n* = 41
Not ready as we do not have a business plan ready for adopting learning innovation	20.1%, *n* = 31
Others	1.3%, *n* = 2

Other reasons reported in the above table was regarding the learners, as one training provider mentioned that some learners were not proficient in the ICT skills thus not ready to adopt learning technologies. One training provider also mentioned it was difficult to decide which learning technologies to use from the diverse and fast changing tools and technologies in the market.

Conclusion

The TAE sector is embracing learning technologies to respond to the changes in the market with close to half of training providers and 4 in 5 adult educators adopting learning technologies in their training programmes and services. However, our results also indicated the demand for technology enhanced learning seem not to be fully picked up among training providers yet, with 1 in 3 training providers were still doing classroom based training only, thinking it can meet the demand of the learners and enterprises.

Whether the mere adoption of learning technology should be taken as successful or effective would require a closer look into how learning technologies are used and whether they are linked with better learner experience and learning outcomes, not just its mere use per se. Learning technologies were found to be not frequently used overall, and when used, it was basically for knowledge transfer like the use of smart boards and recorded videos.

Lack of expertise in technology enhanced learning design and delivery is one big obstacle reported by training providers towards adopting learning technology in their programmes and services. The adult educators were aware of their skill gaps when it comes to adoption of blended learning and learning technologies. They self-rated their proficiency in technology enhanced learning and blended learning as lower than traditional classroom mode of delivery. Adult educators also reported high need for continuing professional development in this area. While they may see the use of learning technology as a trend, how to develop pedagogical expertise for technology enhanced learning is not an easy process. Understanding their challenges is an important first step towards capability development (see Cheng & Chen, 2019).

The findings provider some implications to policy and practice. Leaders of training organisations need to evaluate and predict the market trend and build innovative culture to encourage staff at all levels to be part of the change process to embrace innovation and new ways of training and learning (Chen, Chia, & Bi., 2019). At the same time, it is important to create awareness and understanding about technology enhanced learning, and look at the developmental cost holistically (Chen, Cheng & Heng, 2019).

It also has implications for building partnerships among government agencies, enterprises, training providers and professionals to tackle issues related to capability development, infrastructure support and resources provisions for technology enhanced learning. All stakeholders in the ecosystem has a role to play to support organisations and professionals to share knowledge, gain access to learning resources and develop ways to favourably exploit cutting-edge technology to support learning and performance together.

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Learning Analytics implementations in universities: Towards a model of success, using multiple case studies

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In these pioneering days of Learning Analytics in higher education, universities are pursuing a diverse range of in-house implementation strategies, with varying degrees of success. In this exploratory study we compare and contrast the approaches taken at three demographically different Australian universities. The comparison is made in the context of Delone and McLean's information system success model (1992). In time, a consensus-driven method for using Learning Analytics to improve student learning outcomes will eventuate, including individualized learning, but we are still some distance from this level of maturity. It seems likely that user-friendly proprietary platforms will prosper in the climate of uncertainty. Participants in the study see potential in Learning Analytics but are not sure about how best to realise that potential as the implementation of Learning Analytics systems at Australian universities are still very much in their infancy. Proprietary approaches offering sophisticated functionality seem likely to emerge and take precedence over the trial and error approach. This study addresses an apparent gap in the research as limited studies exist targeting both learning analytics and information system success. The methodology taken explores the research topic through a qualitative lense utlising thematic analysis. The study concludes that digital interventions such as Learning Analytics has great potential to optimize teaching and learning practices. Information systems success research can provide insights into what works and what does not in terms of Learning Analytics implementations. The discipline needs to be systematized for efficient implementation, and must deliver tangible benefits over time.

Keywords: Learning Analytics, Information System Success, Learning and Teaching, Information System Success Model

Introduction

Considering the maturity of Australia's higher education sector, and its demonstrated commitment to the scholarship of teaching and learning, it is perhaps surprising that the tool of Learning Analytics has not played a more pivotal role in providing evidence-based teaching and learning strategies (Universities Australia, 2013). Learning Analytics may be described as the collection, analysis, and reporting of data associated with student learning behaviour (Lockyer, Heathcote and Dawson, 2013). This is not to say that Australian Universities have not been making good use of technology to make the learning and teaching experience more flexible, accessible and engaging, with the overall goal of improving learning outcomes. But full recognition of the potential of Learning Analytics to support more data-driven decisions has not yet been reached. As higher education operates under increasing scrutiny by governments, accrediting agencies and students, new ways to monitor and improve student success will be advantageous. Generally speaking, Australian universities are recognizing the potential of Learning Analytics but given the immaturity of the field and the relatively few successful implementations, there is still something of an experiential vacuum that is impeding progress. Empirical research supports the view that data-driven decisions improve productivity and organisational output, yet for many higher education leaders, it is experience and "gut instinct" that still has greater impact on decisions (Long and Siemens, 2011). As the field of Learning Analytics matures, the focus of theory and practice is moving from post-hoc analysis to the exploration of the possibilities that real-time data can bring (West, et. al, 2015).

What are Learning Analytics?

Throughout the literature, diverse definitions of Learning Analytics can be found (LAK2011; Slade and Prinsloo, 2013; Siemens, 2010; Boyd and Crawford, 2012; Donoghue, Horvath and Lodge, 2019; Lockyer, Heathcote and Dawson, 2013). Emerging from the ongoing discussion has been a degree of consensus for a working definition from the First International Conference on Learning Analytics and Knowledge - "Learning analytics is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs" (LAK2011). (Slade and Prinsloo's (2013) interpretation of the definition is interesting as it includes an ethical angle. They state that Learning Analytics is "the collection, analysis, use and *appropriate* dissemination of student-generated, actionable data with the purpose of creating appropriate cognitive, administrative, and effective support for learners (Slade and Prinsloo, 2013). Analytics used for teaching and learning decision making and analysis are becoming more important for informing teachers on the success or otherwise of their design of learning experiences and activities, together with the monitoring of student learning for support during the teaching period (Lockyer, Heathcote and Dawson, 2013). Although different definitions exist, most researchers agree that big data, which is often used by analytics, involves large volumes of data gathered by different organisations (Koronios, Gao, and Selle, 2014). Siemens (2010) defines Learning Analytics more specifically involving the use of intelligent data and analytical models to discover connections as well as to predict and advise on learning (Siemens, 2010). Boyd and Crawford (2012) see the term of *big data* as an inaccurate one, as it is less about the data and more about the capability to sift, aggregate and cross-reference useful information buried in large data sets – “Businesses are collecting more data than they know what to do with” (McAfee and Brynjolfsson, 2012, p. 59). This is true for Australian universities (Colvin, et. al, 2016). Donoghue, Horvath and Lodge (2019) describe Learning Analytics as an emerging field that has the purpose of supporting, enhancing, facilitating, predicting and measuring human learning in an educational setting. In a review of the literature on LA, Strang (2016) concludes there is an emphasis on prediction as a reason for employing learning analytics. For the purposes of this study, we used Lockyer, Heathcote and Dawson’s (2013) definition, being the collection, analysis, and reporting of data associated with student learning behaviour. We adopted this definition because it encompasses the original definition from the LAK2011 conference and focuses on student learning.

The outcomes of research into what makes a successful Learning Analytics implementation illuminate issues that are a priority in successful implementations. Knowing this allows for the strategic improvement of teaching and learning outcomes. Considerable variation in students’ manner of engagement with their learning environment (Coates, 2008) has been noted, so it is advisable that the derived analytics be a reflection of their preferred style. If we make the individual student the unit of analysis, we create opportunities for optimisation strategies to be developed tailored to a student’s unique learning style. This inherently inclusive pedagogical approach caters to the learning styles of students with broadly divergent backgrounds, including students with disabilities. Strang (2016) examines a study of students and their engagement with Moodle (LMS). The study presents a snapshot of in time of student learning, however the authors finding report that Learning Analytics in this case was not able to predict student learning performance. This paper examines the Delone and McLean model of Information Systems Success as applied to Learning Analytics systems at three Australian universities. This example of digital intervention is useful to illuminate issues associated with learning and teaching supported by learning analytics. Learning Analytics is an information system. Delone and McLean’s model details a comprehensive framework for assessing the performance of information systems in organisations (Delone and McLean, 2003). Said model is robust, having been applied to information systems across a broad range of types over an extended period. The model will be applied to Learning Analytics in order to find specific areas that Universities can focus on to ensure a successful implementation of the system. The authors are unaware of any earlier instances of Delone and McLean’s model being applied to Learning Analytics, though some preliminary work has been done by Strang (2016) examining the critical success factors involved in Learning Analytics implementations.

Information Systems Success

As stated, we classify Learning Analytics systems as belonging to the broad category known as information systems. By definition, an information system involves gathering, processing, distributing and using information by input, processing and output, with a storage and feedback component (Beynon-Davies, 2013). We argue that Learning analytics can be classified as an information system as it refers to the process of collecting, evaluating, analyzing, and reporting organisational data for the purpose of decision making (Campbell and Oblinger, 2007). Information systems implementations are not known to have a good track record in terms of successful implementations (Nguyen, Nguyen and Cao, 2015). Indeed, it has been noted that a large percentage of information systems implementations are a failure (Beynon-Davies, 2013). The authors consider it appropriate to apply the information systems success literature to the implementation of Learning Analytics systems.

The literature on information systems success is extensive. A key development of the theory of information systems success were authors Delone and McLean (1992). The authors have since updated the theory after contributions from IS scholars to create a better model. The information systems success model has been cited in thousands of papers and has been one of the most influential theories in contemporary information systems research (Nguyen, Nguyen and Cao, 2015). It provides a solid foundation for examining the success or otherwise of Learning Analytics implementation, particularly in relation to the strategic improvement of learning and teaching outcomes.

Delone and McLean performed a systematic review of available published material relating to the success of information systems in organisations.

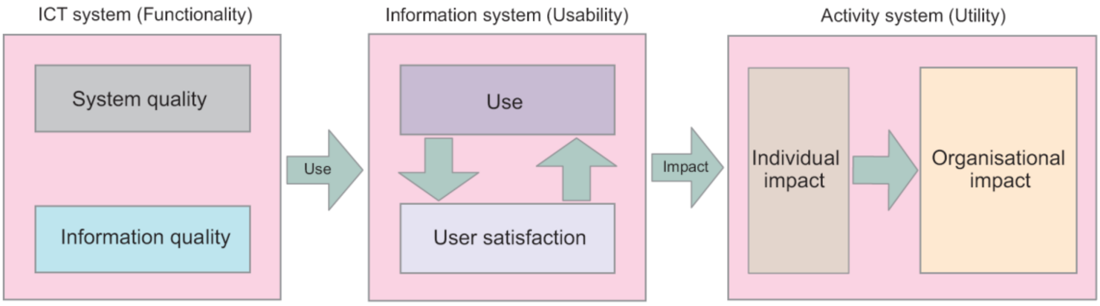

Figure 1: Delone and McLean Model (Delone and McLean, 1992)

There are three main elements to the model. Firstly, the ICT system or Functionality. The system quality focuses on the desired characteristics of the information system whereas the information quality considers the quality of the output from the system. The second element looks at Usability. This element examines how the users interact with the information system in terms of whether the user interface is user friendly and allows them to do what needs to be done. The last element, the Activity system or Utility focuses on the overall impact the information systems has on the individual and the organisation as a whole (Nguyen, Nguyen and Cao, 2015; Beynon-Davies, 2013).

The model was updated in 2003 by Delone and McLean and now includes additions such as the intention to use as well as the use and the overall individual and organisational impact being viewed as the net benefits that include user satisfaction and the use of the information system (Nguyen, Nguyen and Cao, 2015) (see Figure 2 below).

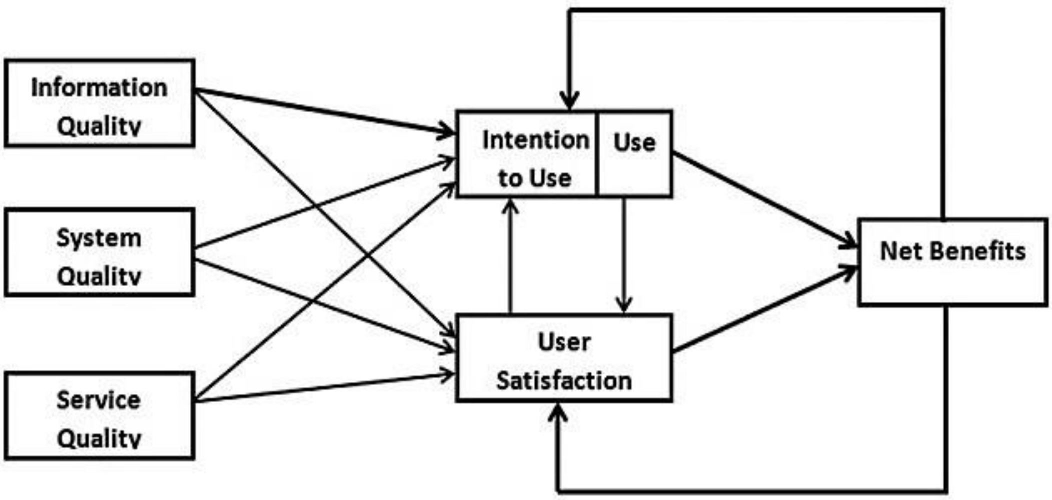

Figure 2: The updated Delone McLean information system success model (Delone and McLean, 2004).

The Delone and McLean model has primarily been used in quantitative studies, but other studies exist that focus on qualitative research. Out of 90 empirical studies outlined in Petter, Delone and McLean (2008) the following qualitative studies were mentioned in Coombs et al, 2001, Scheepers et al, 2006 and Leclercq, 2007. In this project, we put elements of the Delone and McLean model to a qualitative data analysis. In doing so we examine the potential of learning analytics to deliver appropriate functionality and usability to create an information system that delivers actual value to a diverse cohort of students with varying learning styles.

Research Approach

After consideration of the alternatives, the case study approach deemed suitable to the purposes of this project. Researchers have used the case study approach in research across a wide range of disciplines for many years, seeking to understand complex issues. This research aligns with the perspectives associated with the case study approach. Yin (1984) defines case study research as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident"; and in which multiple sources of evidence are used (Yin, 1984: 13). Case studies are often used in research because they offer insights that may not be achieved with other approaches (Rowley, 2002). As the generalisability of the case study approach is sometimes questioned, it is best to establish validity using multiple case studies. Multiple case designs are preferred to demonstrate validity. Having multiple cases can be regarded as equivalent to multiple experiments as opposed to having a single case or single experiment (Rowley, 2002). The case study approach is very suitable for exploratory investigations where there is little or no prior knowledge of reality or of a phenomenon (Järvinen, 2001). Performing qualitative research enables the researcher to study events within their real-world context and this includes the relevant culture of the people, organisation, or groups being studied. It is crucial that the culture, that is, the unwritten rules and norms governing the social behaviour of groups of people, is considered when conducting this project (Yin, 2011).

Interpretive research has emerged as an important branch in information systems research in recent years (Walsham, 1995). Interpretive research is thought to assist Information Systems researchers in understanding human thought and action in social and organisational contexts. It also has the potential to produce deep insights into information systems phenomena (Klein and Myers, 1999). The research design for this project is an interpretive case study that will be analysed through qualitative methods. As the interpretivist perspective will be taken, the world will be viewed as a social construction of reality, interpreted and experienced by people and their interactions within the wider social systems in which they exist. According to this research paradigm, the nature of inquiry is interpretive. The intended purpose of the inquiry is to understand a particular phenomenon, not to generalize a population (Antwi1and Hamza, 2015).

The foundation of a research study lies with the data collected (Yin, 2011). According to Yin, (2011) data collected in qualitative studies come from four field-based activities: interviewing and conversing; observing; collecting and feeling. This research study adopted the following data collection methods: in-depth interviews, direct observation, and examination of relevant documentation (Yin, 1994).

Data collection and analysis

Data collection began with an approach to the Deputy Vice Chancellors (Research) at each university outlining the project and seeking permission to approach appropriate members of their university community. The DVCs(R) were supportive in their responses. Having obtained approval, key staff were identified at each university. These persons were selected based on their direct involvement with Learning Analytic Systems. In-depth interviews were subsequently conducted with the aforementioned staff at each university. The interview protocols were designed around the key issues derived from an extensive literature review on Learning Analytics around the world (Levy and Ellis, 2006). A documentation review was also conducted around the Learning Analytics policies in place at each university.

It must be noted that this is an exploratory study to establish a benchmark of Learning Analytics practices at representative Australian universities. The Delone and McLean (1994) model was not used to inform the research questions at this stage but will be used in the next phase of the research.

The interviews were recorded and transcribed. The interview data was then coded, and analysis performed using exploratory thematic analysis (Braun and Clarke, 2008). An interpretive approach was taken with the analysis, as the researchers felt it was ideal to represent the perceptions of the staff interviewed about the Learning Analytics system implementations. We acknowledge that Learning Analytics systems are quantitative and therefore measurable in nature, but the subjective impressions that staff have about Learning Analytics are best explored through a qualitative lens for the purposes of this exploratory study.

Case Studies

Data for the Case Study was collected from three demographically diverse Australian universities, two of which were metropolitan, the third being a regional university. The demographic spread of the data sources permit a broadly inclusive view of the Learning Analytics situation in Australian universities.

University One

University One is a public research university servicing low to middle socio-economic areas. A higher than average proportion of its students are first in family, have diverse needs and in some cases have a lower entrance score than those of their immediate counterparts.

University Two

University Two is also a public research-intensive university servicing a middle to high socio-economic demographic. This university is perceived both locally and internationally as prestigious. It routinely attracts students with high entrance scores.

University Three

The third test site is a regional university servicing a large agricultural base, and which has specialized in offering on-line programs for which it has a good reputation. The greatest proportion of total enrolments are online students. These come from widely varying backgrounds, including Low SES, mature aged and professionals seeking career enhancement.

Learning Analytics Implementations

It was immediately clear that each of the data collection sites had adopted different approaches to Learning Analytics. Two used a centralized software suite (though different suites), the third took a course-by-course approach taking account of what information the lecturers wanted from the exercise.

University One

In cooperation with the makers of the Blackboard Learning Management System (LMS), a full-function Learning Analytics Dashboard had been implemented in University One since 2016, beginning with a pilot in that year. The dashboard has since been rolled out and made available to the broader university community. The project was coordinated by the university's Professional Development Department. The dashboard provides a configurable, fine-grained view of student's interactions within the on-line learning environment. This included frequency and duration of access to specific on-line pages. From this it is possible to deduce degree of engagement and a number of other metrics and indicators such as when a student is falling behind with meeting their milestones. Proactive interventions can then be performed via email. One of the challenges with the Dashboard was the volume of data generated and the finding of ways to meaningfully use it.

University Two

University Two established a dedicated Learning Analytics department with the mandate to establish and optimize Learning Analytics as a tool for improving student outcomes. The Tableau© software suite is the tool of choice. Tableau© draws performance data from every course at the university, monitoring how the course performs in terms of student attendance, engagement with specific course material, student evaluation scores and a range of other metrics. Performance is evaluated through the application of specific performance indicators situated in the within the context of a mature quality framework. Meaning analytics emerging from this quantitative management approach is then used by course conveners to progressively improve the quality of their courses.

University Three

At the third site, a decentralized approach to Learning Analytics was observed. Each course convener has access to a plug-and-play tool-set with which a tailor made Learning Analytics application can be developed. These applications were not necessarily developed from scratch. A range of templates and suggestions provided guidance for conveners. The usefulness of the results across the various implementations varied depending on factors like the lecturer's programming skills, their understanding of what the capabilities of using such a system might be. Usefulness also depended on several other factors including how busy with other matters the convener was.

Analysis

This section presents the analysis that was conducted using exploratory thematic analysis (Braun and Clarke, 2008). The interview data was coded, and analysis used thematic analysis (Yin, 1994). An interpretive perspective was taken in the analysis as the researchers felt it was ideal to represent the perceptions of the staff interviewed about the Learning Analytics system implementations.

Learning Analytics implementations at Universities is still in its infancy

Even though analytics has been used to good effect in business for some time, the use of analytics at universities is in its infancy. In some Australian universities, analytics is the responsibility of their Business Intelligence departments, as in the case of University One. Learning analytics research is closely related to the field of educational data mining. This field has relevance for understanding and optimizing the learning process (Siemens and Baker, 2012) although much of this research has focused on developing predictive models of academic success and retention (Siemens, Dawson, and Lynch, 2014). In another example, University Two, an entire section is devoted to learning analytics, including the business intelligence area and academic analytics, which includes course analytics. University Three is taking a more adhoc approach so there is no formal department or unit devoted to learning analytics.

Defining 'Learning analytics'

Although some progress has been made, there is as yet no clear consensus on what the term 'learning analytics' means (Van Barneveld et al, 2012). Siemens (2013) posits that as the field evolves an authoritative definition will emerge. Perhaps the difficulties in achieving consensus is because Learning Analytics is a relatively new field, or perhaps the reasons are more complex.

It is self-evident that we operate in an increasingly data-driven environment. Analytics can be applied to specific areas like health and safety analytics, or it may apply to an intention, such as learning analytics in relation to improved learning outcomes, and predictive analytics. Or the term may also apply to the object of analysis, for example Twitter analytics, Facebook analytics, Google analytics. Van Barneveld et al (2012) note that higher education's approach to defining analytics is particularly inconsistent. They found that some definitions were conceptual (what it is) while others were more functional (what it does).

In any event, interested observers use the term in various ways in relation to Learning Analytics. For example, some consider that 'learning analytics' *per se* do not exist since no learning takes place with the use of analytics. It is a meta-level pursuit. A professor interviewed from University One views learning analytics as the managing of student behaviour and the promotion of engagement rather than actual 'learning' taking place with the use of analytics. The course analytics project at University One utilizes Blackboard and is concerned with mapping students' engagement behaviour. The system is a meta-level window into their learning. It is not feeding information back to students about their learning. University two takes two perspectives on learning analytics:student facing and academic facing. University three views learning analytics as improving the use of data and evidence to improve learning and teaching outcomes, doing so on a course-by-course basis.

Student facing analytics versus Academic facing analytics

As noted, we see that different Learning Analytics definitions exist but we ask are these definitions talking about the same thing. A finding from the case study interviews was that participants view analytics as either student facing or academic facing. Long and Siemens (2011) introduced the categorisation of learning versus academic's analytics. Where learning analytics included course-level and departmental analytics as opposed to academic analytics including institutional, regional and national and international analytics. The categorisations were at the objective analysis along with who benefits. In learning analytics, the beneficiaries are learning and faculty whereas the institutional, regional and national and international analytics were at a more systematic level (Long and Siemens, 2011). At University One, student facing analytics is instantiated by feedback to the student about how they are going, for example, are they keeping up with workload/assessment? In this university, the nature of the information in the student facing analytics is distinctly different from that of the staff facing analytics. It is qualitatively different data that poses different challenges in the formulation of meaning by the academic. One academic in the trial commented that there is clearly a lot of potential in this data, but it is not clear how it can be derived. University Two is in the process of building a student dashboard, currently in beta phase in 2019. The beta is being trialled in the medical degree. The choice of student cohort to test the beta upon highlights that different cohorts in different disciplines will probably use the dashboard in distinctly different ways. High achieving medical students' intent on maintaining high grade point averages (GPA) will use the analytics as a strategic tool to maintain their GPA, whereas students in less-demanding programs will likely use the analytics differently, if at all. The majority of work done at both University One and Two make up this classification of academic facing analytics.

Learning analytics applied to course design

The application of learning analytics to course design was different in the three universities. University One was using Learning Management Systems (LMS) centric models supporting staff making better course management and course design decisions based on a series of dashboards. Although this work is very much in its infancy, based on a one-year pilot implementation. In university one, participants stressed that the first four weeks of any semester is crucial to engaging the student. "*So, how do you capture those students? And modelling who they are and taking note of all the different types they are*." (University One participant). This university had a process called first assessment; first feedback where those students who did not submit or who failed their first piece of assessment were invited in and staff worked with them to remedy the shortfall. "*Those that picked up the intervention went on to do very well but you would be surprised how many of those were hard to find and some un-contactable or disappeared. And what we concluded was, by week 4 they psychologically dis-enrolled from university*" (University one participant).

University One had also experimented with predictive modelling concerning at-risk students and attrition. It is very easy to diagnose risk at this university, for example it is possible by week 4 of the trimester to determine to an accuracy of 90%, who is going to fail the course, but it is very difficult to act on prevention strategies *"students don't read their email"* University 1 participant). Early intervention is critical. As an interview participant noted "*too often we are very clever at measuring problems rather than presenting potential preventative solutions that don't require analytics but require a lot of common sense, you know, like for example, we can track student's engagement with a course but you know you don't need analytics to tell you that a small piece of early assessment, give them clear feedback and be available for consultation. Good design is still good design and good support and good teaching is still good teaching*." (University one participant).

University One has created a course analytics system in conjunction with Blackboard. They also have a planned system called Analytics for analytics, which is basically tracking the analytics of engagement. The purpose is to get a supra-level institutional snapshot of engagement in addition to the course level snapshot.

University Two had advanced analytics running on all courses that are offered utilizing the Tableau Tableau© is a proprietary Business Intelligence and Analytics software software. Tableau© is a proprietary Business Intelligence and Analytics software package offering a range of useful functions. On-going risk assessment of every course is performed via this software. The Associate Dean Academic in each school then scrutinises the results. You can take any course and look at the risk factors (scale of 1-3) and see whether the course is at risk in any way. Student evaluation data is also integrated into this system. As an example of a risk factor, declining class numbers (enrolment) are tracked.

Academics at a supervisory level in each school regularly reviews the Tableau© reports to evaluate risk for each school. In an example mentioned during an interview, a course was shown that was not attracting particularly high enrolments at the current semester. Instead of having only intuition to go on, data could be used to determine the root cause of this drop in enrolments. Student evaluations of teaching and learning were loaded into the Tableau© software along with other markers providing data on the current situation. Staff in the Learning Analytics department could drill down into different areas to get more detailed data on all elements of the course.

At University Two, based on examination of previous student behaviour, predictive data analytics was used to interrogate the database and identify patterns. "*You then bring that into the moment and go ok, I now understand the student journey in my course a whole lot better cause I know where they drop off and where they fail. So what I do is put in a series of automated outreach recommenders to those students and then I can use the analytics to monitor the effect of those. I send a recommender to do some more work on getting ready for the assignment and I note that 60% of them pick that up and ran with it. I note that 40% didn't so then I have a triage model and I get my second recommender goes to that 40%."* (University two participant).

Benefits, Limitations and Challenges of Learning Analytics implementations

Interview participants in the three university case studies were asked about their experiences of learning analytic benefits, limitation and potential challenges. In summary, participants recognised the following benefits from learning analytics:

- Increased data literacy of staff, allowing the formulation of optimization strategies
- Evidence-based practice that generates reliable/usable data
- Data-driven decision making, i.e. quantitative management of student learning

- Observing what enhances learning and what detracts from learning
- De-privatising the classroom which can be an uncomfortable conversation
- Greater accountability on the lecturer and transparency of the conduct of courses
- Improved enhanced student experience of the course
- Quality assurance at the institutional level
- Potential to link artificial intelligence to the analytics to automate/optimize the process.

Regarding limitations, the participants felt that the benefits outweighed the limitations by a big margin. Overall, participants mentioned the cautions of being on the web, for example security issues, would be applied to learning analytic implementations. A major theme across the three university case studies was the idea of uninformed inferences. Educators need to be careful what they infer from learning analytic data (. An interview participant notes that just because a student is logged on to a LMS doesn't mean they are engaged in the course material "*It is like mistaking the leaves for the wind. Measuring the movement of the leaves but the wind is something different*." The information might be misinterpreted in misleading ways due to not understanding the implications of making uninformed inferences.

In terms of challenges, the issue of technology acceptance and resistance was highlighted amongst participant interviews. "*Staff get caught in the headlights very quickly. Show them a dashboard and they go …. It is like oh my god. What does all this mean*?" (University one participant).

Using data to support learning is a new way of thinking, one which calls for a new set of skills to look at a set of data and derive useful information from it. The major challenge mentioned by staff at University One is that they are busy and do not have time to look ponder over the data. This would seem to indicate that most of University One's teaching is based on a delivery model rather than a feedback model. Also, at University One, there is not a culture of continuous feedback and improvement. People feel they are time poor and do not see a clear benefit in investing time and effort in wrangling the data on the possibility of getting something worthwhile from it. The way forward is not clear, so further effort is deferred.

According to University One, the perception among staff interviewed is that the success of Learning Analytics implementation is dependent on upper management sponsorship and the provision of scaffolded implementation strategies, that is to say ready-made templates that can be customised and deployed with relatively little effort. Success will be contingent on senior executive facilitating efficient ways of using the Learning Analytics technology. Success will therefore depend on who is in those senior positions.

Discussion

These are the "early days" of learning analytics (LA) in higher education. Optimized ways of using Learning Analytics are evolving in cycles of continuous improvement and doing so uniquely at each university. We note that each is evolving their own style in the absence an external, consensus-driven standard for how Learning Analytics can or should be used. This is a "double-edged sword" in the sense that the absence of standards is making it difficult to know how best to proceed, but it also opens up the field to a great many possibilities for those with energy and imagination.

The current situation favours proprietary platforms like Tableau© if said producers offer an off-the-shelf, customizable service that delivers real value in a user friendly way. We are likely to see more competition in this field, given the size of the higher education sector and the imperative to attract students.

The experience in University One shows that participants see potential in Learning Analytics but are not at all sure about how best to derive it. Given busy work schedules, the necessary trial and error effort over an extended period is likely to be a bridge too far for many course convenors. University Two is using their proprietary platform in constructive ways that demonstrate the effectiveness of their approach. University Three is pursuing a course-by-course strategy that is delivering value but in the less predictable manner than that seen with University Two.

One thing is clear, digital interventions such as learning analytics can do much to improve and inform teaching and learning practices. But it needs to be systematized for easy implementation, and must deliver tangible benefits over time.

This research expands the scope of use for Delone and McLean model as a descriptive tool. More in-depth qualitative research is needed to investigate this topic to gain a more high-resolution view of the situation. We note that in a review of 180 academic papers utilizing the Delone and McLean model, only four were qualitative studies (Petter, Delone and McLean, 2008). While Learning Analytics is concerned with the quantitative management of the teaching and learning process, quantitative studies are useful for understanding those "soft" factors like culture that are difficult to quantify but are nonetheless important.

Conclusion

While Learning Analytics is in its infancy, it nonetheless has an important role in the on-going improvement of the teaching and learning field. As a priority, Learning Analytics must seek to provide the benefits of improved user satisfaction. Petter, Delone and Mclean (2008) suggest that higher levels of user satisfaction are indicated by more frequent and intensive system use. We conclude that increased net benefits, as seen in the Delone and McLean model, can be derived from using Learning Analytics leading to higher levels of user satisfaction.

Analysis of the data suggests that when conducting research in the area Learning Analytics one should clearly define what is meant by that term in view of there being different interpretations. Universities could implement Learning Analytics systems that are either *student facing* or *academic facing*. The stakeholders and implications for Learning Analytics design will be different with each scenario. It should also be noted that the term Learning Analytics is an umbrella that covers many different systems. Learning Analytics is also frequently used to identify at-risk students as well as being used in a "recommender" capacity. These are among the first uses universities attempt when implementing Learning Analytics systems. This research has also shown that the benefits outweigh the challenges in terms of implementing Learning Analytics to improve teaching and learning.
While the Delone and McLean model was considered in the collection of data for this research study, more specific research will be performed to examine specific elements from the model using a qualitative lense. The researchers plan to revisit the case study universities and explore in greater depth the concepts around functionality, use and intention as related to learning analytics. As the Learning Analytics implementations were in their preliminary stages of implementations, it will be instructive to revisit and examine issues such as functionality once the systems have been in place for some time.

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The value of student attendance at face-to-face classes, as part of a blended learning experience

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eLearning can create more flexibility for students; more efficiently utilise infrastructure; and can provide high-quality learning at scale. We have investigated perceived value and learning gains associated with online (eLearning) and face-to-face (f2f) components of a blended learning experience. We hypothesised that individual student preference for eLearning and f2f learning would be variable but that participation in f2f learning opportunities would enhance student learning. Using a design-based research approach, we have evaluated blended learning with interactive eLearning materials, and a collaborative, active f2f class. We have combined qualitative evaluation survey data and quantitative f2f attendance data and student grades. Students overwhelmingly value active learning, both within eLearning materials and f2f classes. Final marks positively correlate with the number of f2f classes students attend. Analysis of a subset of intended learning outcomes (ILOs) shows that students who access the eLearning materials independently and students who attend the f2f class perform equally-well in ILO-related assessment tasks; however, students are more likely to choose an assessment task directly-related to a class they have attended. We suggest that attendance at f2f classes as part of a blended learning experience is beneficial however students can sufficiently obtain selected ILOs from engaging eLearning materials.

Keywords: Blended learning; eLearning; student attendance

Introduction

This study explores the value (perceived and actual) of attendance at face-to-face (f2f) classes as part of a blended learning experience. Students are increasingly requesting more flexible study options, including the ability to engage with learning online due to inability to attend f2f classes (Brown, Davis, Sotardi, & Vidal, 2018; Norton & Cakitaki, 2016). Many major universities, including The University of Melbourne, are adopting teaching and learning strategies that require their educators to provide fully online and blended learning opportunities (FlexAP project, https://about.unimelb.edu.au/teaching-and-learning/innovation-initiatives/pedagogy-and-curriculum-innovation/flexap-project). Here we have utilised a design-based research approach to evaluate changes made to a blended second year undergraduate cell biology course.

Early definitions of blended learning refer to a blend of asynchronous text-based online material and synchronous f2f learning (Garrison & Kanuka, 2004), but as technology has evolved, so too has the definition (Sharpe, Benfield, Roberts, & Francis, 2006). Further descriptions of blended learning introduce the concept of ‘strong’ and ‘weak’ blends, depending on the amount of eLearning and also discuss the variable media and activity blends available (Littlejohn & Pegler, 2007). The Joint Information Systems Committee (JISC) define blended learning as “a combination of face-to-face learning and dynamic digital activities and content that facilitate anytime/anyplace learning” (Hibberson & Barrett, 2017). We define blended learning as requiring two key components: a f2f component that must occur synchronously; and eLearning that can be accessed asynchronously. It is of course possible for students to form study groups and access online material synchronously and in groups, but here we assume that the majority of our students access online materials independently and asynchronously.

The JISC definition refers to “dynamic digital activities”. Based on the Oxford definition of dynamic “characterised by constant change, activity, or progress” (Lexico Dictionary www.lexico.com/en/definition/dynamic), we believe that this could be interpreted in at least two different ways: i) that the digital activities are variable within and between learning sessions and between subsequent iterations of the same learning session with different cohorts; and ii) that the digital activities themselves are interactive and require elements of active student participation. We believe that both of these aspects of the definition of ‘dynamic’ are valid and in designing our digital activities we have included a range of different activities, chosen to best support attainment of ILOs, and to encourage student learning in different ways; and many of the activities themselves are also interactive rather than being static and predominantly didactic in nature. In the blended learning that we describe in this paper, attendance at the f2f classes is not compulsory and many students are unable to/choose not to attend the f2f classes. We also understand from personal communication with current and previous students that many students prefer online learning while other students prefer f2f learning. This led us to question the value of these f2f classes. Specifically, we are interested in investigating the following: How do students value the f2f and online components of the subject and how does each component support student learning? If students do not see value in f2f classes and these do not further support their learning, we should consider whether these classes are necessary. Conversely, if these classes significantly enhance student learning, regardless of whether students see value in them, perhaps attendance at these classes should be further encouraged or mandate.

Active learning takes a constructivist approach to learning whereby students learn through active participation rather than passive transmission (Freeman et al., 2014; Waldrop, 2015). A key aim of active learning is to increase 'deep', transformative learning that can change learners perception of the world and develop new representations of knowledge (Biggs & Tang, 2007; Entwistle & Ramsden, 1983; Marton & Saljo, 1976; Prosser & Trigwell, 1999). We therefore define active learning as that in which students do not passively 'absorb' information, but actively develop their understanding and practice application of knowledge and skill through interactive learning activities, discussion with their peers and teaching staff and ultimately learn through a process of discovery. Examples of active learning include: group problem-solving; completing worksheet activities; participation in tutorials; answering 'clicker' questions or in-class polls; participating in peer instruction; and participating in workshops (Freeman et al., 2014; Matsushita, 2017). There is little debate that active learning is beneficial and should be included where appropriate (Chickering & Gamson, 1987; Freeman et al., 2014; Waldrop, 2015).

Active learning is often combined with 'flipped classroom' (EDUCAUSE, 2012) such that pre-class materials must be studied by students at their own pace before attending an active learning class in which students engage in discussions with teachers and peers. Although research on flipped classrooms is still in a nascent stage (DeLozier & Rhodes, 2017) it has been argued that the method is particularly beneficial to students whose performance in traditional educational environments is impaired (Du, Fu, & Wang, 2014). A key element of active learning that we took advantage of in both our online and f2f components was interactive knowledge checks within the online material, as flipped classrooms have been shown to increase attainment of learning outcomes when quizzes are included in their design (van Alten, Phielix, Janssen, & Kester, 2019) and several studies have shown that practice tests improve learning (Butler & Roediger, 2007; Cranney, Ahn, McKinnon, Morris, & Watts, 2009; Vojdanoska, Cranney, & Newell, 2009). As it has been reported that practice testing with feedback consistently outperforms practice testing alone and protects against perseverance errors, we ensured that all knowledge checks provided students with formative feedback (Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013).

We therefore acknowledge the significant potential to maximise student learning through the use of both blended and active learning strategies. Based on our definition of blended learning, both the online and f2f components can be inherently 'active' and as such our blended learning could be described as active blended learning. Here we describe an intervention in which the use of active learning strategies was increased in both online and f2f components of a blended course and evaluate these changes in an attempt to differentiate between the value provided by the active online learning opportunities and the active f2f learning opportunities

A design-based research approach

Design-based research is a relatively new but well-established methodology which combines "empirical educational research with the theory-driven design of learning environments" (The Design-Based Research Collective, 2003). More recently, 'design thinking' (Elliott & Lodge, 2017) has emerged as a key theme in "Visions for Australian Tertiary Education" (James, French, & Kelly, 2017). A framework has been developed that places educational design research along a continuum of the design process: from analysis and exploration of a pedagogical issue and context; to design and construction of an intervention; and finally to evaluation of and reflection on this intervention and implications to the broader context (Kopcha, Schmidt, & McKenney, 2015; McKenney & Reeves, 2018). A comprehensive review of undergraduate student experience of blended eLearning has highlighted the requirement to "use blended learning as a driver for transformative course redesign" (Sharpe et al., 2006, p4). These recommendations encompass a design-based research approach, reminiscent of that which we have utilised here. Here, we focus predominantly on the design and delivery of an intervention required to address changes in infrastructure and analysis of preliminary empirical evidence collected to evaluate this intervention.

We have designed and implemented changes to a second-year cell biology course, with approximately 120 students, at a large Australian University. The course is taught through lectures and 'computer-aided learning' (CAL) classes, this study focuses solely on the CAL classes. Due to an upcoming change in learning management system (LMS), existing CAL eLearning materials were required to be redeveloped in a new platform. In addition, infrastructure changes enabled the f2f CAL classes to be relocated from a 1:1 (student:computer) computer lab to a brand new, purpose-built collaborative learning space (Figure 1). The CAL eLearning materials were originally designed to be accessed by students individually in the 1:1 CAL lab. The building change and changing student demographics, specifically an increase in student 'BYOD' (bring-your-own-device) has decreased the necessity to provide timetabled teaching in CAL labs and a global shift toward collaborative active learning has identified the opportunity for these eLearning materials and the associated f2f classes to be redesigned. Attendance at CALs is not compulsory and attendance rates have progressively declined over the past years (personal observation). We wanted to make optimal use of the new collaborative learning space and create more engaging eLearning materials. We hoped to encourage student attendance by providing a valuable f2f learning experience but also to provide an active, solely online learning experience for students unable to attend the f2f classes.

There are eight CALs for this subject (CAL1-CAL8) and changes were progressively introduced across the semester. In an attempt to minimise the impact on teaching staff and to mitigate student expectations we implemented a 'soft' transition, whereby more minor changes were introduced this semester with an aim to iteratively make further developments over subsequent semesters. The developments we have introduced and evaluated so far are:

1. redesigning pre-class and f2f eLearning materials in a new software package;
2. moderately increasing the amount of pre-class ('flipped') eLearning; and
3. moderately increasing the amount of f2f active learning.

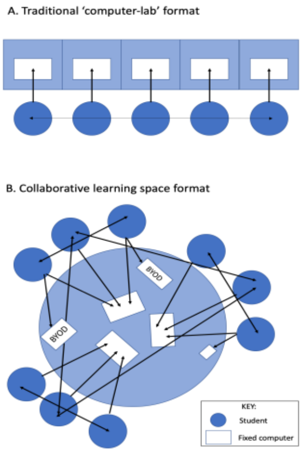

Figure 1. Schematic representation of two learning spaces.

A. Traditional 'computer-lab' format. The main interactions occur between individual students and eLearning resources on fixed computers; some inter-student interactions occur. B. Collaborative learning space format. Fully blended interaction occurs between students, tutors, fixed computers and various students' 'bring-your-own-devices' (BYOD).

We chose to redevelop the eLearning material in Articulate Rise (Articulate 360, Articulate Global, Inc. 2019) as this facilitated inclusion of various design elements that we believed would make the material more interactive, accessible, responsive and ultimately enhance student learning. For example, the software allowed us to implement different ways for students to engage with the material, from activities in which students had to categorise information (sorting activities) to exercises in which they could click on interactive images to receive more information (hotspot activities) and activities in which they had to connect concepts to their definition (connecting activities). The original CAL eLearning materials contained some interactivity, but we extensively increased the number of interactivities in the redeveloped eLearning materials. To illustrate this, the number of interactions increased from 53 to 112 in eLearning materials for CAL7.

In CAL7 we utilised a team-based learning (TBL) approach for the f2f class. TBL is a structured form of active, small group learning that has been shown to enhance mastery of course content (especially for students in the lowest academic quartile) (Koles, Stolfi, Borges, Nelson, & Parmelee, 2010), and can be scaled up for implementation in large classes (Michaelsen, 2002; Parmelee, Michaelsen, Cook, & Hudes, 2012; Rajalingam et al., 2018).

TBL consists of various phases (Michaelsen, 2002; Parmelee et al., 2012). Here we describe the key phases as performed in our classroom. In the preparation phase, students work through pre-class materials, in our case an eLearning module introducing the most important concepts and methods to study cell proliferation and the cell cycle. The f2f phase commenced with an individual Readiness Assurance Test (iRAT), consisting of ten multiple choice questions (MCQs) related to the pre-CAL eLearning. This was then immediately followed by the team Readiness Assurance Test (tRAT). Student groups answered the same ten MCQs, but this time utilised peer instruction and discussion to come to a consensus on their answer. We developed a bespoke tool in Qualtrics which enabled the provision of immediate feedback on incorrect submissions until the correct response was discovered and included a scoring system that added an element of gamification to the activity. In the third f2f phase, the team Application (tAPP) students applied their learning to a series of research-based case studies. Various online tasks were created to accompany student progression through these activities including posting images of a graph of expected results from an experiment through Padlet and responding to MCQs via PollEverywhere. As student groups submitted their responses to these activities, class wide discussions were conducted, and students were encouraged to defend or explain their responses. The best discussions occurred when there were conflicting opinions about the correct answer and indeed the questions and answers were designed to encourage debate rather than to represent 'correct' and 'incorrect' answers. In many cases all answers were valid, and we believe the most powerful learning took place when students realised that there were strengths and weaknesses to all options.

We have initially examined student opinions of all eight CAL classes and have examined the correlation between attendance at CAL classes and final scores. We have then conducted a more focused analysis on CAL7 to compare the value of the active eLearning material and participation in the team-based active learning tasks in terms of perceived learning and demonstration of intended learning outcomes (ILOs) in constructively aligned summative assessment tasks. Qualitative data analysed were anonymous student evaluations of the course. Data were obtained from online and paper-based questionnaires, transcribed and imported into NVivo for coding and memoing. Data were progressively coded to identify key themes and then calculate coverage of relevant comments by the key themes. Specific quantitative data analysed were student LMS access dates; f2f class attendance records; mid-semester test scores; end of semester exam question item analysis; and final subject scores. These data were collated in Excel and statistically analysed in GraphPad Prism 8.1.2 (2019). This research study was approved by the University of Melbourne School of Biomedical Sciences Human Ethics Advisory Group (Ethics ID: 1953765.1).

Results

To gain an overall impression of the benefit of attendance at CAL classes we conducted an analysis of student final marks and correlated these to the number of CAL classes they attended. We see a modest positive correlation with students who attend more CAL classes scoring higher final marks (Figure 2).

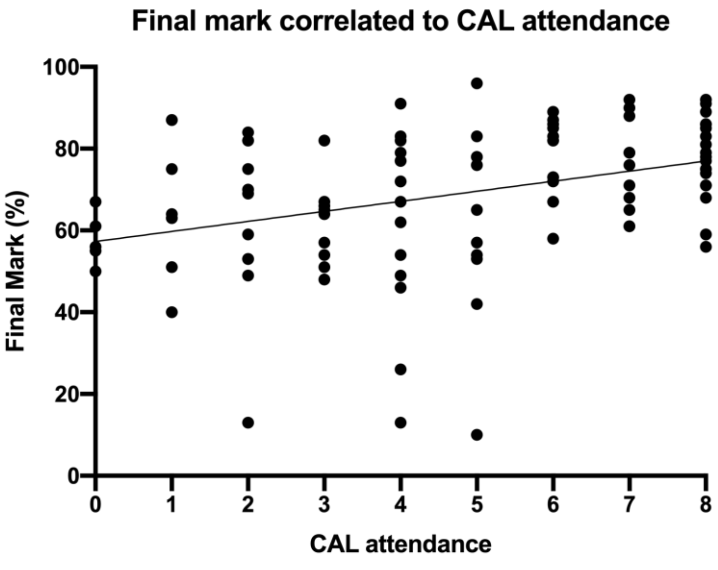

Figure 2. Attendance at CALs is correlated with significantly higher final marks.

Individual final marks (y axis, %) are plotted against the total number of CALs that students attended (x axis). Linear regression demonstrates that the slope of the line of best fit (slope=2.5, R2=0.1292) is significantly positive (p=0.0002) demonstrating a positive correlation between CAL attendance and final mark.

CAL7 followed a team-based learning (TBL) format and was formally evaluated to determine student opinion and impact on learning. In an end-of-semester subject evaluation students were asked: "Which CAL module assisted your learning the most and why?". Some students mentioned more than one CAL, but out of the eight CALs for this subject CAL7 was most frequently mentioned (n=26 students). The reasons students provided were subjected to a coded analysis and five major themes emerged: content; integration; interactivity; engagement; and team work (Table 1). When asked "Which CAL module assisted your learning the least and why?" only 5 students mentioned CAL7. Together these data suggest that overall, CAL7 was well designed and delivered and contributed positively to students' self-reported learning.

Table 1: Aspects of CAL7 that students self-reported helped their learning the most.

Theme	Details and student quotes (in italics)	Number of mentions / % text coverage
Content	Information; topics; concise; thorough and detailed; pre-CAL; related to lecture material; able to be self-taught; layout; clear explanations; diagrams; extensive and informative. *"The CALs tied specifics together."* *"The CALs were a good source for me to review and revise all the content which I learn in lectures."*	16 / 42.4%
Integration	Consolidation; relationship to prior knowledge, "bigger picture". "*The CALs were great, almost like forced revision, really consolidated learning."*	8 / 27.0%
Interactivity	Interactive; application; questions; workshop dynamic. *"The CALs resulted in my deepest learning in general. The interactive format and in-depth content explanations worked very well."*	8 / 16.8%
Engagement	Fun; interesting; engaging. *"I enjoyed the CALs and interactive style."* *'The CALs were the most beneficial as they were particularly engaging and fun to go through."*	4 / 8.0%
Team work	Team-based learning; incentive to participate; talking with peers; group-work. *"[...] learning it together with my friend clarified my understanding and stimulated my learning more."*	4 / 5.8%

Given that students reported that they felt that CAL7 helped their learning the most out of any of the CALs, we were interested to explore this in more detail and so conducted an intended learning outcome (ILO)-based evaluation of constructively aligned assessment tasks. We analysed student scores in a mid-semester test directly related to CAL7 and scores in a final exam question that assessed concepts and skills covered in CAL7. We were interested in evaluating the performance of students who attended the f2f class and participated synchronously ('Attend') and students who accessed the eLearning materials independently and asynchronously ('Async'). We also examined the performance of students who did not attend the f2f class or access the eLearning materials ('No access', as determined by LMS analytics). Students who attended CAL7 and students who accessed the CAL7 eLearning materials asynchronously achieved a significantly higher CAL7-related mid-semester test score compared to students who did not attend the class and who did not access the eLearning materials (Figure 3A). Interestingly, we saw no significant difference in CAL7-related mid-semester test scores between students who attended the f2f class and those who accessed the eLearning material asynchronously and independently. We also conducted a similar analysis of student scores in a final exam question directly related to CAL7 ILOs. Students who attended or asynchronously accessed the CAL7 eLearning material performed slightly, but not significantly, better than students who did not access the CAL7 eLearning materials (Figure 3B). These data suggest that the summatively assessed ILOs can be obtained through interaction with the eLearning materials and that there is no added benefit to students in attending the f2f class, in terms of directly-related ILO attainment.

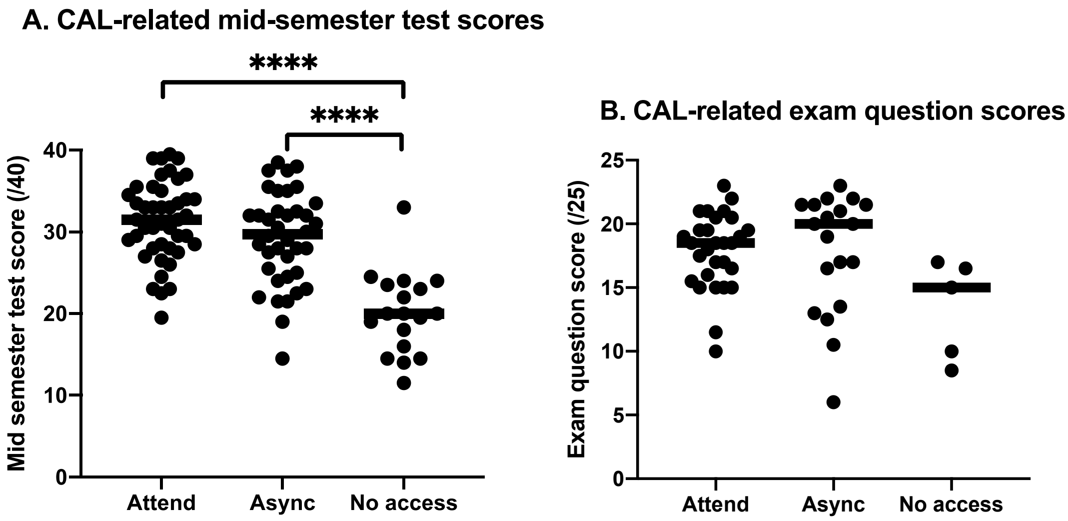

Figure 3. Students who attended CAL7 or accessed CAL7 asynchronously perform better in the CAL7-related mid-semester test compared to students who did not access the CAL7 eLearning materials.

A. Students who attended CAL7 (‘Attend’, median=32/40) and students who accessed CAL7 asynchronously (‘Async’, median=30/40) performed better than students who did not access the CAL7 eLearning materials (‘No access’, median=20/40), in a mid-semester test assessing ILOs specific to CAL7 content ($p<0.0001$). There is no statistically significant difference in performance between the ‘Attend’ and ‘Async’ groups. B. Students who attended CAL7 (median=19/25) and students who accessed CAL7 asynchronously (median=20/25) performed slightly, but not statistically significantly, better than students who did not access the CAL7 eLearning materials (median=15/25), in a final exam question directly related to CAL7 content ($p=0.0507$). Kruskal-Wallis test with Dunn’s multiple comparison test.

While we didn’t see a difference in median CAL7-related final exam question scores between CAL7-attendees, CAL7-asynchronous participants and students who did not access CAL7 we noticed that there were fewer students in the ‘Async’ and ‘No access’ groups who answered the CAL7-related exam question compared to the ‘Attend’ group. We therefore did a subsequent analysis of this observation.

The final exam was divided into three parts: a 20-mark MCQ section; a 40 mark (4 x 10 mark) short answer question section; and a 50 mark (2 x 25 mark) long answer question section. Students were required to answer all questions in Parts A and B, but Part C comprised four questions, of which students had to choose two to answer. Given that we saw no significant difference in scores for the CAL7-related Part C exam question we further asked whether attendance at CAL7 impacted the tendency of students to select the CAL7-related question. 48 students attended CAL7 and of these 30 (62.5%) chose to answer the CAL7-related exam question. 42 students accessed CAL7 asynchronously and of these 21 (50%) chose to answer the CAL7-related exam question. Finally, 22 students did not attend CAL7 or access CAL7 eLearning materials and of these, 6 students (27%) chose to answer the CAL7-related question. Given the available choices, there is a 50% expected chance that any student will answer any given question. Thus, there is a significantly higher percentage of students who attended CAL7 and chose to answer the CAL7-related exam question ($p=0.0104$, two-tailed binomial test). The number of students who chose the CAL7-related exam question and accessed CAL7 asynchronously fits with the expected distribution of 50% and unsurprisingly, students who did not access CAL7 materials were less likely to choose the related exam question ($p=0.0059$, two-tailed binomial test). These data suggest that students who attended CAL7 and were therefore able to discuss the material with their peers and tutors and who were able to participate in the team-based learning component of the active learning class may be more confident in selecting an exam question related to this material.

Discussion

Using a design-based research approach, we designed and delivered blended learning with interactive pre-, f2f and post-class eLearning materials. Our evaluations suggest that students valued the interactive learning activities both in the eLearning material and the active learning activities in f2f class. Moreover, student final marks positively correlated with the number of f2f classes students attended. The class that most students identified as best supporting their learning was CAL7. We have undertaken further analysis of this class, which utilised a significant proportion of 'flipped' pre-class eLearning content and a team-based learning (TBL) f2f active learning structure. Our data show that students who attended the f2f class and students who accessed the eLearning materials independently and asynchronously performed equally-well on assessment of CAL7-related ILOs in a mid-semester test. Students who did not access the eLearning material performed worse on average, than students who attended the f2f class and students who worked on the eLearning independently and asynchronously. We also found an effect of f2f class attendance on students' choice to answer a specific exam question, in that students who attended the CAL7 f2f class were more inclined to answer an exam question directly related to the CAL7 class they attended. These data suggest that while the content can be taught and learned via the eLearning materials, students gain more confidence in their knowledge and skill by participation in the f2f active learning components of the class.

There is a push to move more learning opportunities online to facilitate flexibility for students in terms of what and when they can study. We must make a decision as to whether it is appropriate to offer this subject solely online, if it should continue to be offered as a blended subject with non-compulsory attendance at f2f sessions or whether attendance should be mandated. Others have shown that attendance at classes positively correlates with scores (Devadoss & Foltz, 1996; Oldfield, Rodwell, Curry, & Marks, 2017). Our preliminary data support this observation. At an individual class-level (CAL7), despite students self-reporting that CAL7 helped their learning the most, we do not observe any significant learning gains in students who attended the f2f class versus students who accessed the eLearning materials asynchronously and independently. This demonstrates that we achieved our aim of creating engaging eLearning materials that benefit students equally, whether they are able to attend the f2f class or whether they access these materials independently and asynchronously. However, given that we show that the average final score is higher depending on how many f2f classes students attend, this could suggest that there is a collective benefit to students in attending a series of CAL classes. Reasons for this may include development of confidence in working as part of a team over the semester as well as increased subject-specific mastery due to more content engagement. We also question whether it is possible to replicate any advantages of attendance through engagement with an online classroom, for instance via a discussion board, synchronous video conferencing or other digital methods. These are ongoing areas of interest to us and we will further investigate this in future iterations of this subject.

While we show that student final marks tend to be higher with higher levels of CAL attendance, at an individual CAL class level analysis of ILO attainment we show that attendance at CALs is not beneficial in and of itself. This could of course be due to the fact that more able students may be more likely to attend classes. A positive relationship between prior grade average and class attendance and performance has been found previously (Devadoss & Foltz, 1996), and this is indeed an area that warrants further investigation. This could be further investigated by exploring the reasons that students don't attend classes. But there is no evidence from our qualitative surveys that suggests that students don't attend classes because they are intimidated or feel less able. The most common reasons are logistic: long commute times; clashes with other subjects; and clashes with non-study related commitments (e.g. part-time work, caring responsibilities) which is in line with previous findings that working more hours in paid employment, having more social life commitments, and facing coursework deadlines were, among other factors, predictors of poorer attendance (Oldfield et al., 2017).

One reason that students' performance was similar after the f2f class and after accessing the eLearning independently and asynchronously, may have been the fact that the mid-semester test and final exam questions asked students to remember, understand and apply knowledge, while TBL may also be effective to foster learning in higher levels of Bloom's Taxonomy (Allen et al., 2013; Anderson, Krathwohl, & Bloom, 2001). Moreover, students sat the exam and mid-semester test individually and the questions were more likely related to individual aspects of the students' learning, while the f2f classes, and the TBL-class in particular, were team-based. In future, we aim to shift the focus from individual assessment to the assessment of groupwork and we expect students who attend f2f classes to perform better on this type of assessment.

We saw a statistically significant difference between the mid-semester test marks of students who attended CAL7 or accessed the CAL7 eLearning materials independently and asynchronously. Data from a CAL7-related exam question showed a similar trend but the differences were not statistically significantly different. As mentioned above, one reason for this could be the variable group sizes as a result of skewed student selection of this exam question based on whether students attended the CAL class or did not access the eLearning materials at all. Another area to consider is the short-term versus long-term benefits of the learning intervention as it has previously been shown that TBL may induce short-term learning gains which do not persist in the long-term (Emke, Butler, & Larsen, 2016). The CAL7-related mid-semester test occurred earlier than the final exam, so the learning gains we observed in mid-semester test scores may reflect a short-term increase in student learning that is not retained over a longer timeframe.

Our findings support the further development and evaluation of interactive and active blended learning. One specific aspect we will focus on in the future is assessment reform and shifting the focus from individual to group assessment and from lower to higher order skills on Bloom's Taxonomy. Although our results show promising support in favour of fully online courses, it is also clear that the f2f interactions can significantly enhance student experience, which is key at the undergraduate level as students develop their self-regulation skills.

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Using discussion forums to support continuing education of workplace learning supervisors: enabling a community of practice

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Workplace learning (WPL) supervisors play a significant and fundamental role in enhancing university students' experiences during their placements. Supervision is a multi-faceted and complex interpersonal and professional activity, which requires continued education to ensure contemporary knowledge, practice and capacity. Increasingly universities are viewing the offering of continued education for industry supervisors as an aspect of their mandate. This research reports on the design, facilitation and evaluation of an online learning module, supported by an asynchronous discussion forum aimed at building capacity of WPL supervisors, and developing cross-disciplinary WPL relationships.

Using a mixed method approach, data were gathered using crude statistical measures including frequency counts of discussion postings, layered with thematic analysis of supervisors' postings to weekly learning activity stimuli. The results of the research illustrate the powerful opportunities for continued education offered by participation in a purposely designed and supported discussion forum. Participants felt empowered, supported by their online colleagues and enlightened by their enhanced awareness of others' practices and perspectives. Participants' capacity to further disseminate their embellished understandings of WPL supervision bought to the fore the far-reaching possibilities of discussion forum use in building professional communities of practice and professional capacity.

Keywords: asynchronous, community of practice, continuing education, discussion forum, online learning, professional learning, workplace learning

Introduction

Workplace learning supervisors play a significant and fundamental role in enhancing university students' experiences during their placements (Rowe, Mackaway, & Wincester-Seeto, 2012). While the role of the workplace supervisor could be primarily viewed as being the *eyes of the university* in monitoring, administering and observing the student, it is important to consider that supervisors offer far more. Supervision is a multi-faceted and complex interpersonal and professional activity, as the WPL supervisor "facilitates exposure to authentic experiences, provides a role-model and enables the student to find the potential for learning in their experiences" (Rodger, Fitzgerald, Davila, Millar & Allison, 2011). Thus, quality supervision is central to students gaining a positive and valuable workplace experience (Cooper, Orrell & Bowden, 2010). Given the multitude of responsibilities which encompass the supervisor's role, the question must be raised: Can supervisors effectively fulfil these roles without support and professional development? Thus, for universities, ensuring WPL supervisors are aware of the complexity of their roles and responsibilities is crucial (Patrick et al., 2008), and brings to the fore the call for supervisors to participate in continued professional learning related to supervision.

In order to support quality workplace learning supervision, a WPL academic in an Australian regional university, designed an online learning module offered as continued professional education to WPL supervisors across all health industries/professions. The module design was deliberately framed by Lave and Wenger's (1991) communities of practice concepts: joint enterprise, shared repertoire, and mutual engagement. The principal aim of the module was to build capacity of WPL supervisors, by providing a communal learning space for the development of cross-disciplinary WPL relationships, knowledge sharing and collaboration. To support the module, an asynchronous discussion forum was used as a tool to *gather* participants with differing levels of experience and competence, and act as a space in which *reflection on practice* could be made visible. As evidenced in the literature, discussion forums "facilitate reflective thinking as multiple perspectives and individual reasoning are made explicitly visible among groups of peers" (Lee-Baldwin, 2005, p. 94).

The module introduced an Australian regional university's industry supervisors to the expectations, roles and responsibilities of the placement supervisor, and offered opportunities for engagement with contemporary literature and resources to enhance their supervisory knowledge and capacity. Furthermore, by using a technology-enabled discussion platform, supervisors who were geographically dispersed throughout Australia were provided with an asynchronous dialogic space in which to share their experiences, stories, and histories of supervision, and offer ideas and solutions for negotiating the challenges associated with workload, modelling, reflection, debriefing, relationship building and dealing with 'difficult' students. The framework used in this research can be applied to a multitude of disciplines and global contexts.

The Modules

Conceptual framing: Communities of practice

As defined by Etienne Wenger, Communities of Practice (CoPs) are "groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (https://wenger-trayner.com/introduction-to-communities-of-practice/). In order to operate and identify as a CoP, three characteristics are crucial: i) domain, ii) community; and iii) practice. In a CoP, the *domain* refers to the commitment that participants have to a *joint enterprise* such as a task or aspect of knowledge, for example quality WPL supervision. As the *community* pursue their interest in the domain, they form relationships which evoke the sharing of information, challenges, solutions and expertise, resulting in *mutual engagement*. The CoP members learn to trust and support each other, and this sense of community promotes openness, discussion and provides conditions for reciprocal learning between members. The third characteristic, *practice*, refers to ways of doing the tasks within the domain of interest. The CoP participants develop a *shared repertoire* of resources: their WPL histories, stories, rituals, ways of dealing with issues, resulting in socially-constructed knowledge and shared competence. Framed by these concepts, the modules were designed to be intrinsically motivating, link to authentic workplace practice, provoke participant responses and promote interdisciplinary engagement (Verenikina, Jones & Delahunty, 2017).

Module content

Informed by the university's online pedagogical framework that includes the elements of learning communities, interaction between students, interactive resources, flexible and adaptive learning, and interaction with the professions, the WPL modules comprised 10 learning activities including:

1. My experiences of workplace learning;
2. Defining workplace learning;
3. What makes workplace learning unique?
4. Good practice principles;
5. Ensuring quality workplace learning;
6. Roles and responsibilities;
7. Building relationships;
8. Professional and practice-based standards; and
9. Personal reflection and evaluation of workplace learning.

Figure 1 illustrates an example of the module weekly learning outcomes and activities.

Figure 1: Example of module learning activities

In general, learning activities were introduced with a scholarly narrative, supported by stimulus material such as contemporary literature or media. These inclusions acted as springboards for reflection and interaction between module participants. Scaffolded learning activities, including retrieval templates, sensory charts, and guided discussion questions, assisted participants to gather their thoughts in response to the stimulus material, reflect on their contextual experiences, and respond to the probes/prompts. The time commitment involved for supervisors was approximately 90 minutes - 2 hours per learning activity, except for week 1. At the completion of the modules, supervisors who had posted responses to all 10 learning activities were issued with a certificate of participation.

The Discussion Forum

Technological Framing

An asynchronous discussion forum was selected as a pedagogical tool as it offered a range of affordances for the intended cohort. As the workplace learning supervisors were predominately employed full time, often engaging in shift work, the 'a'-synchronicity provided flexibility and convenience for the individual users. In addition, as a regional university with geographically-dispersed industry partners and campuses, the asynchronous nature allowed supervisors to actively engage despite differences in time zones. In essence, the discussion forum created a space in which all supervisors could participate by posting, which allowed their ideas, opinions and perspectives to be 'heard' by their colleagues. The requirement to respond to others' posts, represented the act of *listening* and acknowledging *hearing* what was posted: much like a 'head nod' in a face-to-face interaction.

Using a simple technology such as a discussion forum, catered for a diversity of participants to engage in continued professional learning without fear of navigating complex technologies, or relying on availability of, or access to, software in their workplace.

The forum was purposely presented in weekly forum categories to assist participants to access the appropriate week's response space and provide commentary on their colleagues' responses. Informed by the characteristic of *joint enterprise*, (Lave & Wenger, 1991) supervisors could focus on a challenge or issue or act of practice each week, and co-construct knowledge. Social interactions, meaningful discussions and developing relationships are the identified characteristics which aid capacity building and awareness raising of quality supervision practice. As a primary purpose of the online experience was to exchange expertise, it was essential to build a culture of discussion, and nurture collective understandings of and reflections on supervision practice (Hendriks & Maor, 2004).

In keeping with quality design practice of discussion forums (Verenikina, Jones, & Delahunty, 2017), the initial call for postings required supervisors to introduce themselves and frame their professional context, and supervisory experience. Figure 2 illustrates the introductory activity requirements. This initial learning activity assisted to establish a positive social learning space (Fleming, 2015).

My Experiences of Workplace Learning

Welcome to the workplace learning module for supervisors of CSU students. As industry partners you play a significant role in supporting, nurturing and professionally socialising our students.

This week we will share our experiences of workplace learning (WPL).

Learning Activity 1:

My experiences of workplace learning

- Click on the **Discussion Forum tab** on the left hand side tool bar of this site.

  Locate Week 1: My experiences of workplace learning and prepare a post that responds to the following questions:

  1. What is the context of your workplace? (dentistry, podiatry, paramedics, teaching);
  2. Briefly describe one experience you have had of workplace learning
     - Which year of student did you supervise?
     - What was your role?
     - For what duration did you supervise the CSU student/s?
  3. Why do you consider WPL to be important?
  4. Why did you enroll in these professional development modules?

Discussion Forum

- Read and comment on several other participants' Discussion posts.

Figure 2: Introductory learning activity

Operation

The university's learning platform played host to the modules and discussion forum. Participants were enrolled as 'guests' on the system, allowing access to the learning materials. The modules were offered within two of the three sessions of the university calendar, thus creating temporal boundaries for participants. The timing of these offerings was systematic as it aided in creating distinct 'cohorts' who used the university's discussion forum as a dialogic space and were placed to coincide with student WPL placements with industry partners. Creating distinct cohorts aided in building the characteristic of *community* (Lave & Wenger, 1991), as supervisors exchanged their responses about workplace contexts, supervision models, and difficult practices. The temporal, relational, and organisational space further supported supervisors to engage in a trusted, safe environment as they shaped professional connections and built relationships and exchanged practice with other disciplinary supervisors: all documented characteristics and activities of a CoP. Enabling a CoP mentality provided opportunities for the co-construction of new knowledge (Wenger, 1998).

Methodology

Research design

The research was constituted by a mixed methods design allowing investigation of the i) rate of engagement with the resource and the forum, and ii) participants' perspectives of their continued education emerging from their online engagement. Mixed method studies allowed for a layering of the data to best understand participants' experiences with, and of, the online learning module. Gay, Mills, and Airasian (2012) state that "mixed methods build on the synergy and strength that exists between quantitative and qualitative research methods in order to understand a phenomenon more fully" (p. 481).

Participant recruitment
Electronic and paper flyers were widely circulated by both academic and professional staff employed to support WPL at the university to promote enrolment in the professional learning module. The promotional material was distributed through industry networks and professional colleagues who practiced in the disciplines, and who were engaged in professional associations. These publicising modes drew on the established connections and relationships between the university and industry partners, further exemplifying the desire to build and strengthen university-industry relationships. The participants completed a guest application, supported by a signed statement to confirm their active and current supervision of the university's students in their WPL professional context. After receipt of the application, the participant was added as a 'guest' to the university's online learning platform (Blackboard) for the duration of the teaching session. The participants enrolled in the initial offering of the module were from a diversity of health discipline backgrounds including dentistry, podiatry, nursing, occupational health, radiography, physiotherapy, social work, clinical psychology, and speech pathology.

Data sources and tools

Ethical considerations
Participants were provided with an Information Sheet and consented to their discussion forum postings being included in the research via email exchange with WPL academic (University Human Research Ethics Approval). A total of 67 participants were enrolled in the online module with 38 formally consenting to the use of their qualitative data in the project.

Data
Data were gathered from two sources. Quantitative data from Blackboard; the university's learning management system, provided a useful measure of weekly log-in frequencies, and total posts. However, in order to layer the investigation, and move it beyond simple metrics, qualitative data complemented the frequency counts. Participants' responses to the final week learning activities were gathered to ascertain the efficacy of the learning opportunities (modules) and the use of the discussion forum as a space for inter-professional engagement and continued education. The final week learning activities required participants to prepare a response to the following guided evaluative questions and post on the discussion forum:

1. What have I learnt from engaging in the WPL online module?
2. How will I apply this knowledge in my supervision of WPL students in my workplace context?
3. What aspects of the WPL module were most beneficial?
4. What aspects of the module could be improved?
5. Was posting to and reading posts on the discussion forum useful?
6. What other WPL topics would I like to explore?
7. Would I enroll in another WPL module offered by X university?

Gathering these data allowed for an exploration of the depth of engagement in the discussion forum, and the quality of participants' learning (Hansmann, 2006).

Data analysis
A weekly and total frequency count was used to represent the findings of the quantitative data analysis. These simple counts provided an uncomplicated way to monitor participant use of the discussion forum and track related "engagement" or lack thereof. As all participants used the same forum, there was the capacity to provide a simple count of participant log-ins, and participant exchanges.

The discussion forum posts were analysed using coding and intra- and inter-textual analysis to determine themes (Burns, 2000). Data driven coding (Saldana, 2013) was used as the principal analysis method. Preliminary codes were initially assigned to the raw data (discussion posts), followed by assigning a final code that was thematically driven from the initial codes. Coding was a way of indexing or categorizing the text in the interview transcripts to create a framework of themes (Gibbs, 2007).

Results
The results are presented in sections including the affordances of and barriers to the development of cross-disciplinary WPL relationships, knowledge sharing and collaboration, in an online asynchronous discussion forum. Initially, the metrics of use are presented.

Blackboard analytics illustrate participants' engagement with the discussion forum either through their postings to the module learning activities or their responses to their colleagues' posts. Table 1 illustrates these findings.

Table 1: Discussion forum posting activity

Week	Weekly topic	Total posts	**Total participants who posted** n=68 enrolments
1	My experiences of workplace learning	177	68
2	Defining workplace learning @ X university	135	48
3	What makes workplace learning unique?	106	44
4	Good practice guidelines	77	42
5	Good practice guidelines 2	120	38
6	Ensuring quality workplace learning	78	37
7	Roles and responsibilities in workplace learning	41	37
8	Building relationships in workplace learning	37	36
9	Professional and practice based standards	40	36
10	Evaluating my workplace learning experiences	51	37

Table 1 illustrates the engagement of the 68 enrolled participants in posting responses to the weekly stimulus material. Not unlike a MOOC, after the initial flurry of postings and exchanges through commenting, the participation and active engagement (that was visible through postings) diminished as the weeks progressed, with several of the participants identifying the declining numbers in postings: "discussion dropped off in the later weeks" (P25), and "you could see after a few weeks who was really committed to learning about WPL because the numbers dropped. Those of us who stayed though seemed to write so much more" (P14). As Delahunty, Verenikina and Jones (2014) suggest a lack of engagement, limited interactions among participants and low contribution rates can act as barriers to learning in an online discussion space. Interestingly though, in the evaluation posts, a number of the supervisors exposed that they were often 'lurking' in the discussion forum, rather than posting. The act of lurking, is however, seen as *legitimate peripheral participation* in both a CoP and in online discussions (Malinen, 2015). Further, after analysis of the weekly postings, each of the remaining 37 participants, generally each prepared a post for the remaining weeks 7-10. Interestingly, these 37 were a subset of the 38 participants who consented to their data being recorded.

Qualitative Results

The analysis of the qualitative responses to the evaluation questions are presented in relation to the themes which arose from the data coding process.

1. Temporal

The discussion forum allowed space for participants to share their experiences of WPL supervision at times that were convenient to the individual participant. In addition, the participants noted that the asynchronous nature of the forum created opportunities for them to revisit their postings and review them as needed. Broadman (2006) points to the strength of an asynchronous forum's ability in creating opportunities for participants to "take the time to make sense of what others are saying and then think about and plan their responses". The forum participants identified this aspect of the forum as follows:

> As the postings were not specifically looked at each week by others on the forum, I could go back, think about what I had written and change it if I needed, or sometimes I added more (P29).
>
> Being 'out of time' (not sure what it is called) I could sit back and draft my response before putting it up for others to read (P36).

The purposeful choice of using an asynchronous forum was applauded by participants as it allowed them the temporal flexibility to engage as, and when they could. The following participant quotes illustrate this support:

> It allowed me to participate beyond my work hours … I didn't have to attend a lecture at a particular … so when I could find a spare half an hour I could log in and read others' posts and learn about their practice (P23).
>
> I liked the online style of the module and being able to work at your own pace and talk online when I could (P11).
> I thought it was good we had the flexibility with response time, however, especially with our job demands (P20).

While many of the participants positively supported the temporal flexibility of the forum, several participants pointed to the "difficulty in keeping track of participants' comments because they weren't posting when [I] was" (P17) and "I really wanted to talk to real people … I know I was, but I wanted to ask them questions then and there about what they had written" (P10). Participants felt that the burden of posting and reading others' submissions became time consuming. Participants commented:

> There was so much to read and not enough time to read all the other participants'responses (P4).
>
> Keeping up was harder at times and I didn't get through all the discussion posts (P2).
>
> … did get busy with life and work and wasn't able to keep up with the weekly postings on the forum, however I did go back and catch up (P6).

Interestingly, one participant voiced her "extreme love of the forum" as she:

> *could go to class* at any time. I didn't have to wait for a scheduled lecture or weekly professional development meeting. This assisted me to remain engaged as I could just jump on when I had a great idea or felt that I needed to blab about my WPL practice that happened that day or week (P2).

Despite communicating to participants that posting responses to the forum did not need to be performed weekly, and the opportunity existed to post in bundles of weeks, participants expressed "I felt pressured to maintain currency and presence in the forum, and felt pressured to get responses posted on time" (P16).

2. Technological skill

The discussion forum was carefully and purposefully selected as a technological tool as it was easy to use, requiring minimal guidance from the facilitator to effectively engage with others online (Boardman, 2006). The simplicity of access was noted as an affordance to engaging in the online community. For some participants however, "the discussion tool thingy was a barrier to starting the online module as [they] had no prior experience in this format" (P27). One of the participants further noted that "I could not post to the forum because my browser didn't support the format, so I uploaded my work as an attachment" (P8). Here, we can see that those will some technological skill or experience could create work-arounds in order to engage in the space. Similarly, a participant shared her total lack of previous experience with discussion fora as follows:

> I haven't completed an online learning experience like this before with posting and reading on a discussion forum. The learning experiences were fantastic even though I found it hard to navigate at the beginning. I am NOT very good at IT but I have now gained skills in this area (P5).

While the data analysis revealed that some participants initially struggled with the requirements of the discussion forum, most of the participants commented on the ease of navigation and use of the tool.

> I liked the discussion forum. I was so easy to use. Just one click and you could write your posts. It wasn't hard either to say something about other people's posts. The first time I mucked it up, but after that I was fine (P11).

3. Opportunity to share and be heard

As the primary aim of the online module and the discussion forum was to foster cross-discipline exchanges and enhance supervisor capability, participants' evaluative comments certainly supported the success of the module design and discussion forum use. There was a breadth of sub-themes which arose in relation to the coding of data related to this theme. These included i) being heard, valued and empowered; ii) feeling like an insider; and iii) opportunity to broaden professional perspectives.

i) Being heard, valued and empowered

The opportunity to post on a shared discussion forum created a safe and inviting professional dialogic space in which participants could offer their ideas and share their WPL experiences, seemingly without judgement. Framed by the sequence of communicative strategies posed by Verenikina, Jones and Dealahunty (2017), i) foster a positive social space; ii) build collective understanding of ideas; and iii) move toward critical discussion, the participants proffered multiple accolades regarding their feelings of shared safety and value. The online discussion space *invited* participants into a conversation; asking them for their stories, perspectives and practice. This strategy assisted participants to feel heard, even when one participant posted repeatedly on a topic, everyone could respond. In addition, participants had the choice whether to respond to the 'over-poster'. Participants commented:

> I am a rather quiet person in my work meetings. I often can't get a word in. The forum made me *talk* to others and I could have *my say* as well. When people started agreeing with my opinions I posted, I felt like what I said was important and respected (P16).
>
> I felt empowered by the opportunity to say what I thought in a professional forum. No one knew me online so I felt really safe to share my ideas. Sometimes at work I don't share because I know everyone and wonder what they might think of my perspectives and opinions (P9).
>
> I loved the forum. Someone asked what I thought about my work and how I supervised and I realised I had so much experience to share with the newer members of my profession. (P3).

Here I draw attention to *old timers* and *newcomers*: terms posed by Etienne Wenger when describing participants in his original CoP work. Wenger (1998) suggests that there are old timers; participants of a practice with the experience, expertise and knowledge. The old timers bear the responsibility for mentoring the newcomers; by modelling, mentoring and overseeing the "apprenticeship of practice".

ii) Feeling like an insider

Regarding the research findings, this was a very poignant sub-theme. The data analysis of the participants' postings clearly revealed that professional relations had been developed throughout the course of the online engagements. The participants' comments highlighted their shared perspectives and attachment to the "like-minded" online community. Significantly, participants expressed the notion of being an "insider in the group". Several of the participants voiced their alliance to the group and expressed that they had shared their experience of being part of the group with the "outsiders" (their workplace colleagues who were not enrolled in the continuing professional education opportunity). One participant illustrated this notion of being an insider in a conversation and group as follows:

> When I added my posts to the forum, I would wait for others to respond and agree with me or thank me for what I have said. I started to feel like we were a group – the insiders – and that my workmates were the outsiders. I think the discussion forum made us a group. A group who had shared so much of themselves and their practice. We had talked about some, I guess, sensitive things, like supervising students who were hopeless. I felt like I had moved from *not knowing* to *knowing*, coming from out of the loop to realising I really do have loads of expertise and I now feel included (P11).

Lave and Wenger (1991) would explain these comments using the notion of legitimate peripheral participation (LPP). As newcomers to a community of practice routinely engage in, and learn about, the culture and practices of a professional community, they progressively are encultured in regard to the rituals, practices, habits and perspectives of that community. It was evident that some of the participants who self-identified as new to WPL supervision were gradually moving from the periphery of dialogue in the online forum to central positions and felt like insiders.

iii) *Opportunity to broaden professional perspectives*

Analysis of the discussion forum posts exposed the marked similarities across professions and disciplinary areas regarding the functions and roles, responsibilities of WPL supervisors, and challenges and potential solutions to issues. The primary aims of the research were explicitly achieved as evidenced by the findings relating to this theme. Participants extended a breadth of commentary that illustrated their enhanced capacity to act as WPL supervisors, through the act of broadening their professional perspectives. The following excerpts from the discussion forum act as evidence:

> I found reading the discussion posts very useful. It has highlighted that there are lots of similarities across WPL even though the health services and disciplines are so different. This means that many other people's experiences and subsequent learnings may be able to be transferred to my setting. Numerous posts have discussed ideas I haven't thought about or looked at elements from different points of view. This has enriched my learnings from the workplace activities (P8).
>
> The WPL module has enlightened and enriched my knowledge of the students' WPL journey. What stands out most is that the there are so many commonalities between the disciplines and we have now offered solutions to each other's challenges and shared our experiences. There are so many things I hadn't thought of, from others' ways of thinking that I can use and share now with my colleagues (P22).

> I can use this new knowledge to help support the students the best I can and help them to gain the most out of their placement. I also feel I can take this knowledge back to my colleagues to encourage them to be more enthusiastic. It has certainly helped to hear all the different ways people, think, do things and solve problems with WPL (P19).

Conclusion

It is clear from the findings that discussion forums have the potential to assist professionals to engage in continued education that builds their ongoing knowledge and skills. Subsequently, this increased capacity can be further disseminated through professional workplace with colleagues who have not engaged in the forum activity. In addition, the benefits of requiring written asynchronous responses to carefully scaffolded learning activities, creates a safe, empowering space for professionals to learn from each other. Specific discipline practices are socialized in the shared space of the discussion forum, and this act empowers participants to engender confidence in their own expertise, knowledge and practice. Furthermore, the evidence prompts us to consider the value of sharing and challenging different perspectives and considering new possibilities. The purposeful design of the forum and the modules have encouraged and allowed time for reflection and considered postings, and generated possibilities for group connection and growth.

The findings further flag that a discussion forum positions participants in a learning space in which they draw on the expertise of *others* in what Wenger (1998) terms *overlapping communities of practice*. The discussion forum has acted as a knowledge, practice and network bridge, linking insiders with the outsiders in the participants' workplaces. Furthermore, the interchange of professional expertise has positioned the participant, not as passive receptacles of learning material, but rather active players who are co-constructing new knowledge with other members of the online community of practice. Thus, the discussion forum; a technologically-enabled dialogic space, has assisted in creating professional connections, and enhanced practice of those in a geographically dispersed community of practice.

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Infographics, assessment and digital literacy: innovating learning and teaching through developing ethically responsible digital competencies in public health

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Infographics are eye-catching one-page documents that provide a concise overview of a topic through visually representing information or data using graphics, icons and/or images, with minimal words. They are an emerging key form of communication in society, government, research, education and industry, and can be found widely in social media, advertising, teaching, policy documents and scientific journal publications, for example. Due to their user-friendly, quick-read format, infographics are highly influential in shaping the opinions of their audience. An emerging issue with infographics, however, is the capacity to mislead or misrepresent information or data. In the contemporary higher education environment, providing students with digital literacy skills, including the capacity to critically evaluate digital media forms such as infographics, is vital. This paper will provide a review of the use of infographics in learning and teaching in the literature, including as assessment, examining the benefits as well as the potential issues, and how some of these challenges might be met.

Keywords: infographics, assessment, digital literacy, public health

Figure 1: Infographic on the benefits and risks of using infographics in higher education.

Introduction

Infographics are eye-catching one-page documents that provide a concise overview of a topic through visually representing information or data using graphics, icons and/or images, with minimal words. Infographics are intended to visually engage their audience using colour and imagery, presenting complex information in an accessible, easy-to-understand visual form. In simple terms, they are a combination of data and design, where data means both numbers and facts, designed to be communicated transparently (Vital 2018). Infographics are extremely useful for conveying complex information quickly and easily.

Infographics are a highly transferrable media form and are currently being used across the entire spectrum of society, government, research, education and industry; in social media, advertising, teaching, policy documents, and scientific journal publications, for example. They are widely used because of their capacity to convey otherwise complex information quickly and easily, in an eye-catching form, within any area or discipline. Few other media forms are capable of this level of accessibility and transferability, and is one of the reasons that they have been so widely embraced, particularly by the commercial sector. As McCrorie, Donnelly and McGlade (2016, p. 72) write, the "commercial sector has enthusiastically taken up infographic design within the last decade or so as a means of communicating large quantities of otherwise difficult to assimilate information in a single easily understood and visually attractive product". In the healthcare sector, for example, infographics have been used for mass public consumption for a large-scale public health campaigns, as well as for communicating with the public on a smaller scale, such as posters within a general practice.

As Toth (2013) has argued, given the rise of infographics in the business world, students need exposure to them, as they will be probably asked to interpret and/or create them in the workplace. If used well, infographics can be very useful in learning and teaching, including assessment. In teaching, long explanations in lectures can be replaced with infographics (Anghel & Dahaila, 2019). Infographics increase student participation because they are visually engaging: they draw the attention of the students when used appropriately and meaningfully, and collaboration on infographics, such as creating team infographic assessment, enhances collaboration and communication skills (Rhodes, Johanesen & Abud, 2019). Infographics can enhance peer learning: students are much more likely to engage with another student's infographic than they are with their essays. They can be posted to a discussion forum, where students are required to comment on each other's infographics. They can also be presented to both peers and teachers in a presentation format.

There are, however, several potential issues in with the use of infographics, particularly in learning and teaching. Although graphic design skills are not necessary to create them, there is still a somewhat steep learning curve to create a meaningful, well-designed infographic. Due to their user-friendly, quick-read format, infographics are highly influential in shaping the opinions of their audience. This capacity, however, means that they are also open to misuse, either intentionally or unintentionally. The capacity to be able to objectively analyse infographics for the quality of the information they present can be challenging, particularly for students.

In 2019, in the Master of Public Health course at Monash University, we began incorporating infographics into learning and teaching in the areas of health and law; occupational health and safety; aviation medicine; and health management, with the aim of enhancing authentic learning for our students. Authentic learning experiences are those that connect students with real-world problems and work situations, through immersing learners in environments where they can gain highly practical, lifelong learning skills (Adams Becker, Brown, Dahlmstrom, Davis, DePaul, Diaz & Pomerantz, 2018). Our challenge in incorporating infographics was to support teachers and students to understand, interpret, and create them, given the steep learning curve, and the potential for them to be misused. This paper discusses the use of infographics in learning and teaching, examining the benefits and the potential issues, and how we might meet some of these challenges. It will discuss how infographics 'work' as a media form, the use of infographics in public health, and an analysis of the benefits versus the risks of using infographics in learning and teaching, in the context of digital literacy.

How do infographics 'work'?

Infographics can be described as a "multimodal" media format, integrating multiple modes of meaning making brought together into a single media text (West, 2019, p. 151). Although the use of infographic-type formats can be found throughout human history, the term infographic first appeared in the 1960's (Vital, 2018), and they were popularised in 1980's and 90's in American newspapers such as *USA Today* and the *New York Times* (Otten, Cheng & Drewnowski, 2015). Research on the use of the infographic as a distinct media form dates to at least the early 90's (see Utt and Pasternack, 1993, for example). There are many different types of infographics, and wide interpretation and variation on these types, from basic annotated image infographics, to much more complex data and statistical infographics. The rise of the popularity of infographics is equivalent to the rise in the era of ‘information overload’: infographics have emerged as a tool that can whittle down the complexity and abundance of information into a user-friendly format.

There is significant evidence that infographics reduce barriers to understanding (Otten, Cheng & Drewnowski, 2015). Visual processing in the human brain is very rapid: it takes an individual less than one-tenth of a second to get the sense of a visual scene, and viewers can quickly find patterns and make comparisons in well-designed infographics (Otten, Cheng & Drewnowski, 2015). Visual information has been shown to have a higher emotional impact and is remembered longer than text (Toth, 2013). Studies show that pictorial elements significantly increase memorability (Byrne, Angus, & Wiles, 2016), and the inclusion of recognisable imagery attracts attention, and aids in understanding and retention of the represented information (Byrne, Angus, & Wiles, 2016). By making information that is both compelling and more easily digestible, infographics enhance decision-making (Otten, Cheng & Drewnowski, 2015). Colours alter mood and energy levels and are used in infographics to attract attention (McCrorie, Donnelly & McGlade, 2016), thereby increasing influence over audience response to the messages being conveyed within an infographic. As Otten, Cheng and Drewnowski (2015, p. 1901) have written, “[t]he most effective infographics help viewers think critically about a particular subject or data set in terms of individual measurements and broader patterns”.

As Lee and Kim have suggested, (2016) infographics convey content using varying methods of presentation that appeal to different human perceptual systems: text, images, audio, and video, for example. Their research has shown that multimodal formats such as infographics, so long as they do not simultaneously compete with one another, enhance learning as compared to single channel communication. That is, spoken and written words presented simultaneously – such as in a spoken lecture that is simultaneously presenting lengthy written text on a PowerPoint slide – has the effect of reducing comprehension, whereas written text and visual images presented in a complementary manner – such as in an infographic – has been shown to enhance comprehension and learning. In short, infographics, when done well, improve information acquisition. Statistical information and procedural tasks, for example, have been shown to be recalled better when presented together in text and graphic formats, than in either mode alone.

Infographics in public health

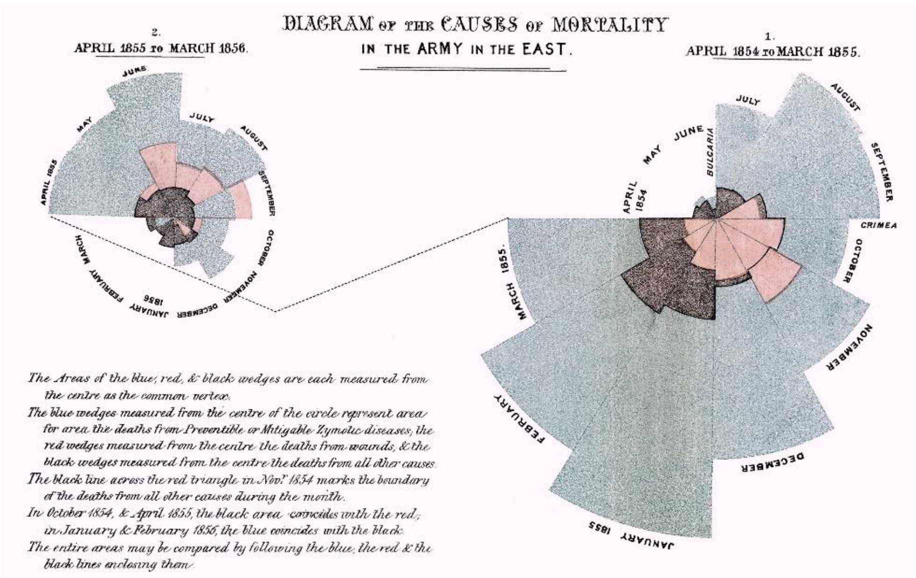

Figure 2: Florence Nightingale’s 19th century “Rose diagram” on mortality in the army during the Crimean War. (Image in public domain.)

Infographic-type formats have a long history, including in medicine and health. Ancient cave paintings, depicting the location and availability of resources can be described as infographics; the Ancient Greeks used graphic information formats, and many historical maps and navigational drawings were what we would now call infographics. Infographics have long been historically important in public health. McCrorie et al (2016) suggest that in the nineteenth century, part of Florence Nightingale’s success in communicating public health issues was due to the graphical representations she used to show causes of mortality amongst British forces during the

Crimean war. Using what we would now call a "polar area diagram" (or "coxcomb graph"), Nightingale illustrated that death from preventable disease outnumbered other causes including battle wounds. She was incredibly successful at reaching her target audience, they argue, whilst simultaneously triggering attitudinal change. These aims are the key to contemporary infographic design.

The user-friendly aspect of infographics makes them ideal for contemporary medicine and public health settings, where they have been widely used. Evidence shows that infographic-type formats enhances understanding and the ability for patients and the general public to make decisions about their health, and there is increasing demand for patient and public access to quality healthcare information, in a manner that is easily understood, so that patents can make better decisions about their care (McCrorie, Donnelly & McGlade, 2016). Through integrating quantitative charts with explanatory text and illustrative diagrams, researchers can create infographics that convey key issues around otherwise complicated public and policy interests (Otten, Cheng & Drewnowski, 2015).

There is substantial use of infographics within the healthcare sector, communicating medical information to patients in an accessible manner, thereby enhancing patient's decision-making capacities regarding their health. They are also widely used at the population level for public health messages (McCrorie, Donnelly & McGlade, 2016). As Otten, Cheng and Drewnowski (2015, p. 1903) write "[i]nfographics provide an effective means to communicate health and nutrition data to decision makers, who need high-quality information but in bite-size and readily accessible forms". In mass media campaigns they are intended to present positive change and/or prevent negative changes in health-related behaviours across large populations (Wakefield, Liken & Hornick, 2010, in Hamilton, Peden, Keech, and Hagger, 2018).

Infographics can be used in a manner that functions on an affective level of the human body, primarily through the use of colour, influencing mood and emotional engagement. In a healthcare context, using a traffic light system of red, amber and green, for example, the use of red in an infographic visually links that information to "danger" or the need to "stop", information that needs consideration in amber, and positive information in green (McCrorie, Donnelly & McGlade, 2016). At the cafeteria within the Alfred hospital in Melbourne, for example, an infographic about food choices represents unhealthy, high-fat, sugary food in red; moderately healthy food in amber, and healthier choices in green.

Infographics can also be used to overcome language barriers, through communicating with patients who may not speak the same language as their practitioners (McCrorie, Donnelly & McGlade, 2016). There is also a higher risk, however, of some patients misunderstanding infographic symbolism and representation, and interpreting it too literally. McCrorie, Donnelly and McGlade (2016) give the example of an infographic that shows the number of fruit that should be eaten daily as part of a healthy diet, which is represented by an image of 5 apples. This may be interpreted by some, however, to mean that people should eat 5 apples per day, and/or that apples are the only fruit that should be eaten.

Infographics – like any media form – are not always effective in changing behaviours or attitudes in public health, and this should be considered when assessing their use. Hamilton, Peden, Keech and Hagger (2018), undertook a study of the use of a video infographic that highlighted the dangers of driving through floodwaters in Australia, including providing safety tips to reduce the risk. Their study evaluated its effectiveness in changing the beliefs and intentions of Australian adults toward this risky driving behaviour. Their study predicted that the infographic would lead to factors such as lower reported intentions, less favourable attitudes, and reduced social pressure to drive through floodwaters, due to the growing evidence that infographics have strong effects on behaviour: "we expected the infographic to deliver longer-term changes in beliefs and intentions" (Hamilton, Peden, Keech & Hagger, 2018, p. 52). Their study found that whilst factors including gender, attitude, intention, emotion and aptitude for understanding the background information all play a role in how information is understood and acted upon, their overall research concluded that intentions to drive through floodwaters were not affected by exposure to the infographic, and that the infographic was ultimately "not … effective in changing behaviour" (Hamilton, Peden, Keech & Hagger, 2018, p. 57).

Infographics in learning and teaching

Infographics are narrative devices: they tell a story. Part of their popularity and utility, particularly in education and research, is their capacity to present quantitative information to audiences who may otherwise have little understanding of the creation and use of scientific data. Infographics enable this data to be presented in a narrative format. As Otten, Cheng and Drewnowski (2015, p. 1902) write, through "integrating quantitative charts with explanatory text and illustrative diagrams, for example, researchers can communicate their findings as engaging, persuasive, or memorable narratives of discovery". As such, they can be very useful for STEMM (science, technology, engineering, mathematics and medicine) disciplines, which may not traditionally use narratives very well. The narratives of infographics could be explanatory (aiming to educate or inform), editorial (making value judgements), persuasive (seeking to influence), or exploratory (testing a hypothesis), for example (ibid).

Infographics function as a stand-alone form of communication, where the "audience should comprehend the information by simply looking at it without seeking additional resources to understand it" (Toth, 2013, p. 448). In a long text, major figures and other numerical data may go unnoticed (Aydin, Aksut, & Demir, 2019), however an infographic can graphically quantify the magnitude of an issue, giving the audience an immediate sense of its significance. Large datasets can be made more coherent, facilitating comprehension. Infographics can be either static (printed as a poster or as a static screen image), animated (an animated screen image), or interactive (displayed on a screen with clickable links and other interactive elements). They can be hand-drawn or electronically created, and many electronically created infographics insert hand-drawn elements.

Whilst visual language is highly flexible, and there are multiple ways in which something might be represented, as (Byrne, Angus, & Wiles, 2016) argue, effective designs make use of conventional graphic and figurative representations and elements for ease of user understanding and remembering, as understanding can happen faster and with less effort, due to the easy recognition of the graphics presented. Sometimes impact is also created through breaking convention, however, which challenges the audience to reconceptualise the information they are presented with in a novel manner.

In many ways infographics have evolved from PowerPoint slides: many infographics are three to four graphically focused, well-designed, minimal text PowerPoint slides combined into one document. Reflecting upon infographics and how they work allows us to think about how we could present information in teaching and research much more effectively, to move away from the infamous 'death by PowerPoint', and towards creating attention grabbing, focused, user-friendly presentations.

It is important to note that the design of infographics should always be informed by the communication setting in which they are to be presented (Otten, Cheng & Drewnowski, 2015). An infographic that is to be developed as part of an oral presentation should be succinct and have a high visual impact, because it is accompanied by a spoken word element. An infographic that is to be used as a stand-alone poster requires more detail and needs additional annotation (Otten, Cheng & Drewnowski, 2015). Infographics also don't necessarily need to be used to present information to others: they can be created for personal use. In teaching and learning students can improve their understanding of technical information, for example, by being taught to create basic infographic "sketchnotes" (Fernandes-Fontecha, O'Halloran, Tan, & Wignell. 2018, p. 8) to review and revise the learning content in preparation for an exam.

Infographics can enhance professional skills in communication. Employers constantly cite communication skills in graduate students as a much higher priority than just having the disciplinary knowledge. They want students to be able to innovate and apply their knowledge, and to have interdisciplinary skills. It's not that their degree isn't important of course, but it is very limited if students do not have communication skills to use that knowledge meaningfully (Choate & Chan, 2016). Infographics can enhance creativity, innovation and interdisciplinarity: teaching students to push their boundaries and to creatively innovate and apply knowledge in a highly communicable form.

Zuk (2011) argues that in order to create a successful infographic, students need a basic understanding of the power of marketing, so that their infographics are focused, and compelling. More than just a tool for public relations, students need to learn to market their learning and their skills, in quick, easily understandable terms. Often referred to as the "elevator conversation" scenario, this skill is about students being able to give a snapshot of their skills and knowledge in a minute to someone of influence, where the question is often framed: "If you ran into your boss in the elevator, what do you say about the value of the work you are doing?" The capacity for students to be able to 'market' themselves meaningfully is a vital professional skill. Infographic resumes have also become popular: they are attention-grabbing, attempting to gain an edge in the competitive job market. Learning to create infographics gives students the skills to be better placed for employment.

Incorporating infographics into learning and teaching in public health is part of Monash University's vision of higher education to expand and enrich staff and student capabilities in digital education; incorporate capabilities of the future into education, including the skills to lead and transform communities; to be proficient in digital literacy, and; to foster development opportunities in digital learning for both staff and students (Monash University, 2019). As Leu argues, "[n]ew forms of strategic knowledge are required with new literacies" (cited in

West, 2019, p. 171), and advances in technology requires new approaches in education for both teachers and students (Aydin, Aksut, & Demir, 2019).

By embedding infographics into learning and teaching – including as assessment items – we can drive digital competencies for educators, researchers and students, developing critical enterprise skills in digital literacy. In order to understand how to create infographics, however, students need to be taught how infographics work to communicate information, how to critically analyse them, and how to create responsible infographics.

The benefits and the risks of using infographics in learning and teaching

Whilst there are many benefits of using infographics in educational teaching and research, there are also a number of risks. Developing responsible data-sourced infographics takes time and commitment (Otten, Cheng & Drewnowski, 2015). This is to say that there can be a steep learning curve involved in creating infographics: they can be laborious and time consuming to create. Due to their visual nature, infographics can appear simple and effortless (Toth, 2013), but appearances can be deceptive, both in terms of the amount of work and thought that is actually required to create them, as well as in terms of the quality – or otherwise – of the information they are presenting. Aydin, Aksut, and Demir (2019) noted that students are often negative when they realise the steep learning curve, but much more positive once they have completed the task.

There must be structured support for creating infographics, not only the practical skills to create them, but also how to create and interpret graphs and data. Whilst effective infographics that communicate meaningfully look great and can be highly beneficial in teaching and research, ineffective infographics tend to be visually overwhelming; use excessive or extraneous data; present information in a way that is confusing; and/or over- or under-value certain information (Otten, Cheng & Drewnowski, 2015).

Due to their steep learning curve, infographics as assessments need to be scaffolded appropriately. Toth (2013) discusses the ways in which an individual assessment can be set up with three parts: an initial rough sketch research proposal, which includes the data students intend to present; the infographic (which is shared with the whole class), and a reflective, evaluative piece on what their intentions were, what they learned, and how they would do things differently in future. Formative assessment could include online infographic drawing module embedded within the Learning Management System that teachers can use either in a face-to-face lesson, or as on online module. The module should be specifically aimed at the level and discipline of the students, and assume no specialised knowledge of drawing, industrial design, or computer graphics.

Students must have clear instructions for expectations, including exemplars that are of the standard that they are expected to produce. Previous work student exemplars are critically important, as students will often look to professionally produced infographics for inspiration, however not having the professional design skills may tempt students to plagiarise online infographics, rather than create one that they think is very poor quality in comparison to the professionally created one. By providing them with multiple examples of previous student work, students gain realistic expectations of the quality of the work they are required to produce. It is important to reiterate with student infographic assessments that professional design skills are not required and are not assessed; what is important is the quality of information being presented and the organisation of the infographic in terms of how it is presented. Clarity and quality of information are the key criteria in student work on infographics.

Toth (2013) notes that in their assessments, the quality of the infographics that the students produced varied widely. Some were very high quality, some very low. The most common trouble areas Toth noted were organisation, clarity, text and consistency: poor organisational structure; information that was unclear; too much text; and inconsistency with the use of visuals and text. It was also noted that students commented positively on the infographic assignment, including that it helped them tie together concepts from earlier in the semester; they enjoyed the freedom of creating an infographic; and they found it “fun”. Students also noted that they were surprised at how much work and thought was involved. From a marking perspective, it was noted that infographics are less time consuming to mark than longer papers.

Designing an infographic in terms of the use of colour and graphics is only one part of the process of creating an effective product: it is also critical that infographics are created ethically and responsibly. Creating a compelling infographic from primary research can be challenging: there is the chance of oversimplification, and to inadvertently (or otherwise) distort data (Otten, Cheng & Drewnowski, 2015). As Molek-Kozakowska (2019) notes, one of the challenges of the popularisation of science, including the creation of media forms which include visual enhancements that are understandable to a lay audience, is to ensure that they continue to frame scientific work legitimately, without distorting, aggrandising, or sensationalising it.

This raises issues in relation to the information that is provided to students. What data or questions do educators use to shape the complexity of the infographic students are expected to produce? How do educators frame expectations without being too limiting? How can educators teach students about ensuring that infographics are scientifically responsible?

One risk is misinterpretation of what is represented, which can be due to a number of factors. Successful creation and interpretation of infographics is dependent upon accurately decoding the visual information into a message about the underlying data (Byrne, Angus, & Wiles, 2016). Motivation and prior knowledge have also been shown to be key factors in information retention. That is, if a student lacks either the motivation or the ability to process the message (including through lack of prior knowledge of a topic), they are more likely to show low levels of understanding (Lee & Kim, 2016). In regards to infographics, care must be taken with students who have poor language skills in the language infographics are presented in, as it has been shown that foreign language students learning can be negatively impacted due to interpretation of visual, textual and cultural language conventions, resulting in an inability to distinguish relevant and irrelevant information, and instead focus on the more superficial, rather than substantive aspects of the infographic (Lee & Kim, 2016).

The convincing nature of infographics can be somewhat of a double-edged sword. Whilst numerical data and statistical information are more convincing and concrete because of the use of graphics (Aydin, Aksut & Demir 2019), however this is also potentially an issue if that data or information is used irresponsibly. As Toth (2013, p. 449) writes, infographics that use statistical information in some way present an illusion of trustworthiness due to their visual nature, and viewers "are more likely to believe information presented on infographics". Therefore, educators need to assist students to make ethical and responsible choices when creating them. Otten, Cheng and Drewnowski (2015) argue that collaborative, team-based activities are a way to potentially alleviate potential issues around the misuse of data in the creation of infographics in learning and teaching, as active input from multiple team members reduces the possibility that data will be ambiguous or inaccurately represented.

Infographics, digital literacy, and future focused education

Teaching students digital literacy is a key employability and life skill, and accordingly is also a key priority of higher education institutions, in order to enhance student employability. In the online, information overload environment, students are required to make informed judgements about information, and particularly online information: to navigate, critically evaluate and responsibly use information (Feerrar, 2019). That is, students need to be able to not only use and create digital tools, but also think critically in the way they consume them (Feerrar, 2019). When it is now so easy to consume and disseminate information digitally, it is the responsibility of educators to ensure that students understand the implications of creating socially, politically, ethically and scientifically responsible information. This includes determining appropriate media, making effective design choices and reflecting on the ethics and impact of their work. Creating visual media such as infographics, videos, and animations are vital to digital literacy (Hobbs, in Feerrar, 2019).

Students need to be taught how to judge infographics in order to create their own effectively. Toth (2013) recommends a critical analysis that incorporates an understanding of infographics as a media genre, a comprehension of the informative and persuasive techniques that are used to successfully communicate their message, an application of the traits of effective document design, and an understanding of the topic or disciplinary context in which they are to be used.

Educators need to prepare students for the future. Price (2017) argues that there is currently a mismatch between both current and future employment needs and contemporary higher education models, and that the critical gap is in interpersonal and professional skills. Graduates are critically underemployed: not working as many hours as they want to, and not doing the level of job that their degree prepared them for. There has been much discussion around changing the higher education system for a long time, Price argues, but we're still not delivering on what needs to change. Students need high-level critical knowledge skills: less knowledge for its own sake and much more of how to responsibly apply, analyse, evaluate and create it.

Teaching, in any discipline, should always include a critical understanding of the importance of ethical issues in relation to the presentation of data, to use information responsibility, and that information cannot be divorced from its social, political and cultural contexts. Educators have a responsibility to teach students digital literacy, to ensure that they are critically evaluating information, including questioning the credibility of data sources, examining structural manipulation, and are aware of the ways in which statistics can be used to mislead (Otten, Cheng & Drewnowski, 2015). The use of infographics in higher education must include teaching students the capacity to read and interpret digital content in a critical manner, so that they understand that the presentation of information is always socially, politically, commercially and culturally contextualised.

Conclusion

This paper has discussed the use of infographics in a higher education context, including the benefits and risks in their use in learning and teaching. It has argued that the use of infographics in higher education requires the inclusion of digital literacy, which is not simply the capacity to skilfully use digital tools, but also the capacity to critically engage with digital content. Information is always presented in ways that are designed to influence understanding. To be digitally literate is to have the knowledge and skills to use and create digital media responsibly and ethically. Digital literacy and infographics are as much about understanding the use of ideas as they are about the use of technology. This paper has also argued that although there are potentials risks with the use of infographics – particularly in a scientific context – the risk of the misuse of data and information through the use of the incredibly popular infographic type formats only adds weight to the argument that, from a digital literacy perspective, they should be incorporated into learning and teaching in a structured, scaffolded manner, so that students learn to critically engage with information, to provide them with essential lifelong learning skills and take them forward into the future.

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Using blogs to develop and determine graduate competencies in an undergraduate business subject

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Graduate competencies are increasingly in demand from professional sectors, but with insufficient response from professional degree programs. This study examines the use of blogs as assessment in a first-year Bachelor of Business program. Three hundred and nine students responded to an online questionnaire exploring their perceptions of blog as a learning and assessment tool. Of particular focus were students' perceptions on ease of use, benefit and impact on the recognised graduate competency of writing skills. A regression model was applied to data analys in association between perception of improvement in the quality and quantity of the students' work (Q&Q) and several other variables. Results suggest a significant and complex relationship between participants' perception of the flexibility and benefit of the blog and three areas relevant to writing skills: self-reported improvement in writing, increased ownership of learning, and development of reflective skills. Implications for further research and practice are discussed.

Keywords: Blogs, graduate competencies, technology-enhanced assessment, business education, professional education

Introduction

Graduate competencies are positioned as especially worthwhile outcomes of learning engagements; they serve as bridges between learners' role as student and the subsequent personal and professional roles that they play. Graduate competencies are of special interest in professional degree programs which are specifically charged with the development of learners into professions and professionals. Effective professional writing, for example has been long been positioned as an essential graduate competency for professional degree programs and business degree programs, specifically (Hodges & Burchnell, 2003; Moore & Morton, 2017).

Despite the recognition of their importance, graduate competencies have not swiftly nor easily integrated into curricula. Discipline-specific knowledge and skills that reflect academic priorities rather than professional competencies remain the central, sometimes exclusive emphases in professional degree programs (Boud & Rooney, 2015). Thus, there appears to be a discontinuity between the espoused priorities of programs and the experienced priorities of their curricula. Causes may lie within the means of engaging learners. Assessment and learning engagements are often highly traditional, academic processes that do not easily lend themselves to supporting and determining graduate competencies (Dow, Diaz-Granados, Mazmanian & Retchin, 2014).

Problems in implementation are mirrored within the research. There has been limited empirical research, into the efficacy of undergraduate business education, for example in fostering graduate competencies, generally or of students' perceptions of the efficacy of such efforts (Azevedo et al., 2012). Thus, there is a need in professional degree programs to research the impact of innovative approaches to learning and assessment on the development of graduate competencies. This study seeks to contribute to this growing area of research by looking at how undergraduate business students experienced the use of blogs as an engagement and corresponding perceived impact on the development of graduate competencies.

Graduate competencies in professional degree programs

Graduate competencies encompass a host of concepts (e.g. generic skills, sustainable outcomes, 21st century competencies, etc.). A holistic understanding is that graduate competencies are the complex skills and utilized knowledge that support authentic professional performance within and across myriad disciplinary and professional contexts (Teijeiro, Rungo, & Freire, 2013). Graduate competencies may be seen as the bridge between education and profession (Boud & Rooney, 2015). These competencies range from ownership of development/learning to accurate self-assessment and effective writing skills.

Professional degree programs are increasingly concerned with development of graduate competencies, such as depth of engagement and student ownership (Shroff & Deneen, 2014). People entering the workforce have increasingly seen themselves as free agents, moving across multiple jobs and positions in a career. With this shift have come concomitant demands on programs to broaden the scope of outcomes to sustainable, career-long competencies (Moore & Morton, 2017). As professional workplace roles grow in complexity and change more rapidly, graduate competencies become increasingly important for long-term career success (Chapman, 2010). Thus, professional degree programs are concerned with developing authentic, work-related competencies.

Achieving a corresponding shift in curriculum has proven challenging. Professional degree programs often privilege self-referential and academic learning rather than outcomes highly related to performativity in flexible professional contexts (Boud, 2000; Boud & Rooney, 2015). The means of enacting and determining learning, curricula and assessment continue to emphasize within-discipline outcomes and provide summative, traditional assessments such as final projects and essays (Dow, Diaz-Granados, Mazmanian & Retchin, 2014). Professional degree programs may therefore not inculcate graduate competencies often or deeply enough (Jackson & Chapman, 2010; Azevedo, Apfelthaler & Hurst, 2012). Complex and deep outcomes require innovative approaches to supporting and determining achievement. Thus, innovation in assessment is an essential co-commitment (Deneen & Boud, 2014). Business programs have, however begun integrating innovations to learning and assessment as well as balancing the aims of discipline-specific skills and knowledge with graduate competencies (Jackson & Chapman, 2010).

Blogs

Blogs are a well-established educational medium for teaching, learning and assessment (Chawinga, 2017; Churchill, 2009; Top, 2012; Williams & Jacobs, 2004). Blogs provide personalized, versatile space and ownership for authorship (Liu, Kalk, Kinney, & Orr, 2012). This versatility allows blogs to function as a communication tool more easily than discussion forums or e-mails while allowing authors to retain ownership of their contributions (Du &Wagner, 2007; Kim, 2008). The use of blogs as a specific medium of writing may carry developmental benefit in comparison to traditional academic writing. Blogs embody writing for an unknown audience; which is a fundamentally different paradigm than traditional academic writing for instructor or peer review (Alfaki, 2015). In this respect, blogs may be seen as a teaching, learning and assessment tool particularly well-suited for developing authentic writing competency. Writing is also recognised specifically as a professional skill in which graduates are inadequately prepared (Moore & Morton, 2017; Wells et al., 2009). Thus, written communication beyond an academic audience through blogging would seem a prime target for innovation and development.

Using blogs to access and develop writing has additional benefit; There is evidence for blogging as a means to developing critical thinking and reflective skills (Joshi & Chugh, 2009; Kim, 2008; Weller et al., 2005). Blogging has been shown to foster deeper and trans-disciplinary understandings of course material (Davi, Frydenberg, & Gulati, 2007; Yang, 2009). Blogs have been shown to enhance students' skills at self-regulating information management; specifically goal setting and planning for tasks and assessments (Dabbagh & Kitsantas, 2012). Blogs are potential platforms for expanding beyond an academic or discipline-specific focus (Weller, Pegler, & Mason, 2005). Thus, blogging connects writing to other graduate competency focus and development. It is equally worthwhile to determine what connections the development of writing might have to other graduate competencies.

The importance of learners' perceptions

A growing body of research demonstrates the significance of students' perceptions of assessment and learning on outcome achievement at all educational levels, including tertiary (Deneen, Brown & Carless, 2018; Brown, 2013). Similarly, models of technology utilization indicate users' perceptions of technology may predict future or continued use of that technology (Shroff, Deneen & Ng, 2011; Teo, 2009). Current research also suggests that the intersection point between students' perceptions of technology and assessment may create complex dynamics that impact efficacy (Deneen & Shroff, 2014). It is of particular importance, then that research be conducted into the meeting place of learning, assessment, technology and graduate competencies. Further, it is appropriate to apply the lens of students' perceptions to accomplish this.

The perceptions of students in a first-year paper (i.e. subject) in an undergraduate business program were obtained and results subsequently analysed using descriptive, correlational, and regression analysis. A framework of quality and quantity (Q&Q) is used to interpret results. These interpretations are then discussed in relationship to research; recommendations are made to inform practice and further research.

Context

The study was conducted within a Bachelor of Business degree programme at a university in New Zealand. Students in a first-year, compulsory undergraduate business paper were provided with required weekly assessment tasks to complete and upload to their personal blog space created on the learning management system. The blog assessment had a weighting of 25%; a business report carried a weighting of 35% and an exam carried a 40% weighting. The blog was structured with authorship exclusive to the student and feedback exclusive to the instructor.

Formative feedback was provided by the lecturer at six points. Summative feedback was provided at the end of the semester.

After completing and uploading their writing tasks, students were asked to engage in a guided reflection for each task. Prompts asked students to reflect on difficulty of tasks, and the relevance of these tasks to the paper. They were also asked to discuss the applicability of what they had learnt within professional contexts. Finally, students were required to assess their achievement in relationship to the program curriculum and its intended outcomes.

Methodology

Research aim and questions

This study investigates the perceived efficacy and ease of using blogs to develop graduate competencies. A model was designed using various explanatory factors described in the following methodology section. The two main questions the study aims to answer are:

What were students' perceptions of efficacy and ease of using blogs?
To what degree and in what ways did students perceive the use of blogs as supporting graduate competency development and achievement?

Prior to initiating formal investigation, the study was granted approval by the university ethics committee.

Participants

733 students were enrolled in the surveyed Bachelor of Business paper; a total of 309 valid survey responses were collected (n=309). This represented a valid response rate of 42%. The survey was carried out in the second semester. 51% of the respondents were male and 49% female. The majority of respondents were full time students (95%), and most respondents were domestic students (82%). These identified characteristics were highly representative of the total cohort enrolment.

Most participants were in their first year at university and reported that they had not used blogs prior to the paper. Development/instruction was therefore provided in use of the software and the specific task of blogging. This included instruction in creating links to secondary information they had sourced, uploading completed work to their blogs and using the different writing functions to complete their reflections. Participants gave their informed consent to participate in the study.

Data collection

Data was collected through a 24-item, three-section survey. Section one collected demographic data patterns of computer and internet access and use. Section two collected information on ease of blog use. Section three collected information on perceived impact of blogs on competence development and achievement. Responses for sections two and three were elicited using a centre-weighted, five-point Likert scale.

Items for the survey were developed based on constructs validated in the technology acceptance model (TAM). Specifically, this survey focuses on ease of use and perceived usefulness of a particular technology predict respondents' intention to continue use of that technology (Davis, 1989; Yi & Hwang, 2003). Most of the students were using blogs for the first time; examining ease of use was therefore important. Utility items were framed by the potential of blogs for the development of graduate competencies. The survey was administered online through the web-based service, Survey Monkey.

Data analysis

Section one data was analysed using descriptive statistics; results are reported in the 'participants' section of this paper. Data from section two (ease of using the blogs) was analysed using descriptive statistics to find mean score for each item. Data from section three (efficacy of use and perception of quality) was analysed using descriptive statistics, correlation and regression analysis. Mean scores were calculated to determine impact of the intervention on the various independent variables listed in Table 2.

Correlation and regression analysis were used to determine strengths of relationships between responses for set three items. Perceived improvement in quality and quantity of students work (hereafter referred to as Q&Q) was used as a proxy for perceived competence development and overall achievement. Associations between stated variables using pairwise correlation was tested. Further tests were conducted on degree of effect of these independent variables on Q&Q.

A regression model was designed with Q&Q as the dependent variable representing perceived competence development and overall achievement of students. The following contributing factors are used as independent variables: increased interest in learning, ability to check work regularly, flexibility in completing tasks, increased ownership of learning, getting feedback from lecturers, improvement in ability to reflect on learning, improvement in writing ability, and the effectiveness of using blog tools. The following equation has been used to measure the impact of each of the independent variables on the Q&Q of students work.

Reliability of the regression model was established through a sequential check by members of the research team. Researchers independently confirmed model fit and analytical procedures.

$$Quality\&\ Quantity = \alpha + \beta_1 Interest + \beta_2 Check + \beta_3 Flexibility + \beta_4\ Ownership \\ + \beta_5 Feedback + \beta_6 Reflection + \beta_7 Writing + \beta_8 Tools$$

Limitations

This design of the study focuses on students' perceptions of the development of their competencies. This is a worthwhile focus, as students' perceptions of the impact of a particular technology is a strong predictor of their intention to use that in the future. Equally important, student perceptions of quality play a seminal role program and subject evaluation. This is, however, complimentary to rather than substitutional for observable changes in graduate competency development. That development, however, is recognised as highly longitudinal; it is unlikely that large changes would be observed in a semester-long engagement and therefore an observational component for a study of this length is unlikely to add value. The intended next stage of this study is a program-level, multi-year study tracking changes in both perception and observable expressed competencies.

Results

Ease of use

Students generally found blog use was easy to use, with a high mean score of 3.90. The item with the highest mean score (4.20) represented student endorsement that digital uploading was easier than hard copy submission. While this would seem intuitively obvious, a common issue is whether digital medium does, in fact represent an easier use, especially where new technology is being employed (Deneen & Shroff, 2014; 18; Teo, 2009). This was especially salient, given that most of the students had reported not having used blogs prior to the course. Results relating to ease of use are given in Table 1.

Table 1: Ease of Use

Question	Mean
Uploading work directly to the blog was easier than submitting hard copy	4.20
Overall the blog was easy to use	3.90
It was easier to create links to the articles instead of uploading them straight into the blog	3.86
Sufficient information was provided for using blogs	3.70
I was familiar with how to use the blog tools	3.66

Competence development

Student mean responses to section 2 items were all positive. One goal of using the blog was to afford students regular feedback from lecturers throughout the semester. The corresponding item yielded the highest mean within this section, suggesting that students perceived this goal as having been met. From the perspective of both perception and practice, this is a positive finding. Feedback is a core mechanism in assessment for learning (Williams, 2011). Students also tend to value instructor feedback over peer feedback both generally and in a blogging paradigm (Xie, Ke & Sharma, 2008). Thus, the blog appears to meet this benchmark.

Table 2: Descriptive statistics pertaining to competence development

	Mean	Std. Deviation
Helped get feedback from lecturers (Feedback)	3.799	0.925
Helped check work regularly (Check)	3.735	0.868
Increased flexibility for task completion (Flexibility)	3.718	0.991
Increased ownership of learning (Ownership)	3.667	0.899
Effective tool for writing assessments (Tools)	3.553	1.039
Quality and quantity of work (Q&Q)	3.437	0.987
Improved reflective skills (Reflection)	3.359	0.917
Improved writing ability (Writing)	3.320	0.914
Increased interest in learning (Interest)	3.294	0.957

Interestingly, the three lowest rated items pertained to writing skills development, increased interest in learning and reflective skills. All three of these items strongly relate to recognised graduate competencies (Jackson, 2010; Moore & Morton, 2017). The mean was still positive for these items, suggesting that the blogs had some desired effect, but not to the degree one might hope. As an effective tool for writing assessments, students endorsed blogs, suggesting that the low improvement score was not a categorical rejection of blogs as a modality for improving writing. These findings may, therefore confirm that graduate competencies take substantial time to develop and must be thought of longitudinally.

Results of the correlation analysis are shown in Table 3.

Table 3: Correlation matrix

	Q&Q	Interest	Check	Flexibil-ity	Owner-ship	Feed-back	Reflect-ion	Writing Improve-ment	Writing Tool
Q&Q	1.000								
Interest	0.599	1.000							
Check	0.575	0.512	1.000						
Flexibil-ity	0.591	0.478	0.600	1.000					
Owner-ship	0.626	0.590	0.506	0.569	1.000				
Feedback	0.516	0.386	0.495	0.434	0.399	1.000			
Reflect-ion	0.504	0.512	0.357	0.300	0.362	0.460	1.000		
Writing Improve-ment	0.607	0.541	0.422	0.451	0.597	0.410	0.451	1.000	
Writing Tool	0.539	0.645	0.484	0.565	0.493	0.454	0.401	0.473	1.000

All pairings demonstrated positive correlation, with 18 pairs showing significant correlation. The strongest correlation, at 0.645 was between blogs increasing interest in learning and serving as effective writing tools. There was also a strong correlation between perceived flexibility in completing weekly tasks and respondents' ability to check their work regularly. Given the importance of self-regulation and its recognised connection to regular task engagement this is an especially interesting finding in terms of blogs facilitating graduate competencies.

With the exception of Q&Q correlation, feedback pairings all fell below the threshold of significance. This is especially interesting, given that feedback yielded the highest mean response (see Table 2). This suggests that while the mechanism of instructor feedback was seen as well served by the blog, its relationship to other substantive areas, such as writing was limited. Feedback is critical to assessment of and for learning, and an issue of concern in choosing private versus public blogging. One implication is that concomitant with increasing access to feedback, students must be afforded feedback that is better focused on the desired aims, such as fostering graduate competencies.

Table 4. Regression results

	Coefficient	t-statistic	P value
Intercept	-0.551***	-2.82	0.005
Interest	0.120**	2.09	0.037
Check	0.147***	2.59	0.010
Flexibility	0.168***	3.26	0.001
Ownership	0.194***	3.38	0.001
Feedback	0.119**	2.43	0.016
Reflection	0.148***	3.03	0.003
Writing	0.204***	3.86	0.000
Tools	0.023	0.46	0.647
R^2 F-Statistic No. of observations	0.609 58.39 309		

*** and ***indicate significance at p < 0.05 and p < 0.01 or better level respectively*

The results of the regression analysis are shown in Table 4. The regression model shows an R2 of 0.61 suggesting that the factors used to test the dependent variable (Q&Q) are relevant variables with an adjusted R2 of 0.60. The model demonstrates good fit with an F value of 58.39 and a significance level of 0.000. The intercept with a coefficient of -0.551 and significant at 5% indicates that participants' perception of improvement in the quality of their work cannot be possible without the explanatory variables used in the model.

The most significant impact on Q&Q is from perception of improvement in writing ability with a t-statistic of 3.86 and significant at 1% (p= 0.000). Thus, improvement in writing ability was the seen as the most significant reason for improvement in the Q&Q of participants' work. It's not that the low endorsement indicated little perceived change; rather, this may be understood as a conservative process; participants may not see themselves changing radically if they see themselves as skilled already. That does not, however prevent incremental changes in writing ability from having a profound effect, as seen in both the correlation matrix and regression table. Thus, this finding affirms that writing ability is perceived as a graduate competency; it appears longitudinal in nature and participants make powerful connections to other valuable areas of the learning engagement and assessment.

As part of their weekly tasks, students were required to write paragraphs on their learning using trigger questions provided. Analysis shows that writing weekly reflections resulted in perception of improved of writing ability with the most positive influence on Q&Q of their work. Improved writing ability yielded the lowest mean, but this was still perceived as having a potent relationship to enhanced Q&Q. It may be that this single blogging opportunity did not yield sufficient opportunity for students to perceive dramatic changes in their writing, but that the changes that were perceived mattered. Taken together with the correlation between interest in learning and the blog as a writing assessment, this suggests a potentially complex relationship around graduate competencies, assessment and writing.

Increased ownership of students learning, flexibility in task completion and development of reflection skills all demonstrated significant regression onto Q&Q. The increased ownership of learning may provide students' greater motivation to achieve at a higher level. Giving flexibility to students to complete their work may have a positive effect on their work since it enables them to access their work anytime and make changes as and when they have new ideas. The development in students' reflective skills may help them to reflect on the feedback given by lecturers and to incorporate new ideas into their work. The results show that the students found formative feedback from lecturers very useful and that it had a positive impact on the Q&Q of their work ($t= 3.03$; $p=0.03$).

Discussion

Students seemed to connect interest in learning to the blogs ability to function as a writing assessment. Students who reported that the blog provided greater flexibility in completing weekly assessment tasks were also likely to have reported that this improved ownership of their learning. Those students who reported an increased ownership of learning were also more likely to have indicated that it led to an overall improvement in the quality and quantity of their work (Q&Q). This adds to a growing body of research suggesting that technology-enhanced assessment(TEA), when perceived as useful may have a strong relationship to ownership of learning (Shroff & Deneen, 2014).

There was also a strong correlation between students who reported that they were able to check their work regularly and make improvements based on formative feedback received from their lecturers and those that reported that it increased the Q&Q of their work. Thus, students who perceive blogs as a flexible, regular learning and assessment engagement appear more likely to perceive benefit in areas essential to graduate competencies. Sustainable assessment and sustained engagement with assessment are key factors in assuring both assessment for learning and learning that extends beyond the immediacy of an academic environment (Boud, 2000). In designing blogs as sustained and sustainable assessment, attention should, therefore be given to assuring blogs are well-received by students and that the curriculum requires they regularly build on the blog.

This supports existing research that as a graduate competency, writing has a connection to other recognised graduate competencies (Hodges & Burchnell, 2003; Moore & Morton, 2017). However, the most significant impact on Q&Q was the improvement in students' writing ability. Although improved writing ability yielded the lowest mean score in section 2, this was still in the view of the students a potent relationship to enhance Q&Q. Given the strong correlation between interest in learning and blog as a writing assessment, this suggests a potentially complex relationship around graduate competencies, assessment and writing. This further supports the idea that future research and practice should expand the use of blogs as assessment beyond a single paper. Doing so might further enhance the potential of blogs to develop writing ability and its connection to other graduate competencies.

Using blogs at the higher education level is appealing because technology literate students readily adopt such tools (Chawinga, 2017; Top. 2012). One would therefore expect an increase in interest in learning to then impact significantly on students' learning and achievement. However, our results show that the increase in interest in learning due to the use of computer-based technology with 'tech-savvy' students does not have a very significant impact on Q&Q. Thus, while increased interest in learning has a significant correlation with some of the elements under study, this does not seem to hold to the larger concept of Q&Q. Given the importance of students' interest in learning to life-long and career long development, the complex relationship of interest to Q&Q, blogs and Graduate Competencies warrants further study.

Conclusion

It is essential for university graduates to have an array of graduate competencies for immediate and long-term success in professional work environments. Emerging research suggests that professional degree programs are not optimizing opportunities to enhance graduate competencies development. This paper reports on the findings of a research project that aimed to explore student perceptions on the efficacy of blogs as assessment for fostering graduate competencies development.

One implication for practice is that the use of blogs or any TEA for graduate competencies development might be better suited to longitudinal use, such as a multi-year student tethered design. Further research on this is warranted.

The low positives for the graduate competency results suggest that the blog was not as high-impact in these areas. This may have been due to the relative complexity and time needed to develop these as compared to the more mechanical elements such as increasing frequency of feedback. This finding may confirm that graduate competencies take substantial time to develop and must be thought of longitudinally.

As areas for future research, students' perceptions between public and private blog use might be compared, to determine what, if any difference collaborative blog models have on perceptions of graduate competencies achievement. Similarly, there are plans to extend this research further by utilizing work product evaluations, to compare student perceptions with instructor perceptions of impact.

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Vision - A space for digital learning and exploring pedagogies: Virtual world education

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The Australian and New Zealand Virtual Worlds Working Group (VWWG) was established in 2009. Members of the group have written papers for ASCILITE conferences since 2010. Each paper's intention is to provide an overview on using virtual worlds in higher education, especially the practical aspects of incorporating 3D worlds to enhance student learning. This VWWG's paper looks at a virtual world as a space for digital learning and exploratory pedagogy – meaning, that the authors perhaps do not perceive virtual worlds as ordinary. However, they do acknowledge that those who do not regularly engage in virtual worlds may see it as new and innovative, perhaps even untested ground, but still with a degree of unfamiliarity. A survey was sent to the members of the VWWG in which the narratives have provided rich data for in depth understanding. The themes focused in the survey were 'disruptive thinking', 'emerging ideas' and 'lateral connections', from the perspective of the respondents' experiences in the implementation of virtual worlds in education. They discuss the idea of a virtual world used in education as a new treasure, or perhaps it has been in use for some time and now classified as traditional.

Keywords:
Virtual worlds, Second Life, disruption, emerging ideas, lateral connections

Introduction

The study is to investigate whether virtual worlds are a space for digital learning and exploring pedagogies. The paper discusses virtual worlds from the perspective of disruptive thinking, emerging ideas and lateral connections. A survey was sent out to The Australian and New Zealand Virtual Worlds Working Group (VWWG) community in which the 13 authors who responded provided rich data for further understanding current themes and issues. It is held that the respondents represent expert opinion. The paper was written by a team of researchers who had diverse backgrounds and viewpoints on the topic. What was found from the process is that it there still seems to be a perception that virtual worlds are untested grounds.

Context

The Australian and New Zealand Virtual Worlds Working Group (VWWG) was established in 2009 rapidly expanding to a steady membership of approximately 200 members. Since its establishment, the VWWG have conducted research and in which the results have been disseminated at conferences such as ASCILITE to provide a longitudinal account of the members' experiences of using a virtual world in higher education. In this paper, we first provide an overview of past papers written by members of the VWWG, followed by an outline of this paper. In 2017, 18 members of the VWWG wrote a paper for ASCILITE looking at virtual worlds from the perspective of individuals, institutions and technology (Gregory et al., 2017). Twenty VWWG members presented the perspective of their students on innovation and design (Gregory et al., 2016). In 2015, 30 authors looked at critical perspectives of educational technologies (Gregory et al., 2015). In 2014, 32 authors discussed past, present and future uses of virtual worlds (Gregory et al., 2014). In 2013, 52 authors wrote a paper on remembering the past, understanding the present and imagining the future (Gregory et al., 2013). In 2012, 46 authors discussed sustaining the future through virtual worlds (Gregory et al., 2012). 2011 saw 47 authors exploring how virtual worlds were contributing to change through innovative teaching and learning (Gregory et al., 2011) and, in 2010, 21 authors outlined how virtual worlds were transforming the future (Gregory et al., 2010). There has been much insight and advice given via these papers, and it should serve to prove the path well marked.

Literature review

Online learning has become popular in higher education in Australia due to the advancements in technology, developments in the job market, and the geographic location of students (Murphy & Stewart, 2017; Xiaoxia & E-Ling, 2012). There is a different approach and set of skills required in online learning in contrast with face-to-face learning (Boling et al, 2017; Yamagata-Lynch, 2014). 'Digital natives' are "assumed to be more digitally adept and digitally attuned than previously was the case" (Henderson, Selwyn, Ashton, 2017, p. 1567). Factors for success in online learning comprise of socialising, support, interaction, flexibility and minimising technical difficulties (Schrum & Hong, 2002). The social side of university, including social networking, does have a positive impact for those learning online (Hamid, Waycott, Kurnia & Chang, 2015) through explorative pedagogy.

There are many uses of virtual worlds in learning and teaching in which the virtual world of Second Life is prevalent (Baker, Wentz, Woods, 2009). The virtual world has in some ways become an alternative way of learning and a viable option in learning and teaching spaces. Virtual worlds are seen as a new transformative and disruptive way in the teaching and learning context (Yee, Bailson, Urbanek, Chang & Mer-get, 2017).

Methodology

This is a mixed methods study using both quantitative and qualitative methodologies. A survey was sent out to academics working at universities in Australia and New Zealand who were members of the VWWG. The 17 questions of the survey were designed to acquire semi-structured responses as well as closed questions for statistical and thematic analysis. The survey was open for a fixed timeline, and the identities of the respondents were kept confidential. The main focus of the questions reported here were on disruptive thinking, emerging ideas and lateral connections. Through the analysis of the results, the authors discussed the notion that a virtual world is a new educational space, or, perhaps one that has been in use for some time and therefore an established space. The information was collated and reedited by the authors, forming a loose Delphi process. The qualitative method used for the study was through a thematic analysis. This was selected as it can identify, analyse, and code common themes from the data (Braun & Clarke, 2006; Rubin & Rubin, 1995). Narrative research analysis was also used to further explore their experiences in virtual worlds to represent this in a textual format. Rich data provided more detail and the complexities with working in the virtual world environment.

Results

Background of respondents

There were 13 respondents to the survey in which eleven were from Australia and two from New Zealand. Out of the 13 respondents, seven were from universities in capital cities, and six in regional centres. Four were also from institutes of technology. Due to the long distances between cities and towns, especially in Australia, virtual reality maybe regarded as a vital form of communication for those who otherwise would not be able to engage in learning.

Discipline areas taught

When members of the VWWG were asked to indicate the discipline they used virtual worlds for, the overwhelming response was in education with 57% (Figure 1). The other areas were in business (15%) and health, law, visual and performing arts and other with one respondent each of 7%. The response from law and visual and performing arts was from the same respondent. The high percentage of education respondents appears atypical of the active membership group of the VWWG.

One respondent described in detail the use of virtual worlds. They were not only used widely, but were seen as the norm:

In the past I used virtual worlds with foundation (bridging/enabling) students. I used virtual worlds with students from Level 2 to Level 4 (lowest foundation with little high school experience to certificate level) in cohorts from pre-degree nursing, teaching, engineering, social services, and trades. Currently, I am responsible for professional development and my students are lecturers. The work I do has a focus on elearning, tertiary teaching, embedding literacy and numeracy, and assessment and moderation.

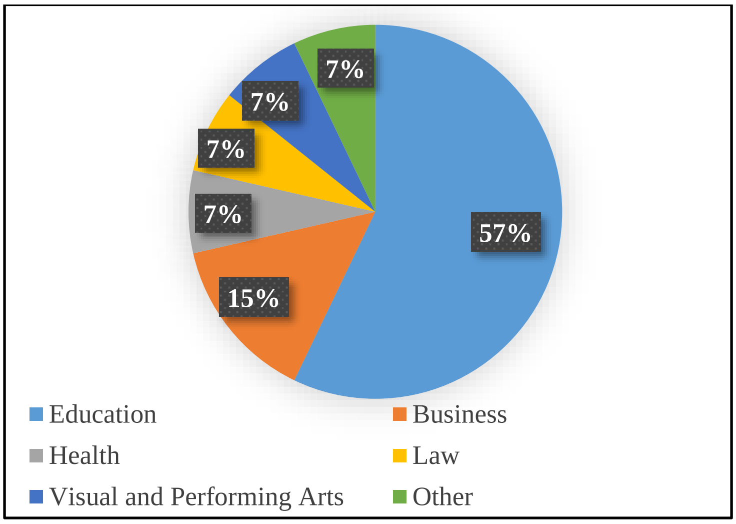

Figure 1: Discipline area where virtual world used

Another lecturer discussed how virtual worlds were used by students at all stages of their university experience: 'Students, Initial Teacher Education undergraduate and postgraduate, master's students studying educational technologies.'

Virtual worlds as a means for disruptive thinking

Members of the VWWG discussed a virtual world in terms of disruptive thinking. Virtual worlds, from the perspective of disruptive thinking, is how the world is transforming. They are transforming from being virtual to mixed and augmented. It is penetrating into health, business, logistics and teaching. In 2007, Hedberg and Freebody (p. 8) stated that while technology has been heavily invested in and implemented in the K-12 classroom "no such disruptive technological innovation seems yet to have challenged traditional pedagogies".

Virtual worlds have the capacity to stimulate disruptive thinking in students by putting them in learning spaces that are unusual to them. By asking them to attend class in a virtual space embodied as an avatar, students report that everyone is so used to 'chalk and talk' or teachers writing notes then talking for long extended periods of time about them. This new wave of innovative pedagogies opens up the classroom environment to a wider world of communication for a school and particular students to engage with. The students mentioned ways in which virtual worlds could be used, such as: virtual stores could teach students about commerce in spaces where they can trade goods and services for real rewards. Virtual governments could teach students about civics and responsibility. Historical characters could be brought to life and scenes re-enacted. Theoretical mathematics could be given real applications in the virtual world. Virtual teaching could be practiced prior to going into the real world to teach.

As Jacka (2018, p. 29) states, "the introduction of an innovative technology, like virtual worlds, into the conservative environment of education can be challenging because it has the capacity to disrupt the status quo." She went on to state that "the lessons that can be learnt from observing the patterns in the adoption of disruptive innovations is that they often at first appear to be of little value to current practices. It is not until the practices have changed in an almost synchronistic manner with the technology adoption that the type of use, usefulness, and ease of use of the technology emerge as an obvious and integrated part of society and/or education" , (p. 32). If we can disrupt the norm through digital innovation that in turn becomes a disruptive innovation, then we can hope to begin to see changes in the level of engagement that both teachers, faculty and students will have for collectively coming together in traditional spaces for learning.

By allowing students to form narratives and control their content and output, virtual worlds afford greater freedom than might be easily achieved in a classroom setting. It can allow a level of anonymity so students could assess themselves or interact in ways that bolster their self-esteem and social interaction. Virtual worlds can be used to support roleplay in a way that cannot be afforded in a classroom setting. This may allow for students to develop empathy with communities or population they may otherwise have no buy-in.
The weight of 'pedagogical' thinking and decisions are being heavily led by 'student satisfaction' scores leaving academics to play in a very safe zone far away from disruptive thinking. The concept of using an avatar in virtual worlds frees up one's identity and 'permits' disruptive thinking in an academic world which is increasingly regulated and controlled.

The traditional approach to the use of narrative is either short disconnected text-based problems discussed in tutorials and/or references in lectures or tutorials, to literature (such as the Merchant of Venice or Bleak House). Machinima created using virtual worlds disrupts that traditional model: it enables the creation of engaging, multi-layered and dynamic scenarios that are tailored to the material being taught and, for a generation of students who have typically grown up in a world surrounded by films and television, makes that material more accessible by enabling them to put faces to names in situations which they can readily identify. In this way it helps them to appreciate the relevance of what they are studying to real world practice.

Virtual worlds provide opportunities in teacher education to disrupt student thinking in relation to the classroom and school learning spaces, to practice pedagogical approaches in such spaces, to go beyond limitations of real world physical spaces, i.e., for students to build large objects impossible in real, or a space station (Boyd, & Ellis, 2013). In addition, it provides a disruptive perspective on/off-campus learning through virtual excursions to virtual spaces, static 3D images, and streamed or recorded 3D video spaces.

One VWWG respondent stated that their first entrance into virtual worlds, a decade ago, left them feeling a sense of extreme discomfort. It originated in a fear of the unknown or possibly even a sense of inadequacy. They refused to fail and challenged themselves to get to a point where they felt comfortable operating in the environment. Without that sense of discomfort, they would have missed the shift to disruptive thinking. Virtual worlds provide a constant push towards disruptive and creative thinking and this can be seen in the students as well as lecturers. Those who persevere enjoy the benefits of learning in a unique environment. The technical limitations become fewer and fewer as time goes by and the possibilities for the future are endless.

Virtual worlds in 2003 and 2019 are very different. As technology develops, so too does the potential for educational engagement in virtual world pedagogy. The technology is now easier to use and less fraught with potential technical glitches. Students are more receptive to working in a virtual environment as life around them gravitates more and more online. Lecturers see the software as less frightening and the learning curve is not as steep as it was in the past. Disruptive, creative, challenging thinking leads to change. Virtual worlds are not immune to this change. The changes are exciting for education. The possibility of engaging with real world objects, or address real world problems while immersed in a virtual world, hold great potential station (Boyd, & Ellis, 2013). The use of mixed realities opens up potentialities for engrossing learning experiences. The traditional lectures will soon be relics from the past. Digital reality is the natural progression from virtual worlds, virtual reality (VR), augmented reality (AR), and mixed reality (MR). Digital reality will allow students to see precise demonstrations, participate in training with 'real' equipment, and engage in accurate workplace scenarios far earlier than currently possible.

The technical and social settings in virtual environments are constantly evolving, paving the way for new ideas and developments in education. The demand for more improved features will drive the need for research and development. The developments will also attract more users to 3D virtual spaces, creating a virtuous circle of learning and teaching. Virtual worlds provide spaces to encourage brain storming and the discussion of emerging ideas. They are a space for molding emerging ideas. Microsoft HoloLens and Oculus Rift are examples of how the virtual world is transforming the use of technology in various domains.

It seems that as an emerging idea, the technology of a virtual world itself, has not really progressed if we focus on virtual worlds such as Second Life. However, the development of other parts of the technology such as virtual reality and augmented reality that combine with virtual worlds and extend the idea seem to be moving us in a direction that will eventually show that adoption in education is as likely as in the area of entertainment. Having access to virtual worlds (and the extras; VR, AR) mean that we can experiment with ideas in a fairly 'low-fi' way. That is, we do not necessarily need a lot of money to put into place exploratory pedagogy and learning. This is what is exciting about virtual worlds, one can create the spaces they are imagining without employing a designer

or programmer. It opens up potential for teachers and students to do the same and to have a place to prototype various ideas in a simulation of the 'real world'. This way, we can test out 'emerging ideas'.
From the design and construction perspective, the use and accuracy of virtual worlds in building modelling begins to blur the lines between the virtual and the real world. Improved modelling capabilities that increase the accuracy and ability of the virtual world to 'replicate' the real world where not only does art imitate life, but art influences life. Virtual worlds provide spaces in which to integrate VR experiences and sandpit environments in which learners can engage with exploratory pedagogy – for example, design and construction, physical learning space creation and experimentation.

Lateral connections of virtual worlds

Virtual worlds have always had the capacity to create cross-disciplinary work. It can connect people from a range of disciplines and expertise which more easily enables lateral connections. For example, the use of the virtual world in design modelling has increasingly been merging architecture and drafting with cost engineering, or quantity surveying fields; as a social space in which lecturers, students and researchers come together and experience the same thing at the same time, and work together. It also lends itself to having collaborations in order to fully develop some of the more complex ideas researchers and lecturers are trying to investigate. In some ways it is found to flatten hierarchy. This may be because all are embodied as avatars and many come in with the same level of 'skills' in terms of navigation and building.

Building communities, as well as virtual artifacts, are highly significant and necessary in virtual worlds. Virtual environments can be seen in 3D versions of the popular social media sites. In an open world context, the student may form large social networks, however with the same constraints put on learning within a virtual world that is present in real life learning spaces, the student's ability to form these connections is retarded, thinking that constraints in real life learning spaces need to be reconsidered and the affordances of virtual worlds given space to develop.

Learning in a virtual world cannot occur in the traditional sense of gathering knowledge (e.g., accumulating facts). Learning within a virtual world incorporates 'things' lateral to the central act of knowledge gathering. This involves concepts such as collaboration, building relationships, problem solving, navigating and existing in not one but two worlds, i.e., through social presence. The nature of learning in a virtual world enables these lateral connections to flourish as learners who are unencumbered by their 'real self/real world' norms may have enhanced experiences and outcomes of learning.

Virtual worlds are bringing forth lateral connection by merging various fields and endangering a fusion of technology and business. A virtual world such as Second Life offers so much flexibility and possibility from a storytelling point of view that it enables even mundane study programs to be redesigned as vibrant learning experiences. It also facilitates the building of bridges not only between different parts of one subject but also between different subjects in a way not possible using traditional approaches. Virtual worlds often provide examples of the use of spaces and activities within virtual worlds, particularly as exemplars, that students and academics may not experience in the real world. i.e., approaches used in drama education for science educators and students.

Finally, an example of the importance of a collaborative group, such as the VWWG, was outlined by one respondent where they describe how they were first involved in a virtual world project, Second Life Education New Zealand (SLENZ) in 2009. They were an educator for the foundation (bridging/enabling) project. The respondent was impressed by the collaborative nature of education in Second Life. Later, this person joined the VWWG. This group of educators shared their projects, ideas, and research. For several years she has used Second Life for a role-play assessment for her pre-degree nursing students. The role-play 'patients', who also functioned as assessors, were their colleagues from the VWWG. Students would select a condition that affected a body system. They would research the condition and produce an informative leaflet/brochure for their patients. These would cover everything from breast cancer to diabetes. Her colleagues, members of the VWWG, would receive their leaflets/brochures in time to prepare for their timetables role-play(s). Student feedback from these assessments was very positive. The main thing they appreciated was meeting a 'real patient' and receiving feedback about their performance from someone other than their lecturer. One student response stated 'meeting someone new was great. My assessment report had lots of details and I knew what I had done right and what I could do better. It was fun and I learned a lot'.

Disruptive thinking, emerging ideas and lateral connections

The respondents of the survey discussed the three themes, disruptive thinking, emerging ideas and lateral connections from a view of a virtual world as an innovation and through student feedback. Following are responses from the VWWG members through the survey in relation to innovation. The survey asked how respondents are being innovative in their use of virtual worlds as a learning resource. Following this are some responses from students about how they felt about their experiences in using virtual worlds for learning.

Respondent feedback on innovation

As outlined, the respondents to the survey found virtual worlds in education not to be a new space but perhaps more of an untapped, unmined or even forgotten resource. Respondents discussed how they had been innovative in the virtual world space in which they taught/researched.

One respondent stated that they re-use and re-purpose the resources that exist currently in virtual worlds. An example was through the use of a foundation interviewing site in a virtual world which had been used for a nursing interview room for role-play assessments with pre-degree nursing students. Many of the respondents stated that they are prepared to try anything that will be of benefit to their students and assist them in disruptive, creative thinking and lifelong learning.

Several respondents state that they have plans to move their virtual world activities and games in a virtual reality activity, demonstrating the use of emerging ideas through the coding that would have to be undertaken for this to eventuate. This is particularly true of any of the virtual world games that have been used with students that lend themselves to this conversion.

One member of the VWWG community uses virtual worlds to create machinima, through lateral connections, which involves film making techniques and multiple stages of production. Video recording and recording of voice talent is undertaken separately, with video and audio synchronised in the editing process. In addition, the narratives depicted by machinima are linked by recurring characters and continuing storylines. This aids engagement because students are already familiar with the characters, their relationships with each other, and the context of those relationships. Machinima is used in a variety of ways in the various subjects, including to facilitate class discussions, summative class activities (e.g., negotiation role plays), to provide instruction, to provide feedback, and to contextualise otherwise abstract principles.

One second-year elective class is through a blended delivery as 50% of the course is delivered face-to-face in a lab, the other 50% is delivered virtually in Second Life. Both methods complement each other but can also ‘feel’ disjointed from the learner’s point of view. The challenge was to bring theory and practice together through disruptive thinking. The learners are often paired-up to ‘teach’ each other. This concept is not new, and is considered to be an industry standard in software development referred to as ‘pair programming’. Once the learners are paired up, one learner takes the role of the ‘driver’, and the other learner becomes the ‘navigator’. The driver has control of the keyboard but strictly listens to the instructions from the navigator, who has to give instructions to follow but is not permitted to touch the keyboard. The aim of this practice is to encourage learners to become ‘teachers’ and cement their learning by teaching the other learner. This practice takes longer but encourages learners to justify their actions in using and building in virtual worlds.

Pre-service teachers were taken into the virtual world and asked to imagine how they can get their future classroom students to use virtual worlds to respond to the learning they were going to develop through emerging ideas. The pre-service teachers were asked to think about what types of technology they would use with their classroom students (K-12 classroom students). This often means that the pre-service teachers have to really change (and challenge) their thinking about what is possible, particularly when shown the work that eight-year-old classroom students have made.

Student feedback on their experiences in virtual worlds

All respondents of the survey stated that they regularly receive feedback from their students in relation to their experiences in using a virtual world for learning. Various quotes from different student groups follow.

In the pre-degree nursing role-play assessments, students stated that “It is a good experience. It gives me some ideas about what a real nurse is. It is also a good challenge. I feel more confident that I can be a nurse.” This was reassuring for the lecturer to know that the students found their learning a challenge but the experience made them more confident to put what they had learnt into practice. They stated that they liked communicating with their patient. Saying “I really enjoyed communicating and understanding the importance of the role as nurse. Nursing is my career because I love helping people”.

One comment depicts one of the major benefits of using a virtual world: “Today on our virtual ability visit in Second Life virtual world we had the chance of interacting virtually and asking questions after introducing ourselves. This opportunity to meet a very large virtual community of disabled residents has taught me many things. Second Life has given emotional and physical mobility to people who in the real world struggle with their disabilities. They enjoy each other’s company no matter their ages or impairment. They seem so close and loving even though they are separated by continents and cultures. I thoroughly enjoyed my session in their world”.

Further, another student from the same group, demonstrated disruptive thinking, by reiterating the previous response with “We visited virtual ability island where we had an opportunity to meet avatars from other countries. These avatars in real life are actually living with limited mobility and face challenges performing simple tasks that we take for granted such as sitting and walking. In Second Life they are able to be free of their disabilities and to meet as friends and equals. Their connection is intense and I couldn’t believe how close their friendships were”.

One respondent stated that a reason the virtual world community is quite effective is because it is very welcoming to people from all over the world belonging to different race, age group, ethnicity, culture and gender. People who may be visually impaired, have certain health conditions, and mentally or physically challenged, can also join this community which creates a positive and vibrant atmosphere for them. A student stated that “The continuity in storyline and characters ... was valuable because we didn’t have to focus as much on who was who and could instead concentrate on the issues.”

The students that one respondent spoke with overwhelmingly liked the experience of learning in Second Life. They agreed it provided a safe space to learn through scaffolded approaches where theoretical concepts were first tested in Second Life before going out on practical with real people. Figure 2 provides an example of a school practicum (professional experience) that was being undertaken in a role play with teacher and learner avatars. Learners also acknowledged that learning occurred through repetition and reflection - techniques that are used in real life learning.

Finally, one student summed up their experience with the following: “Thanks so much for setting this up - it was hilarious and a lot of fun, as well as being educational. Really appreciate this opportunity”. Many learners throughout Australia and New Zealand have been provided with similar opportunities over the past 10+ years and each respondent would have very similar stories to share.

Figure 2: Demonstration of a virtual class being undertaken with teacher/student avatars

Conclusions

Despite such hurdles, virtual worlds continue to demonstrate an experience that is difficult, impossible, or even too expensive, to replicate in real life. The main question of whether a virtual world is a new space for digital learning experiences can be answered quite easily. It is mostly definitely a space that is valued by many educators, researchers and students who have had the privilege of experiencing the use of a virtual world in teaching, research and learning. The authors of the VWWG formed in 2009, ten years ago. They formed when virtual worlds in education had been undertaken for some time (for example, Second Life, was established in 2003). Therefore, in terms of technology, virtual worlds are definitely not new. In terms of a new space and pedagogy, the members of the VWWG would all agree that virtual worlds are as they provide a way in which to teach, learn and research in ways that are simply impossible in real life. They also provide a space in which to replicate real life to take away barriers that prevent the teaching, learning and research that inhibit this – be it cost, time, safety or a multitude of factors.

The authors have discussed their perspective of virtual worlds from three different angles: disruptive thinking, emerging ideas and lateral connections. From the authors perspective, virtual worlds are a tool in which educators, researchers and students can use in almost any context to provide experiences and a definitive answer to the question of whether or not virtual worlds are a space for digital learning and exploration of pedagogies – they most definitely are, they are just not new.

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Exploring knowledge reuse in design for digital learning: tweaks, H5P, constructive templates and CASA

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Higher education is being challenged to improve the quality of learning and teaching while at the same time dealing with challenges such as reduced funding and increasing complexity. Design for learning has been proposed as one way to address this challenge, but a question remains around how to sustainably harness all the diverse knowledge required for effective design for digital learning. This paper proposes some initial design principles embodied in the idea of Context-Appropriate Scaffolding Assemblages (CASA) as one potential answer. These principles arose out of prior theory and work, contemporary digital learning practices and the early cycles of an Action Design Research process that developed two digital ensemble artefacts for 7 courses (units, subjects) and in less than a year been used in over 60 sites. Experience with this approach suggests it can successfully increase the level of design knowledge embedded in digital learning experiences, identify and address shortcomings with current practice, and have a positive impact on the quality of the learning environment.

Keywords:
Design for Learning, Digital learning, NGDLE.

Introduction

Learning and teaching within higher education continues to be faced with significant, diverse and on-going challenges. Challenges that increase the difficulty of providing the high-quality learning experiences necessary to produce graduates of the standard society is expecting (Bennett, Lockyer, & Agostinho, 2018). Goodyear (2015) groups these challenges into four categories: massification and the subsequent diversification of needs and expectations; growing expectations of producing work-ready graduates; rapidly changing technologies, creating risk and uncertainty; and, dwindling public funding and competing demands on time. Reconceptualising teaching as design for learning has been identified as a key strategy to sustainably, and at scale, respond to these challenges in a way that offers improvements in learning and teaching (Bennett et al., 2018; Goodyear, 2015). Design for learning aims to improve learning processes and outcomes through the creation of tasks, environments, and social structures that are conducive to effective learning (Goodyear, 2015; Goodyear & Dimitriadis, 2013). The ability of universities to develop the capacity of teaching staff to enhance student learning through design for learning is of increasing financial and strategic importance (Alhadad, Thompson, Knight, Lewis, & Lodge, 2018).

Designing learning experiences that successfully integrate digital tools is a wicked problem. A problem that requires the utilisation of expert knowledge across numerous fields to design solutions that respond appropriately to the unique, incomplete, contextual, and complex nature of learning (Mishra & Koehler, 2008). The shift to teaching as design for learning requires different skills and knowledge, but also brings shifts in the conception of teaching and the identity of the teacher (Gregory & Lodge, 2015). Effective implementation of design for learning requires detailed understanding of pedagogy and design and places cognitive, emotional and social demands on teachers (Alhadad et al., 2018). The ability of teachers to deal with this load has significant impact on learners, learning, and outcomes (Bezuidenhout, 2018). Academic staff report perceptions that expertise in digital technology and instructional design will be increasingly important to their future work, but that these are also the areas where they have the least competency and the highest need for training (Roberts, 2018). Helping teachers integrate digital technology effectively into learning and teaching has been at or near the top of issues facing higher education over several years (Dahlstrom, 2015). However, the nature of this required knowledge is often underestimated by common conceptions of the knowledge required by university teachers (Goodyear, 2015). Responding effectively will not be achieved through a single institutional technology, structure, or design, but instead will require an "amalgamation of strategies and supportive resources" (Alhadad et al., 2018, pp. 427-429). Approaches that do not pay enough attention to the impact on teacher workload run the risk of less than optimal learner outcomes (Gregory & Lodge, 2015).

Universities have adopted several different strategies to ameliorate the difficulty of successfully engaging in design for digital learning. For decades a common solution has been that course design, especially involving the adoption of new methods and technologies, should involve systematic planning by a team of people with appropriate expertise in content, education, technology and other required areas (Dekkers & Andrews, 2000). The use of collaborative design teams with an appropriate, complementary mix of skills, knowledge and experience mirrors the practice in other design fields (Alhadad et al., 2018). However, the prevalence of this practice in higher education has been low, both then (Dekkers & Andrews, 2000) and now. The combination of the high demand and limited availability of people with the necessary knowledge mean that many teaching staff miss out (Bennett, Agostinho, & Lockyer, 2017). A complementary approach is professional development that provides teaching staff with the necessary knowledge of digital technology and instructional design (Roberts, 2018). However, access to professional development is not always possible and funding for professional development and training has rarely kept up with the funding for hardware and infrastructure (Mathes, 2019). There has been work focused on developing methods, tools and repositories to help analyse, capture and encourage reuse of learning designs across disciplines and sectors (Bennett et al., 2017). However, it appears that design for learning continues to struggle to enter mainstream practice (Mor, Craft, & Maina, 2015) with design work undertaken by teachers apparently not including the use of formal methods or systematic representations (Bennett et al., 2017). There does, however, remain on-going demand from academic staff for customisable and reusable ideas for design (Goodyear, 2005). Approaches that respond to academic concerns about workload and time (Gregory & Lodge, 2015) and do not require radical changes to existing work practices nor the development of complex knowledge and skills (Goodyear, 2005).

If there are limitations with current common approaches, what other approaches might exist? Leading to the research question of this study:

How might the diverse knowledge required for effective design for digital learning be shared and used sustainably and at scale?

An Action Design Research (ADR) process is being applied to develop one answer to this question. ADR is used to describe the design, development and evaluation of two digital artefacts - the Card Interface and the Content Interface – and the subsequent formulation of initial design principles that offer a potential answer to the research question. The paper starts by describing the research context and research method. The evolution of each of the two digital artefacts is then described. This experience is then abstracted into six design principles encapsulated in the concept of Context-Appropriate Scaffolding Assemblages (CASA). Finally, the conclusions and implications of this work are discussed.

Research context and method

This research project started in late 2018 within the Learning and Teaching (L&T) section of the Arts, Education and Law (AEL) Group at Griffith University. Staff within the AEL L&T section work with the AEL's teachers to improve the quality of learning and teaching across about 1300 courses (units, subjects) and 68 programs (degrees). This work seeks to bridge the gaps between the macro-level institutional and technological vision and the practical, coal-face realities of teaching and learning (micro-level). In late 2018 the macro-level vision at Griffith University consisted of current and long-term usage of the Blackboard Learn Learning Management System (LMS) along with a recent decision to move to the Blackboard Ultra LMS. In this context, a challenge was balancing the need to help teaching staff continue to improve learning and teaching within the existing learning environment while at the same time helping the institution develop, refine, and achieve its new macro-level vision. It is within this context that the first offering of Griffith University's Bachelor of Creative Industries (BCI) program would occur in 2019. The BCI is a future-focused program designed to attract creatives who aspire to a career in the creative industries by instilling an entrepreneurial mindset to engage and challenge the practice and business of the creative industries. Implementation of the program was supported through a year-long strategic project including a project manager and educational developer from the AEL L&T section working with a Program Director and other academic staff. This study starts in late 2018 with a focus on developing the course sites for the seven first year BCI courses. A focus of this work was to develop a striking and innovative design that mirrored the program's aims and approach. A design that could be maintained by the relevant teaching staff beyond the project's protected niche. This raised the question of how to ensure that the design knowledge required to maintain a digital learning environment into the future would be available within the teaching team?

To answer this question an Action Design Research (Sein, Henfridsson, Purao, & Rossi, 2011) process was adopted. ADR is a merging of Action Research with Design Research developed within the Information Systems discipline. ADR aims to use the analysis of the continuing emergence of theory-ingrained, digital artefacts within a context as the basis for developing generalised outcomes, including design principles (Sein et al., 2011). A key assumption of ADR is that digital artefacts are not established or fixed. Instead, digital artefacts are ensembles that arise within a context and continue to emerge through development, use and refinement (Sein et al., 2011).

A critical element of ADR is that the specific problem being addressed – design of online learning environment for courses within the BCI program – is established as an example of a broader class of problems – how to sustainably and at scale share and reuse the diverse knowledge required for effective design for digital learning (Sein et al., 2011). This shift moves ADR work beyond design – as practised by any learning designer – to research intending to provide guidance to how others might address similar challenges in other contexts that belong to the broader class of design problems.

Figure 1 provides a representation of the ADR four-stage process and the seven principles on which ADR is based. Stages 1 through 3 represent the process through which ensemble digital artefacts are developed, used and evolved within a specific context. The next two sections of this paper describe the emergence of two artefacts developed for the BCI program as they cycled through the first three ADR stages numerous times. The fourth stage of ADR – Formalisation of Learning – aims to abstract the situated knowledge gained during the emergence of digital artefacts into design principles that provide guidance for addressing a class of field problems (Sein et al., 2011). The third section of this paper formalizes the learning gained in the form of six initial design principles structured around the concept of Contextually Appropriate Scaffolding Assemblages (CASA).

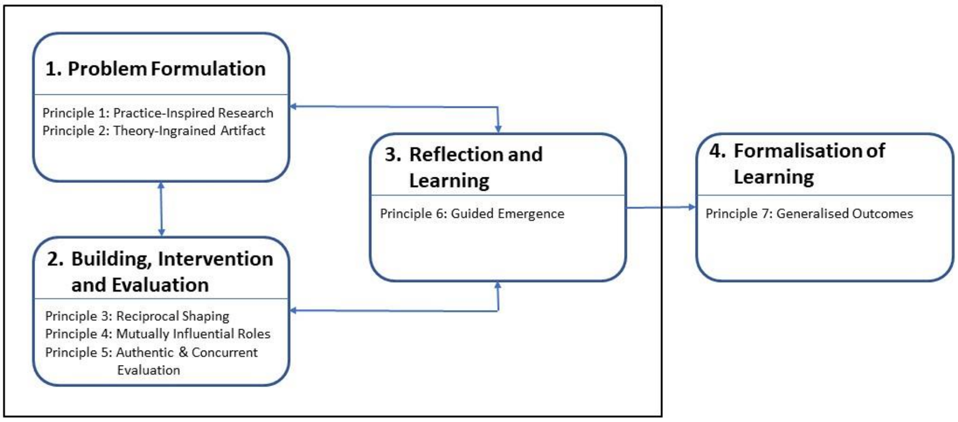

Figure 1 – ADR Method: Stages and Principles (adapted from Sein et al., 2011, p. 41)

Card Interface (artefact 1, ADR stages 1-3)

In response to the adoption of a trimester academic calendar, Griffith University encourages the adoption of a modular approach to course design. It is recommended that course profiles use modules to group and describe the teaching and learning activities. Subsequently, it has become common practice for this modular structure to be used within the course site using the Blackboard Learn content area functionality. To do this well, is not straight forward. Blackboard Learn has several functional limitations in legibility, design consistency, content arrangement and content adjustment that make it difficult to achieve quality visual design (Bartuskova, Krejcar, & Soukal, 2015). Usability analysis has also found that the Blackboard content area is inflexible, inefficient to use, and creates confusion for teaching staff regardless of their level of user experience (Kunene & Petrides, 2017). Overcoming these limitations requires levels of technical and design knowledge not typically held by teaching staff. Without this knowledge the resulting designs typically range from purely textual (e.g. the left-hand side of Figure 2) through to exemplars of poor design choices including the likes of blinking text, poor layout, questionable colour choices, and inconsistent design. While specialist design staff can and have been used to provide the necessary design knowledge to implement contextually-appropriate, effective designs, such an approach does not scale. For example, any subsequent modification typically requires the re-engagement of the design staff.

To overcome this challenge the Blackboard Learn user community has developed a collection of related solutions (Abhrahamson & Hillman, 2016; Plaisted & Tkachov, 2011) that use Javascript to package the necessary design knowledge into a form that can be used by teachers. Griffith University has for some time used one of these solutions, the Blackboard Tweaks building block (Plaisted & Tkachov, 2011) developed at the Queensland University of Technology. One of the tweaks offered by this building block – the Themed Course Table - has been widely used by teaching staff to generate a tabular representation of course modules (e.g. the right-hand side of Figure 2). However, experience has shown that the level of knowledge required to maintain and update the Themed Course Table can challenge some teaching staff. For example, re-ordering modules can be difficult for some, and the dates commonly used within the table must be manually added and then modified when copied from one offering to another. Finally, the inherently text-based and tabular design of the Themed Course Table is also increasingly dated. This was an important limitation for the Bachelor of Creative Industries. An alternative was required.

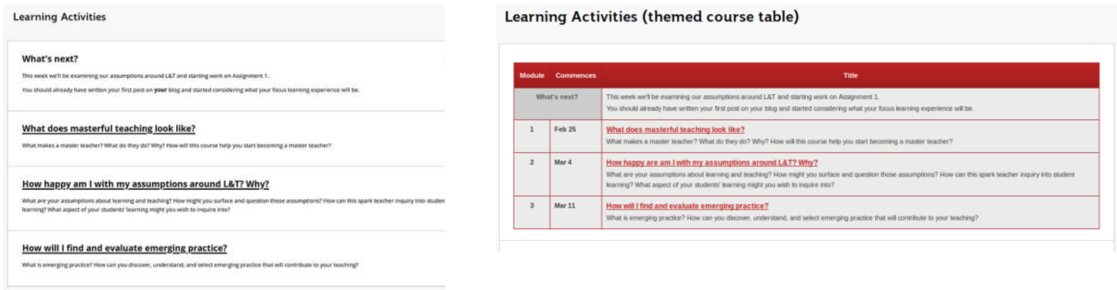

Figure 2 – Example Blackboard Learn Content Areas: Textual versus Themed Course Table

That alternative would use the same approach as the Themed Course Table to achieve a more appropriate outcome. The approach used by the Themed Course Table, other related examples from the Blackboard community, and the H5P authoring tool (Singh & Scholz, 2017) are contemporary examples of constructive templates (Nanard, Nanard, & Kahn, 1998). Constructive templates arose from the hypermedia discipline to encourage the reuse of design knowledge and have been found to reduce cost and improve consistency, reliability and quality while enabling content experts to author and maintain hypermedia systems (Nanard et al., 1998). Constructive templates encapsulate a specific collection of design knowledge required to scaffold the structured provision of necessary data and generate design instances. For example, the Themed Course Table supports the provision of data through the Blackboard content area interface. It then uses design knowledge embedded within the tweak to transform that data into a table. Given these examples and the author's prior positive experience with the use of constructive templates within digital learning (Jones, 2011), the initial plan for the BCI Course Content area was to replace the Course Theme Table "template" to adopt both a more contemporary visual design, and a forward-oriented view of design for learning. Dimitriadis and Goodyear (2013) argue that design for learning needs to be more forward-oriented and consider what features will be required in each of the lifecycle stages of a learning activity. That is, as the Course Theme Table replacement is being designed, consider what specific features will be required during configuration, orchestration, and reflection and re-design.

The first step in developing a replacement was to explore contemporary web interface practices for a table replacement. Due to its responsiveness to different devices, highly visual presentation, and widespread use amongst Internet and social media services, a card-based interface was chosen. Based on the metaphor of a paper card, this interface brings together all data for a particular object with an option to add contextual information. Common practice with card-based interfaces is to embed into a card memorable images related to the card content (see Figure 3). Within the context of a course module overview such a practice has the potential to positively impact student cognition, emotions, interest, and motivation (Leutner, 2014; Mayer, 2017). A practical advantage of card-based interfaces is that its widespread use means there are numerous widely available resources to aid implementation. This was especially important to the BCI project team, as it did not have significant graphical and client-side design knowledge to draw upon.

Next, a prototype was developed to test how effectively a card-based interface would represent a course's learning modules. An iterative process was used to translate features and existing practice from the Course Theme Table to a card-based interface. Feedback from other design staff influenced the evolution of the prototype. It also highlighted differences of opinion about some of the visual elements such as the size of the cards, the number of cards per row, and the inclusion of the date in the top left-hand corner. Eventually the prototype card interface was shown to the BCI teaching team for input and approval. With approval given, a collection of Javascript and HTML was created to transform a specifically formatted Blackboard content area into a card interface.

Figure 3 shows just two of the six different styles of card-based interface currently supported by the Card Interface. This illustrates a key feature of the original conception of constructive templates - separation of content from presentation (Nanard et al., 1998) – allowing for different representations of the same content. The left-hand image in Figure 3 and the inclusion of dates on some cards illustrates one way the Card Interface supports a forward-oriented approach to design. Initially, the module dates are specified during the configuration of a course site. However, the dates typically only apply to the initial offering of the course and will need to be manually changed for subsequent offerings. To address this the Card Interface knows the trimester weekly dates from the university academic calendar. Dates to be included on the Card Interface can then be provided using the week number (e.g.

Week 1, Week 5 etc.). The Card Interface identifies the trimester a course offering belongs to and translates all week numbers into the appropriate calendar dates.

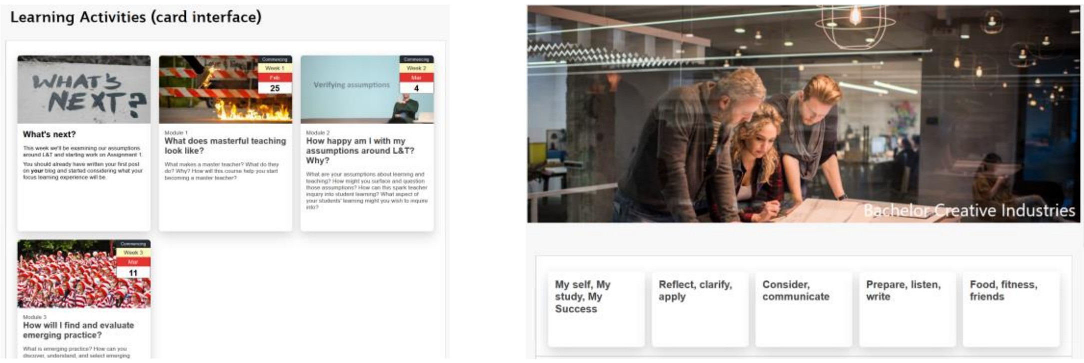

Figure 3 – Two early visualisations of the Card Interface

Despite being designed for the BCI program, the first use of the Card Interface was not in the BCI program. Instead, in late 2018 a librarian working on a Study Skills site learned of the Card Interface from a colleague. Working without any additional support, the librarian was able to use the Card Interface to represent 28 modules spread over 12 content areas. Implementation of the Card Interface in the BCI courses started by drawing on existing learning module content from course profiles. Google Image Search was used to identify visually striking images that could be associated with each module (e.g. the left-hand side of Figure 3). The Card Interface was also used on the BCI program's Blackboard site. However, the program site had a broader purpose leading to different design decisions and the adoption of a different style of card-based interface (see the right-hand image in Figure 3).

Anecdotal feedback from BCI staff and students suggest that the initial implementation and use of the Card Interface was positive. In addition, the visual improvements offered by the Card Interface over both the standard Blackboard Content Area and the Course Theme Table tweak led to interest from other courses and programs. As of early October 2019, the Card Interface has been used in over 100 content areas in over 60 Blackboard sites. Adoption has occurred at both the program and individual course level led by exposure within the AEL L&T team or by academics seeing it and wanting it. Widespread use has generated different requirements leading to creative uses of the Card Interface (e.g. the use of animated GIFs as card images) and the addition of new functionality (e.g. the ability to embed a video, instead of an image). Requirements from another strategic project led to a customisation of the Card Interface to provide an overview of assessment items, rather than modules.

With its voluntary adoption in multiple courses and use for different purposes the Card Interface appears to have successfully encapsulated a collection of design knowledge into a form that can be readily adopted and adapted. Use of that knowledge has improved the resulting design. Contributing factors to this success include: building on existing practice; providing advantages above and beyond existing practice; and, the capability for both teaching and support staff to rapidly customise the Card Interface. Further work is required to gain greater and more objective insight into the impact of the Card Interface on the student experience and outcomes of learning and teaching.

Content Interface (artefact 2, ADR stages 1-3)

The Card Interface provides a visual overview of course modules. The next challenge for the BCI project was the design, implementation and support of the learning activities and resources that form the content of those course modules. A task that is inherently more creative, important and typically involves significantly more content. Also, a task that must be completed using the same, problematic Blackboard interface. This requirement is known to encourage teaching staff to avoid the interface by using offline documents and slides (Bartuskova et al., 2015). This is despite evidence that failing to leverage affordances of the online environment can create a disengaging student experience (Stone & O'Shea, 2019) and that course content is a significant influence on students' perceptions of course quality (Peltier, Schibrowsky, & Drago, 2007). Adding to the difficulty, the BCI teaching staff either had limited, none, or little recent experience with Blackboard. In the case of contracted staff, they did not have access to Blackboard. This raised the question of how to support the design, implementation and re-design of effective modular, online learning resources and activities for the BCI?

Observation of, and experience with, the Blackboard interface identified three main issues. First, staff did not know how or have access to the Blackboard content interface. Second, the Blackboard authoring interface provides limited authoring functionality. For example, beyond issues identified in the literature (Bartuskova et al., 2015; Kunene & Petrides, 2017) there is no support for standard authoring functionality such as grammar checking, reference management, commenting, and version control. Lastly, once the content is placed within Blackboard the user interface is limited and quite dated. On the plus side, the Blackboard interface does provide the ability to integrate a variety of different activities such as discussion forums, quizzes etc. The intent was to address the issues while at the same time retaining the ability to use the Blackboard activities.

For better or worse, the most common content creation tool for most University staff is Microsoft Word. Anecdotal observation suggests that many staff have adopted the practice of drafting content in Word before copying and pasting it into Blackboard. The Content Interface is designed to transform Word documents into good quality online learning activities and resources (see Figure 4). This is done by using an open source converter to semantically transform Word to HTML that is then copied and pasted into Blackboard. A collection of design knowledge embedded into Javascript then transforms the HTML in several ways. Semantic elements such as activities and readings are visually transformed. All external web links are modified to open in a new tab to avoid a common Blackboard error. The document is transformed into an accordion interface with vertical list of headings that be clicked on to display associated content. This progressive reveal: allows readers to get an overall picture of the module before focusing on the details; provides greater control over how they engage with the content; and is particularly useful on mobile platforms (Budiu, 2015).

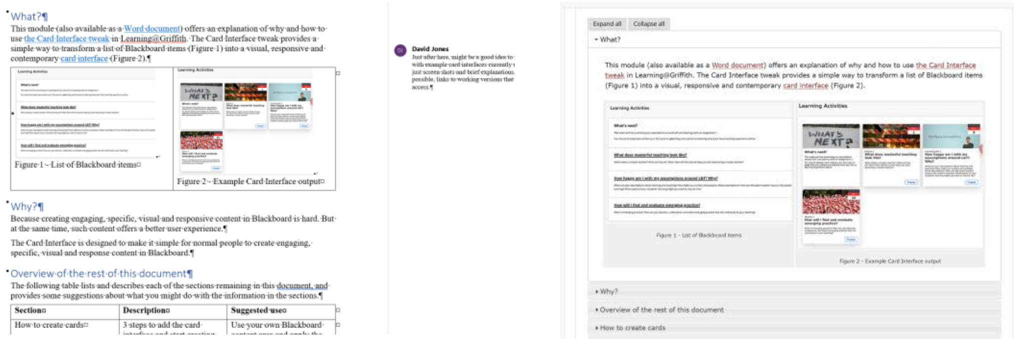

Figure 4 – Example Module as a Word document and in the Content Interface in Blackboard

As of early October 2019, the Content Interface has been used to develop over 120 modules in 28 different Blackboard sites. Experience using the still incomplete Content Interface suggests that there are significant advantages. For example, Library staff have adopted it to create research skills modules that are used in multiple course sites. Experience in the BCI shows that sharing documents through OneDrive and using comments and track changes enables the Word documents to become boundary objects helping the course development team co-create the module learning activities and resources. Where staff are comfortable with Word as an authoring environment, the authoring process is more efficient. The resulting accordion interface offers an improvement over the standard Blackboard interface. However, creating documents with Word is not without its challenges, especially the use of Word styles and templates. Also, the extra steps required can be perceived as problematic when minor edits need to be made, and when direct editing within Blackboard is perceived to be easier and quicker, especially for time-poor teaching staff. Better integration between Blackboard and OneDrive will help. More advantage is possible when the Content Interface is further contextually customized to offer forward-oriented functionality specific to the module learning design.

Initial Design Principles (ADR stage 4)

This section engages with the final stage of the ADR process – formalisation of learning – to produce design principles that help provide actionable insight for practitioners. The following six design principles help guide the development of Contextually-Appropriate Scaffolding Assemblages (CASA) that help to sustainably and at scale share and reuse the design knowledge necessary for effective design for digital learning. The design principles are grouped using the three components of the CASA acronym.

Contextually-Appropriate

1. A CASA should address a specific *contextual* need within a specific *activity system*. The highest quality learning and teaching involves the development of appropriate context-specific approaches (Mishra & Koehler, 2006). A CASA should not be implemented at an institutional level. Such top-down projects are unable to pay enough attention to contextually specific needs as they aim for a solution that works in all contexts. Instead, a CASA should be designed in response to a specific need arising in a course or a small group of related courses. Following Ellis & Goodyear (2019) the focus in designing a CASA should not be the needs of individual students, but instead on the whole activity system. That is, consideration should be given to the complex assemblage of learners, teachers, content, pedagogy, technology, organisational structures and the physical environment with an emphasis on encouraging students to successfully engage in intended learning activities. For example, both the Card and Content Interfaces arose from working with a group of seven courses in the BCI program as the result of two separate, but related, needs. While the issues addressed by these CASA apply to many courses, the ability to develop and test solutions at a small scale was beneficial. Rather than a focus primarily on individual learners, the solutions were heavily influenced by an analysis of the available tools (e.g. Blackboard Tweaks, Office365), practices (e.g. modularisation and learning activities described in course profiles), and other components of the activity systems.

2. CASA should be built using and result in *generative technologies*. To maximise and maintain contextual appropriateness, a CASA must be able to be designed and redesigned as easily as possible. Zittrain (2008) labels technologies as generative or sterile. Generative technologies have a “capacity to produce unanticipated change through unfiltered contributions from broad and varied audiences” (Zittrain, 2008, p. 70). Sterile technologies prevent this. Generative technologies enable convivial systems where people can be “actively engaged in generating creative extensions to the artefacts given to them” (Fischer & Girgensohn, 1990, p. 183). It is the end-user modifiability of generative technology that is crucial to knowledge-based design environments and enables response to unanticipated, contextual requirements (Fischer & Girgensohn, 1990). Implementing CASA *using* generative technologies allows easy design for specific contexts. Ensuring that CASA are implemented *as* generative technologies enables easy redesign for other contexts. Generativity, like other technological affordances, arises from the relationship between the technology and the people using the technology. Not only is it necessary to use technology that is easier to modify, it is necessary to be able to draw upon appropriate technological skills. This could mean having people with those technological skills available to educational design teams. It could also mean having a network of intra- and inter-institutional CASA users and developers collaboratively sharing CASA and the knowledge required for use and development; like that available in the H5P community (Singh & Scholz, 2017).

For example, development of the Card and Content Interfaces was only possible due to Blackboard Learn supporting the embedding of Javascript. The value of this generative capability is evident through the numerous projects (Abhrahamson & Hillman, 2016; Plaisted & Tkachov, 2011) from the Blackboard community that leverage this capability; a capability that has been removed in Blackboard’s next version LMS, Ultra. The use of Office365 by the Content Interface illustrates the rise of digital platforms that are generative and raise questions that challenge how innovation through digital technologies are enabled and managed (Yoo, Boland, Lyytinen, & Majchrzak, 2012). Using the generative jQuery library to implement the Content Interface’s accordion enables modification of the accordion look and feel through use of jQuery’s theme roller and library of existing themes. The separation of content from presentation in the Card Interface has enabled at least six redesigns for different purposes. This work was possible because the BCI development team had ready access to the necessary technological skills and was able to draw upon a wide collection of open source software and online support.

3. CASA development should be *strategically aligned* and supported. Services to support design for learning within Australian universities are limited and insufficient for the demand (Bennett et al., 2017). Services capable of supporting the development of CASA are likely to be more limited. Hence appropriate decisions need to be made about how and what CASA are designed, re-designed and supported. Resources used to develop CASA are best allocated in line with institutional strategic projects. CASA development should proceed with consideration to the “manageably small set of particularly valued activity systems” (Ellis & Goodyear, 2019, p. 188) within the institution and be undertaken with institutionally approved and supported generative technologies. For example, the Card and Content Interfaces arose from an AEL strategic project. Both interfaces were focused on providing contextually-appropriate customization and support for the institutionally important activity system of creating modular learning activities and resources. Where possible these example CASA have used institutionally approved digital technologies (e.g. OneDrive and Blackboard). The sterile nature of existing institutional infrastructure has made it necessary to use more generative technologies (e.g. Amazon Web Services) that are neither officially approved or supported. However, the approach used does build upon an approach from an existing institutional approved technology – Blackboard Tweaks (Plaisted & Tkachov, 2011).

Scaffolding

4. CASA should package appropriate design knowledge to enable (re-)use by teachers and students. Drawing on ideas from constructive templates (Nanard et al., 1998), CASA should package the diverse design knowledge required to respond to a contextually-appropriate need in a way that this design knowledge can be easily reused in different instances. CASA enable the sustainable reuse of contextually applied design knowledge in learning activity systems and subsequently reduce cost and improve quality and consistency. For example, the Card Interface combines the knowledge from web design and multimedia learning research (Leutner, 2014; Mayer, 2017) in a way that has allowed teaching staff to generate a visual overview of the modules in numerous course sites. The Content Interface combines existing knowledge of the Microsoft Word ecosystem with web design knowledge to improve the design, use and revision of modular content.

5. CASA should actively support a *forward-oriented* approach to design for learning. To "thrive outside of the protective niches of project-based innovation" (Dimitriadis & Goodyear, 2013, p. 1) the design of a CASA must not focus only on initial implementation. Instead, CASA design must explicitly consider and include functionality to support the configuration, orchestration, and reflection and re-design of the CASA. For example, the Card Interface leverages contextual knowledge to enable dates to be specified independent of the calendar to automate re-design for subsequent course offerings. As CASA tend to embody a learning design, it should be possible to improve each CASA's support for orchestration by implementing checkpoint and process analytics (Lockyer, Heathcote, & Dawson, 2013) specific to the CASA's embedded learning design.

Assemblages

6. CASA are conceptualised and treated as contextual *assemblages*. Like all technologies, CASA are assemblies of other technologies (Arthur, 2009) where technologies are understood to include techniques such as organisational processes and pedagogies, as well as hardware and software. But a contextual assemblage is more than just technology. It includes consideration of and connections with the policies, practices, funding, literacies and discourse across levels from societal and down through sector, organisational, personal, individual, formal and informal. These are elements that make up the mess and nuance of the context, where the practice of educational technology gets complex (Cottom, 2019). A CASA must be generative in order to be designed and re-designed to respond to this contextual complexity. A CASA needs to be inherently heterogeneous, ephemeral, local, and emergent. A need that is opposed and ill-suited to the dominant rational system view underpinning common digital learning practice which sees technologies as planned, structured, consistent, deterministic, and systematic. Instead, connecting back to design principle one, CASA should be designed in recognition of and as the importance and complex intertwining of the human, social and organisational elements in any attempt to use digital technologies. It should play down the usefulness of distinctions between developer and user, or pedagogy and technology. For example, the Card Interface does not use the Lego approach to assembly that informs the Next Generation Digital Learning Environment (NGDLE) (Brown, Dehoney, & Millichap, 2015) and underpins technologies such as the Learning Tools Interoperability (LTI) standard. Instead of combining clearly distinct blocks with clearly defined connectors the Card and Content Interface is intertwined with and modifies the Blackboard user interface to connect with the specifics of context. Suggesting that the Lego approach is useful, perhaps even necessary, but not sufficient.

Conclusions, Implications, and Further Work

Universities are faced with the strategically important question of how to sustainably and at scale leverage the knowledge required for effective design for digital learning. The early stages of an Action Design Research (ADR) process has been used to formulate one potential answer in the form of six design principles encapsulated in the idea of Context-Appropriate Scaffolding Assemblages (CASA). To date, the ADR process has resulted in the development and use of two prototype CASA within a suite of 7 courses and within 6 months their subsequent adoption in another 24 courses. CASA draw on the idea of constructive templates to capture diverse design knowledge in a form that enables use of that knowledge by teachers and students to effectively address contextually specific needs. By adopting a forward-oriented view of design for learning CASA offer functionality to support configuration, orchestration, and reflection and re-design in order to encourage on-going use beyond the protected project niche of initial implementation. The use of generative technologies and an assemblage perspective enables CASA development to be driven by and re-designed to fit the specific needs of different activity systems and contexts. Such work will be most effective when it is strategically aligned and supported with the aim of supporting and refining institutionally valued activity systems.

Use of the Card and Content Interfaces within and beyond the original project suggest that these CASA have successfully encapsulated the necessary design knowledge to address shortcomings with current practice and had a positive impact on the quality of the digital learning environment. But it's early days. These CASA can be improved by more completely following the CASA design principles. For example, the Content Interface currently offers only generic support for module design. Significantly greater benefits would arise from customising the Content Interface to support specific learning designs and provide contextually appropriate forward-oriented functionality. More experience is needed to provide insight into how this can be done effectively. Further work is required to establish if, how and what impact the use of CASA has on the quality of the learning environment and the experience and outcomes of both learning and teaching. Further work could also explore the questions raised by the CASA design principles about existing digital learning practice. The generative principle raises questions about whether moves away from leveraging the generativity of web technology – such the design of Blackboard Ultra and the increasing focus on mobile apps – will make it more difficult to integrate contextually specific design knowledge? Do reported difficulties accessing student engagement data with H5P activities (Singh & Scholz, 2017) suggest that the H5P community could fruitfully pay more attention to supporting a forward-oriented design approach? Does the assemblage principal point to potential limitations with some conceptualisations and implementation of next generation of digital learning environments?

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Barriers, enablers, and motivations for staff adoption of learning analytics: Insights for professional learning opportunities from an Australian university

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Understanding the capabilities and motivations of academics towards adopting and using Learning Analytics (LA) to support their development of technology-enhanced learning is an important first step in designing an effective and flexible adoption plan. Situated in a regional university, this paper reports on the initial data-gathering stage of an on-going study aimed at designing and trialing an adoption plan to support individual staff to engage deeply with LA to inform and enhance their teaching practice and their students' experiences. This paper analyses a staff survey (N=74) and transcripts from 28 semi-structured interviews conducted over 22 months with eight academics. Survey respondents reported low levels of knowledge about, and use of, LA, as well as a lack of confidence in accessing, interpreting, and acting on, data. Inductive and deductive thematic analyses of interview transcripts support these findings. Analysis further identified three main themes of indicators of successful LA adoption: effective learning design and enhanced teaching practice; improved student experience; and academic recognition. Based on these results, this paper proposes elements that can be included in a suite of professional learning opportunities that will enable academic developers and institutions to support individual staff to successfully adopt of LA.

Keywords:
Learning analytics adoption, teaching practice, professional learning, learning design.

Introduction

The field of learning analytics (LA) has grown significantly over the past decade, moving from identification of the potential of using data to improve teaching and learning (Fritz & Whitmer, 2015; Gasevic, Dawson & Siemens, 2015; Greller & Draschler, 2012) through to studies of how to use data to improve teaching and learning (Colvin et al. 2015; Sclater & Bailey, 2015; Siemens, 2013) and what successful use of LA looks like (Beer, Tickner & Jones, 2014; Brooks, Greer & Gutwin, 2014). Whilst there is recognition in the literature that LA is useful, this knowledge seems to be remaining at the theoretical level and focused at an institutional level, with practical application of this knowledge to teaching practice and learning design by individual staff still not commonly occurring. This makes an investigation of the barriers, enablers and motivations for individual academics to adopt LA both timely and necessary. Much of the focus of Learning Analytics (LA) research and practice has been on learners and their interaction with their learning environment, with less of a focus on another important stakeholder group: the teachers responsible for designing, developing and working within the learning environment. It is in this context that this ongoing study investigates the design and trial of an extended professional learning opportunity, running for 20 weeks to enable individual academics to engage deeply with LA to inform and enhance their teaching practice to have a positive impact on students' learning. This paper describes the initial data-gathering phase of the ongoing Design Based Research (DBR) study of academic staff conducted at a regional Australian, as outlined in Figure 1.

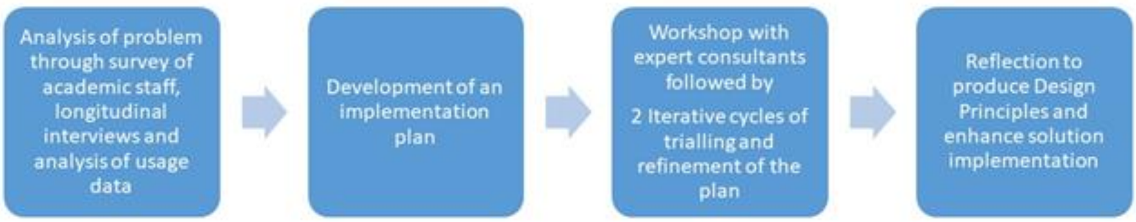

Figure 1: Outline of the full DBR study

Learning Analytics has been defined as"… the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs" (LAK11, 2011, para 5). This paper establishes a foundation for the design of professional learning for academics about LA, by investigating the different ways in which academics perceive LA use to be "successful". To meet this overarching aim, this paper considers the enablers and barriers to academics adopting LA at a regional university in Australia to inform and enhance their teaching practice. It further considers the opportunities and supports they identify as being important in using LA to develop their teaching practice. The study is specific to one university, but it provides an example of the type of investigation that can be followed to determine the wants and needs of academic staff and provides insights that can inform approaches for the development of an appropriate adoption strategy in a range of institutional contexts. It shows how gaining knowledge of the barriers, enablers, and complex motivational issues surrounding LA adoption allows academic developers and institutions to implement an adoption strategy that will more likely lead to wide scale adoption by individual staff.

Literature Review

Studies of implementing educational technologies in universities have repeatedly shown that the usefulness of educational technologies does not necessarily result in their implementation. It is only through empowering and engaging staff through inclusive and collaborative approaches; the provision of professional development and suitable infrastructure; technology frameworks; and policy and planning strategies that these technologies come to be successfully adopted (Campbell, DeBlois & Oblinger, 2007; Ertmer, 1999; Gosper et al., 2010; Lawson et al., 2014; Scott, 1999). There is a need to examine barriers and enablers for adoption of LA as this can inform design and development of relevant approaches for successful use of LA by academics.

A wide range of implementation and adoption frameworks for LA have been developed over the last eight years that explore the different dimensions of adoption. Many of the earlier frameworks had their origins in data science with an emphasis on how to collect and use data and to what end LA was being implemented. Many of these early frameworks also adopted an institutional approach and considered that one model would be appropriate for a wide range of contexts (Greller & Drachsler, 2012; Siemens, 2013, van Harmelen & Workman, 2012). There has been a trend since 2014 for the human and socio-cultural aspects to be included in implementation and adoption frameworks and for more research to include qualitative data (Colvin et al, 2015, Gunn et al, 2017). Many of the elements identified as being important factors for successful LA implementation are similar to those noted for implementation of different educational innovations. These include the involvement of all relevant stakeholders at all stages of implementation (Beer et al., 2014; Gasevic et al., 2015), integration with educational research on effective institutional practice (Gasevic et al., 2015), strong leadership (Hrabowski III, Suess & Fritz, 2011), development of a strong learning and teaching culture through different levels of the institution that supports use of LA, implementation of policies (Gasevic et al., 2015; Macfadyen, Dawson, Pardo & Gasevic, 2014), and development of staff skills. Provision of appropriate infrastructure that enables staff to easily access and interpret data is the main technological aspect considered (West et al., 2015), whilst an understanding of the pedagogical intent of using specific tools and activities within the LMS implementation is also considered important (Gasevic et al., 2015). Colvin et al. (2015) suggest that a key component to sustainable uptake of LA is building academic staff capabilities to enable them to move from being interested in LA to implementing LA. Gaps in the LA research surrounding mindful innovation, intentional implementation design, consideration of human and social elements of implementation, and evaluation of impact have been identified by Jones, Beer and Clark (2013), Fritz and Whitmerr, (2017) and Wise and Vytasek (2017). This study considered the socio-cultural aspects of LA adoption through investigation of what academics consider are the capabilities they need to successfully adopt LA.

Continuing the discussion of the importance of human factors in successful LA adoption, Colvin et al. (2015) and Howell, Roberts, Seaman & and Gibson (2018) note that academics' perceptions of the usefulness of LA need to be more carefully considered when designing and developing implementation strategies, with Howell et al. (2018) noting that "it would be informative to specifically identify how academics view learning analytics so that academic concerns can be addressed in the implementation of learning analytics systems. Such an approach may then facilitate the adaptation of technological advancements within academic settings" (p3). Two recent studies (Gunn et al., 2017; Rehrey, Goth, Fiorini, Hostetter & Shepherd, 2018) augment this discussion through reporting on pragmatic approaches to adoption strategies. They provide two different approaches with the same aim of building staff capabilities and confidence in adopting LA. Rehrey et al. (2018) describe a Student Learning Analytics Fellows Program which has been successfully running for three years and addresses cultural barriers and resistance to change through ongoing support and access to communities of staff with an interest in using LA to conduct scholarly research. Gunn et al. (2017) outline the development of a framework to support academics to choose relevant LA data to address their specific questions regarding learning and teaching. They also focus on professional development for academics noting that this, along with incentives, is necessary to "promote both the benefits and the methods of data informed teaching, learning design and learning support" (p8). This study combined elements of both these approaches and contributes to this emerging conversation through a broad and deep investigation of academics' beliefs about the usefulness of LA and their motivations for adopting LA at one institution.

Methods

The present study was conducted at a regional university where approximately 75% of students enroll as online students and their interaction with all course content, and most contact with the university, is conducted through the Learning Management System (LMS), in this case, Moodle. On-campus students experience a blended approach to learning, using the LMS to view online course material and resources and submit in-semester assessment tasks. The institution currently has no overarching institutional strategy or LA policy, placing it at the *Aware* stage of LA deployment maturity (Siemens, Dawson & Lynch, 2013), where basic reports and log data are the main forms of data used and there is no cross-system data integration.

This study, which was granted ethical approval by the university's Research Ethics Committee (HREC), adopted a qualitative research methodology to determine the barriers and enablers that impact how individual academics implement LA to inform and enhance their teaching practice; including the design and development of their learning environments. The study began with a survey which was disseminated by email to all academic staff in the institution (420 in total), and a total of 100 responses were received, with 68 complete responses. A further 6 respondents answered only the first section of the survey on knowledge and use of the LMS and LA tools, which was sufficient to include these results in this analysis for a total of 74 responses. The instrument included one short answer and 31 multiple-choice questions and took participants approximately 15 minutes to complete. The survey was conducted in March – June 2016 and was administered using Qualtrics software. There were three main sections to the survey with questions focused on knowledge and use of the LMS and LA tools; perceptions of LA and motivations to adopt; and demographic information related to their academic level and length of service. Deductive thematic analysis was applied to the one free response question.

The demographic distributions of respondents in terms of academic levels and length of service were similar to the actual distribution of staff across the university, according to data provided by the Human Resources department who reported a total population of 420 academic staff. Most staff are Level B Academics (40.5% of respondents and 44.5% of total staff) and there was a slight under-representation of Level C staff (24.3% respondents compared with 30.2% total staff). In terms of years of service at University of Southern Queensland (USQ) and in higher education, the highest proportions were for >10 years' service; 47% at USQ (compared with 37.4% of all staff) and 63.5% in higher education.

Building on responses to the survey, a series of 28 semi-structured interviews were conducted over a period of 18 months in 2016-2017 with each of four pairs of academic staff from across the university. The number of interviews for each pair ranged from five to ten, depending on when the staff were recruited and their availability. Using semi-structured interviews allowed for consistency of the opening questions across the four groups whilst providing opportunities for all participants to expand on these in their own way, which also gave the participants some ownership of the tone and direction of the conversations. The aim of the interviews was to collect in-depth data on participants' knowledge and use of LA and their motivators and approaches to adopt LA and to determine if having the opportunity for such discussions over an extended period had any effect on these factors. Both inductive and deductive thematic analysis of the transcripts was conducted with the deductive themes related to the research questions and considerations of the barriers and enablers to adoption, along with the participants' motivations and the supports they indicated they would need. The inductive analysis focused on emerging themes and ideas from the interviews.

Results

Survey

Within Moodle there are a series of reports that staff are able to access to gain insights and data on how their students are interacting with the various activities and resources included in their course sites. These range from simple, high level reports that indicate the number of students who have accessed a particular resource or activity to the more in-depth and detailed statistical analysis of results for quizzes. The more in-depth reports generally require some interaction and input from staff through choice of parameters and manipulation to interpret the data. Each of these tools or reports are standard inclusions in the Moodle LMS, except Communications, a custom-made report at this institution. Staff were asked about their current levels of knowledge and use of the various reports and analytics tools that are available within the LMS and these responses are summarised in Table 1.

Table 1: Knowledge and Use of LA Tools in the LMS (n=74)

	Knowledge			**Use**		
	Mean	SD	Median	Mean	SD	Median
Participant List	4.45	1.04	5	3.86	1.25	4
Gradebook	4.43	0.86	5	3.19	1.10	3
Course Participation	3.81	1.12	4	2.54	1.40	2
Activity Report	3.73	1.17	4	2.46	1.31	2
Quiz Results	3.70	1.42	4	2.38	1.17	2
Communications	3.64	1.49	4	3.49	1.71	4
Quiz responses	3.59	1.46	4	2.27	1.20	2
Quiz statistics	3.38	1.53	4	2.12	1.18	2
Log data	3.18	1.44	3	2.00	1.16	2
Activity completion	3.09	1.46	3	1.96	1.14	2
Statistics	3.08	1.32	3	1.62	0.84	1
Progress bar	2.76	1.37	3	1.46	0.81	1
Engagement analytics	2.69	1.32	3	1.74	1.07	1

Key: Knowledge 1=I don't know anything about this, 2= I have seen this but know nothing about it, 3= I have seen this and have a vague understanding of this, 4= I have a moderate understanding of this, 5= I have a good understanding of this
Use 1=I have never used this, 2= I use this 1-5 times per semester, 3= I use this once a month, 4=I use this 2-4 times a month, 5=I use this at least once a week

These results showed that the two most well-known and used reports were the Participant List, which provides details of all students and their last access to the course; and Gradebook, which collates students' results and grades for each assessment task administered through the LMS. Respondents also indicated that they generally had good understanding of easily accessible reports, such as Course Participation and Quiz Results which are also likely to be those that staff perceive to be most immediately relevant or important. However, staff levels of knowledge decreased quickly as the level of detail of the reports and complexity in accessing increased. Whilst there were some minor changes in the order of rankings for means between Knowledge and Use, there were still indications that it was the high level, easy to access reports that were more regularly used.

When participants were asked about barriers to adopting LA (see Table 2), time constraints were reported as the main barrier to current levels of knowledge and use of LA with lack of training also rated as an important factor, being noted by 62% of respondents. Lack of institutional guidelines regarding use of LA was the least noted factor, with only about 30% citing this as a factor. Seventeen respondents noted that all 4 options impacted their level of knowledge and 14 of those also noted all 5 factors as barriers to use. Conversely, for the 16 respondents who only noted one barrier to knowledge and use, time was the only barrier being noted by 12 of these 16 respondents.

Table 2: Barriers to adopting LA (n=74)

	Impacts my level of knowledge of LA		Impacts my level of use of LA	
	Number	%	Number	%
Time constraints	54	88.5	52	85.2
Lack of training	38	62.3	38	62.3
Lack of support	29	47.5	28	45.9
Lack of institutional guidelines	19	31.1	17	27.9
Lack of knowledge	na	na	35	57.4

Responses to questions regarding confidence levels in a range of aspects of LA use, (see Table 3) showed that respondents generally had low levels of confidence in their abilities to access and interpret data and implement appropriate actions based on interpretation. Whilst 51% agreed or strongly agreed that they were confident in accessing data, only 44% had similar responses regarding ability to interpret data, and 45% to take appropriate actions. There were also approximately 25% who indicated they neither agreed nor disagreed with each of the statements. Comparison across all of these questions for individual respondents showed that most respondents had the same level of confidence for each of the statements in Table 3, with 6 respondents noting they strongly agreed with all statements, 11 agreed across all statements, 7 were neutral across all statements, 9 disagreed with all statements and 3 strongly disagreed with all statements.

Table 3: Confidence levels (n=74)

I am confident in my ability to:	Strongly disagree/ disagree (%)	Neither agree nor disagree (%)	Strongly agree/ agree (%)
access appropriate student data from the LMS	25.7	23.0	51.3
interpret student data extracted from the LMS	29.5	26.2	44.3
implement appropriate actions based on interpretation of student data	34.4	19.7	45.9

The importance of aspects of accessing data and support were measured on a 4 point scale where 1= not at all important, 2= slightly important, 3= moderately important and 4= extremely important (see Tables 4 & 5). All aspects were considered important, with mean scores of >3. The one exception was policy/guidelines on ethical use of student data. A 4-point Likert scale was deemed appropriate for these questions as there was no clear mid-point or neutral response (Chyung, Roberts, Swanson, & Hankinson, 2017).

Table 4: Importance of aspects of accessing student data

	Mean	SD	Median
Being able to easily access the data in a format I can use	3.82	0.42	4
Knowing what student data is available	3.54	0.61	4
Having support for accessing data	3.47	0.66	4
Having access to consolidated information from a number of sources and systems about my students	3.46	0.76	4
Having support for analysing and interpreting data	3.32	0.74	3
Having easy access to graphical representations of data	3.19	0.76	3
Having access to professional development regarding accessing LA	3.16	0.8	3

Comparing Tables 4 & 5 suggests staff were more interested in having support to undertake different aspects of LA rather than having the professional development to enable them to complete those tasks themselves.

Table 5: Importance of support

	Mean	Std Dev	Median
Support for accessing data	3.43	0.7	4
Support for contacting students identified as at risk of not satisfactorily completing course	3.29	0.81	3
Support for analysing and interpreting data	3.19	0.76	3
Professional development in regards to understanding learning analytics	3.16	0.84	3
Policy/guidelines on ethical use of student data	2.94	0.9	3

Sixty-five responses were received to the open-ended question, “What is your opinion on learning analytics?” Responses generally showed cautious optimism towards LA, with 25 responses commenting on the usefulness of LA and a further 18 including qualifiers such as “good”, “important”, “valuable”,” essential”. However, most comments included caveats or cautions. These comments were coded to expand on the barriers and areas of support raised in the multiple-choice questions and the main themes are described in Table 6. There were 22 comments indicating a more negative perception as indicated through use of language including “don’t know” and “too slow”.

Table 6: Barriers to adoption identified in free response question

Barrier	Responses	Exemplar Comments
Knowledge & skills	9	...using them more meaningfully and accessing them and interpreting them more expediently is something I don't fully understand how to implement. IF I knew more about it and how it could enhance learning and teaching I might be interested in using it in my own teaching, but I sense it may be of less use to courses where student numbers are small.
Time	7	Something that could improve my teaching if the information was timely. Something I hardly bother with because it sounds too academic and I don't see how I can use it is a time effective practical way. Also I am not allocated any time to use it.
Interpretation	7	...unless a full understanding of interpreting analyses and the implications of those analyses is gained, learning analytics are not likely to be very useful. A useful tool that needs careful interpretation
Accessibility of data	6	Can be very useful for broad data gathering but the time for downloading often leads to system freeze Probably useful but currently inaccessible
Training and support	2	Would be useful but no training has been given on how to use this information. An important tool in improving outcomes, retention and progression, but support is required to act on students at risk
Institutional guidelines	1	Platform is solid but use is fragmented with little to no overarching theme or direction.
Other	4	I believe it has a lot to offer but also to be weary of it - quantitative tool. useful but not to overtake substance of curriculum design. They are useful but should not be another aspect of evidence used to judge the lecturer / student experience. The tracking of interactions with course materials and tasks by ONL students is improved when the tasks / assessment is expectant weekly. I have used analytics to track interaction across course offerings for the benefit of arguing interaction often equals better results. Good in theory, not sure about its practical application at USQ.

Interviews

The 28 interviews conducted with eight participants were designed to build on the responses to the survey to provide a deep knowledge of the different ways academics choose to engage with LA and any changes over a period of time. This approach resulted in many different strands of conversations and the data presented here represents one small portion of these. Deductive thematic analysis of the interview transcripts focussed on the barriers and enablers to adoption and Table 7 provides some examples of comments, showing that access to data is a major area of concern.

Table 7: Barriers identified in interviews

Barrier	Exemplar comments
Knowledge & skills	*Yes so these are things I don't know, I'm not sure about the detail of what to look at, some things will tell you how many times it has been accessed, not who or when, is there data that tells you, there must be data that tells you when students accessed* (Finlay)
Time	*Time obviously one of the barriers* (Dallas)
Interpretation	*We need the help of a statistician to help interpret so we can report on this* (Jamie)
Accessibility of data	*Lack of easy access is an inhibitor* (Blake) *I wish the analytics were much more of a push analytics and targeted at important dates* (Greer) *Limitations of using Useful links to recordings etc does not record analytics* (Dallas) *There are issues with missing* data (Hunter)
Training and support	*I need session on how to download and collect data and store fo*r *future* (Jamie)
Institutional guidelines	*so much we could be doing and need time and reward/incentive* (Jamie)

Inductive thematic analysis of transcripts from the interviews revealed three main themes of main motivators for engaging with LA. An example of comments from each of the participants are included in Table 8.

Table 8: Motivations for using Learning Analytics

Theme	Exemplar comments
Students: LA were useful in understanding what resources students were accessing, when and why they were accessed, and whether particular patterns had any correlation to grades or tendency to engage in academic misconduct	*"It might be interesting from their (student) point of view. What do they find useful to help them, you know tracking their progress and helping them in the course"* (Dallas) *"…progression/retention, being able to provide student husbandry- identifying students at risk and providing appropriate support, why are students struggling with assignments"* (Finlay) *"…is cohort A who have been found guilty of academic misconduct are they behaving differently to cohort B who have done minor misconduct or cohort C who have done nothing wrong so that's the kind of thing, maybe we can get something from the logs that give some kind of measure"(*Frankie*)* *"if I got a weekly summary of students at risk so I or the tutors could reach out to students and ask if there is anything we can do, is it something as simple as technology or something as complicated as my life is falling apart and I'm sleeping in my car"* (Greer)
Teaching Practice –LA could help staff become more effective and efficient as well as the benefits of upskilling themselves through professional learning opportunities associated with building levels of knowledge around different aspects of adopting LA. The skills required to access, analyse and interpret appropriate data and then implement interventions as a result of that analysis and interpretation were also mentioned	*"I'm writing another course. When I have the time this stuff will influence me in how I work and how I deliver."* (Jordan) *"Do changes to course design have impact on students; - what is my cost/benefit ratio for the amount of effort undertaken; I want to gain an understanding of what interventions work* (Blake)
Academic recognition – staff considered factors such as they type of publications they would be able to write from their investigations, and how using LA would help with recognition through Teaching Grants and Awards and how this could help their career progression and promotion.	*"Acknowledgement of my excellence in teaching has been provided through the following awards…"* (Hunter, in response to how they measured success) *"I think it would be good if this could lead to a publication for the school."* (Jamie)

Discussion and implications

Overall, the results from the two different types of evidence of this phase of the study highlighted similar patterns showing low levels of knowledge and use of LA. However, many were keen to learn more and use LA more regularly to inform their practice, if the barriers of lack of time and lack of support could be minimised.

Comparison of means for responses on levels of knowledge and use of LA (Table 1) show that there were higher levels of knowledge than use for all reports and tools. This suggests that knowledge alone does not mean that staff will adopt LA and it is thus important to also consider other factors. The responses to the question on barriers to knowledge and use suggest that time is the most common barrier although institutional guidelines are not an important factor (Table 2). Most respondents (54/64) noted multiple barriers, indicating that an effective implementation plan needs to include training and support, and finding ways to embed the use of LA in normal workload will be important to overcome the barrier of time constraints. The low levels of confidence in ability to interpret data and implement actions (Table 3) reinforced the need for training and support to include these aspects of adoption. A significant aspect from both the survey results and interviews was that staff attributed more importance to support than professional development (Tables 4 & 5). This may be due to the reported lack of time as a major barrier, and a preference for some tasks to be undertaken by support staff rather than building the knowledge and skills to complete themselves. A deeper understanding of what staff actually mean by "support" is still needed as is an understanding of how this intersects with professional development, which academics may understand as simply attending workshops.

Approximately half of survey respondents reported high levels of confidence in ability to access (53%) and interpret data (44%) and implement changes as a result of that interpretation (46%) (Table 3). Matching this question with the demographic data showed that staff who responded positively were spread across the two faculties (19 from Faculty A and 13 from Faculty B). This suggests that discipline background and the concomitant teaching needs of those backgrounds do not necessarily play a role in the confidence levels of staff in these areas. In contrast, interview participants all noted that accessing data in a usable format was a barrier for them. Having ready access to actionable data also ranked highly in terms of importance and support (Tables 4 & 5), suggesting that readily accessible data is instrumental to any successful implementation plan. Just as important though is ensuring that staff have high levels of knowledge about how each set of data or tools can be used and data interpreted as this will improve their ability to select the most appropriate data to address their specific questions.

All interview participants discussed elements of each of the identified themes of motivations for use of LA, for example, Jordan and Greer each discussed students and teaching practice in one of their conversations:

> "*...what things are students focusing on? How can I make them more fantastic (as opposed to working on things they are not engaging with?)* and *"This stuff will influence me in how I work and how I deliver."* (Jordan)
> *"In my StudyDesk these are the things that students focus on and so, for instance I know they will focus on assessment and things like that so if they focus on some things in a good way I can spend more time on making them fantastic, you know doing videos around assessment or something but if they don't touch on some of the other things then I'm wasting my time on those and I would reform the way I deliver."* (Greer)

All participants did, however, have different emphases, and a diverse range of goals from use of LA: Finlay, Greer and Dallas all focused on the student, while Jamie and Hunter both held some focus on the benefits for themselves. Knowing these differences can help in the way staff are approached and supported, all with the aim of providing a satisfying learning experience for students. For academics like Finlay, Greer and Dallas - academics who are focused on pastoral care - the support and discussions would focus on how interventions will help their students and how they can build up an evidence base that the interventions have had a positive outcome. In contrast, for academics like Jamie, who are focused on publication, it will be important to ensure that they have a relevant and measurable research question. They can be directed to relevant literature and previous research that has investigated similar questions and the discussion can be centered on the understanding of how implementing these changes will not only benefit their students but also help provide evidence for their teaching grants and awards or promotion applications. The areas that staff do not focus on can also be used as a focus for further support and development.

Referring back to the Research Questions, this paper has shown that:

- The main barriers for LA adoption are lack of knowledge of the tools and reports available in the LMS; in interpreting data; implementing appropriate actions; as well as lack of time to effectively engage with LA;
- The opportunities and supports that need to be provided to academics include provision of time to engage, and provision of support to access and interpret data and design appropriate interventions; and
- Academics perceive successful adoption of LA in a number of different ways, including a combination of improved student experience, more effective course design and efficient teaching practice, and evidence to enable academic recognition and career progression.

Building on these results it is proposed that the following elements need be included in a suite of professional learning opportunities, to meet the challenge of successful adoption of LA by individual staff.

1. Understand the motivations and competencies of staff to allow some personalisation and cater for their diverse goals;
2. Ensure relevant and accessible support from a range of specialist staff is available at all stages of adoption;
3. Ensure that academic staff are core participants and stakeholders and supported to take ownership of the ways they use LA in their unique contexts;
4. Adopt a flexible and adaptable approach that caters to the different focus and meanings of success for individual staff; and
5. Include a variety of professional learning and support options including 1-1, small group, peer support and self-help resources.

Conclusion

This paper has brought together discussions of results from a survey of academic staff and analysis of interviews with staff, to provide an understanding about the barriers, enablers and motivations for adopting LA to enhance technology-enabled learning in a regional university. It has shown that, in general, there is a perceived lack of knowledge about tools and reports available within the LMS that may provide relevant data to inform and enhance their teaching practice as well as how to interpret that data and implement appropriate actions and interventions based on that interpretation. These findings are supported by log data from the LMS which showed low levels of engagement with these tools across the university. Findings from the survey and interviews have also shown that staff generally have positive perceptions of the benefits of LA, and are cautiously optimistic about the benefits of engaging with LA. Further, they will be willing to adopt LA, provided appropriate support and professional learning are provided, and they receive recognition in their workload models of the time that will be required to engage deeply with LA. Three themes emerged from inductive thematic analysis of the interviews of the reasons for engaging with LA and consequent benefits: improved student experience, more effective course design and efficient teaching practice, and evidence to enable academic recognition/career progression. Taken together, these findings support an understanding that, in the university studied, academics generally have a positive attitude towards LA and are likely to engage more deeply with using LA to inform and enhance their teaching practice if they are provided with ready access to actionable data, support from relevant professional staff, professional learning and time. Whilst some of the results are not surprising and align with results from previous studies (eg Colvin et al., 2015, Gunn et al., 2017, West et al., 2015), this paper adds to the literature by focusing on a single university and gaining the opinions of teaching staff, rather than institutional leaders of LA.

This study is limited in that it focuses on a single university, and it is not possible to know if results are generalisable to other institutions without further research. The research is concerned not just with identifying these barriers, enablers and motivations, but with attempting to understand how institutions might be able to better support academics in adopting LA. Future work following this research will involve implementation of an LA adoption plan that has been designed to address the elements identified as important in this study, and analysis of the effectiveness of using a carefully designed adoption strategy.

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Game-Based versus Gamified Learning Platform in Helping University Students Learn Programming

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Novice learners of programming may benefit from some prior knowledge in programming before taking their first introductory programming course. In this study, we describe a workshop aiming to do so, that is offered to undergraduate students before their first programming course. Two online platforms are used in this study, a game-based platform (CodeCombat) and a gamified online tutorial (CodeAvengers). We compare the effects on learning of the two platforms on their academic performance, and investigate students' preferences and subsequent usage of these platforms. Results show that the workshop participants prefer the gamified platform over the game-based platform for learning, and use during their programming course for revision and more practice. We found no significant difference in learning outcomes amongst those who participated in the workshop and those who did not. We discuss the findings and implications of this study in the paper.

Keywords: game-based learning, gamification, programming, online platform

Introduction

The ability to program is becoming more important in many engineering disciplines (E. A. Lee & Messerschmitt, 1998) and also in architecture (Leitão, Cabecinhas, & Martins, 2010). Thus, it would be advantageous to any undergraduate in a technological discipline to have sufficient programming skills. Hence, all four degree programs offered by the Singapore University of Technology and Design (SUTD) have several courses that require the use of programming skills. All students in SUTD take common courses in their first three terms, one of which is an introductory programming course in Python programming called "The Digital World". This course has to cater to students with a wide variety of academic abilities, varying levels of prior programming experience and motivation. The majority of the students have no prior experience in programming and thus are novice learners.

The difficulties that novice learners of programming face when learning programming have been well-documented (Robins, Rountree, & Rountree, 2003). Novice learners tend to make syntax errors, possess alternative conceptions in programming concepts and find it difficult to plan, write and debug programs (Qian & Lehman, 2017). Other studies have reported that novice programmers lacked skills in reading and tracing code (Lister et al., 2004) and problem-solving ability (McCartney, Boustedt, Eckerdal, Sanders, & Zander, 2013; McCracken et al., 2001). This is due to the observation that programming tasks tend to be cognitively demanding, with several cognitive demands on learners, starting with the learning of language features, and ending with developing problem-solving skills (Linn & Dalbey, 1985).

Hence, it seems intuitive that students with some form of prior programming experience should perform better on assessments programming course compared to those without. Currently, studies are mixed on whether prior programming experience has a positive effect on their performance on their first programming course in the university. The study by Hagan and Markham (2000) suggests that students who knew one or more programming languages prior to attending university showed better academic performance in programming assignments. Watson et al (2014) found a similar effect but suggested that the number of languages that a student knows has no effect. However, Bryne and Lyons (2001), Bergin and Reily (2005) and Ayalew et al (2018) reported no effect on students' performance. Such different results could possibly be explained by differences in educational context and sample size.

Among several interventions that have been shown to improve learning outcomes in CS1 courses, one intervention is to introduce a separate introductory course (termed "CS0") before the beginning of the formal introductory programming course (termed "CS1" in the literature) (Vihavainen, Airaksinen, & Watson, 2014). Some of these courses have used media computation with Python (Sloan & Troy, 2008), Scratch (Rizvi, Humphries, Major, Jones, & Lauzun, 2011) or focused on applications of programming to robotics, games and music (Haungs, Clark, Clements, & Janzen, 2012).

In some educational contexts, like ours, it may not be possible to introduce a CS0 course in the curriculum. Bittencourt et. al. (2015) describes a one-week Scratch workshop that was conducted prior to the beginning of a C programming course in a Brazillian university. Although they viewed the workshop favourably, the effect on the participants' motivation and performance in the subsequent C course was not reported

Apart from Scratch, online learning platforms have the potential to provide prior knowledge in programming. Kim and Ko (2017) analysed over thirty such online platforms. Many of these platforms were assessed to have sufficient content coverage, and able to provide immediate feedback that was shallow. Both CodeAvengers and CodeCombat (the online platforms that are employed in this study) were assessed to have the required coverage of introductory programming topics, possess features that showed how code is used but lacking features on why each content taught should be used. Participants in the study by Lee and Ko (2015) comparing two online platforms, Gidget and Codeacademy, showed learning gains when measured by a pre-test/post-test format. However, as the participants of this study were recruited from the general public, it is unclear if the results are applicable to the higher education context. In another study, it was found that university students preferred using CodeCombat to the "Robot Turtles" board game in learning basic programming concepts (Kurniawan, Cheung, & Ng, 2019).

We conducted a one-week workshop in 2017 that employed two online learning platforms, CodeCombat and CodeAvengers. CodeCombat is a gamed-based online platform, making use of a game to teach programming, while CodeAcademy is a traditional tutorial platform that has gamified features such as levels, badges, and leaderboard. This workshop was conducted prior to the beginning of The Digital World course, and thus aimed to provide novice learners with some prior knowledge in programming. These online platforms thus act as scaffolding to help these students move through their zone of proximal development in the learning of basic programming concepts (Anderson & Gegg-Harrison, 2013).

We are interested to find out the impact of the two online platforms, game-based and gamified learning platforms, on students' learning experience. We refer to learning experience as user experience, preference, interest, rationale for using and achievements of learning outcomes. In particular, we want to (1) compare participants' learning preference of the two platforms, (2) investigate if students continue to use the platform after the workshop on their own and the reasons for their use, and (3) investigate whether there is any significant difference between those exposed to the online platforms in the preparatory workshop and those who are not with regards to the learning outcomes in the official programming course. Our null hypothesis is that there is no significant difference between the two platforms in terms of their learning experience.

Methodology

Education Context

This study was conducted prior to and during first-year introductory programming course "The Digital World" at the Singapore University of Technology (SUTD) in 2017. The majority of students taking The Digital World do not have programming experience. Most students joining SUTD have the GCE-"A"-level qualifications offered by the Junior Colleges (JC), but only a few of such students have taken Computing as a subject. A minority of our students join us from the polytechnics with Engineering or IT diplomas and would have varying degrees of programming ability.

We conducted a five-day, preparatory workshop named "Introduction to Computational Thinking" which introduces students to computational thinking concepts using the Python programming language. This workshop was aimed at students who have little or no programming skills in order to provide them with some programming background at the start of The Digital World. We sent an email to all first-year students inviting them to take part in the workshop. Participation in the workshop is voluntary. The criteria for participation were (1) that students have little or no programming background and (2) students need to attend all the sessions.

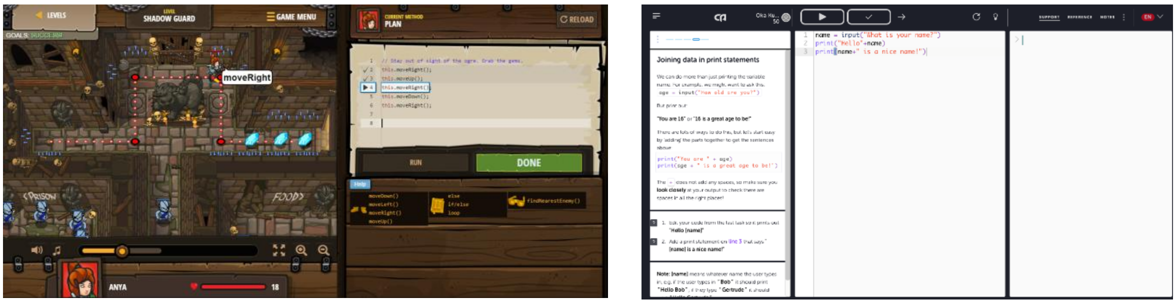
Participants

A total of 457 first year students were enrolled in the programming course The Digital World in the third term of the academic year 2016/2017. From these students, 81 students joined the workshop, and out of these, 48 students gave consent to participate in this study, with 28 students completing the Reflection survey at the end of week six (see

Table 1). Students were aged 18 to 21 years old, with 50% of them female.

Online Platforms

The screenshots of the two online platforms used in this study, CodeCombat and CodeAvengers, are shown in Figure 1. A game-based online platform like CodeCombat makes use of a game-like environment to help users learn programming. Users are engaged in an immersive game activity. This can also be considered as "serious gaming". In the process of game and play, users learn programming starting from the basic syntax and can be up to different programming concepts such as conditionals and iteration. On the other hand, a gamified online tutorial like CodeAvengers uses traditional structured online lessons with gamification elements such as rewards, levels, badges, and a leader board. Thus, instead of an actual game, the platform uses game elements to engage and motivate students. For our study, we purchased the necessary subscriptions for CodeCombat and CodeAvengers, and verified that the content covered by the two platforms are similar and met our requirements.



(a) (b)

Figure 1: Interface of (a) CodeCombat, and (b) CodeAvengers.

Study Protocol

We divided the participants of the workshop randomly into two classes, and both classes were taught by several undergraduate teaching assistants (UTA). On the first day of the workshop, all participants did a background survey to assess their programming background and were invited to take part in this study. Those who agreed to take part in the study then did a pre-test programming quiz. Each class started with one of the two platforms, before switching to the other in the middle of the five-day duration, as illustrated in Figure 2.

At the end of the workshop, participants completed a post-test programming quiz and a survey on the two online platforms. The post-test programming quiz is similar in concept and difficulties as the pre-test quiz. We then informed the participants that they will continue to have access to the two online platforms for the next few months, and that a follow-up survey will be held in week six of The Digital World course. This process is summarized in Table 1.

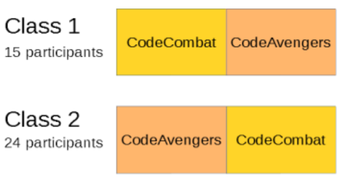


Figure 2: The sequence of how the platforms are used during the workshop

Table 1: Measurement Instruments and Its Timing

Timing	Instrument	What It Measures
Start of workshop	Background survey* (10 questions)	Participants programming experience and background
	Pre-test programming quiz^	Programming content and skills before workshop
End of workshop	End of workshop survey (10 questions)	Participants' perception on the workshop and online platforms
	Post-test programming quiz^	Programming content and skills after workshop
Start of course	Background survey of non-workshop participants* (10 questions)	Students programming experience and background
Week six of course	Reflection survey (8 questions)	Participants' perception on the long-term use of online platforms and impact of workshop
Mid-term of course	Mid-term programming assessment (5 questions)	Students learning outcomes

* same survey questions
^ similar content and difficulties

Analysis

Quantitative Analysis

For the statistical analysis of quantitative data from the surveys, quizzes, and assessments, we used programs such as Excel, Tableau, and some Python statistical libraries. We calculated the learning gain (Hake, 1998) and conducted a paired t-test between the pre-test and the post-test scores. We then compared the mid-term programming scores between students who attended the workshop and students identifying as novice learners who did not attend the workshop using an independent samples t-test.

Qualitative Analysis

We asked the participants what they liked and disliked about the two online platforms in the Reflection survey conducted at week six of the official course. A total of 28 students responded on the open-ended questions. Students' open-ended responses were categorized, and frequency counted to understand their sentiments.

Results

Programming Background

Table 2 shows the self-assessment of the participants' programming background. Most participants consider themselves to have zero programming background or novice learners, with four students claiming to have written more than 50 lines. We cross check this background with a programming test which is conducted at the beginning of the workshop. The average for the pre-test was 0.103 out of 1.000 (normalized). There were only three participants who have scores greater than or equal to 0.5 in the pre-test. This agrees with the self-assessment of participants' programming background that most of the participants do not have any programming experience, and only a few of them had some programming background. This is also similar to our other previous studies students' profile (Kurniawan et al., 2019).

Table 2. Participants' Self-reported Programming Background .

Zero*	Novice

0 lines	1 to 10 lines	1 to 10 lines	10 to 50 lines	> 50 lines
24	13	2	4	4

* one participant under "Zero" category choose Others and put a comment instead. Total number is 48.

Learning Experience of Platforms and Workshop

At the End of Workshop survey, we asked participants to respond on a 5-point Likert scale regarding the ease of use, motivation to use, and challenge in using the two platforms. The average score of this result is presented in

Table **3**. In general, participants found both platforms to be easy to use and motivating. The average scores for both platforms on all questions are above 3.0. However, the results suggest that students find CodeAvengers more challenging compared to CodeCombat.

Table 3: Average Likert Score on Participants' Learning Experience of The Two Platforms

	CodeCombat	CodeAvengers
Easy to Use	3.80	3.76 (↓)
Motivate to Learn	3.61	3.73 (↑)
Challenging	3.32	3.76 (↑)

In the Reflection survey conducted at week six of The Digital World course, we asked the participants for open-ended responses on what they liked and disliked about the two platforms. Overall, the respondents seemed to prefer CodeAvengers over CodeCombat. The most frequent phrases among the comments are shown in Table 4.

Table 4: Frequent Words in Open Ended Responses on The Two Online Platforms

	Liked	**Disliked**
CodeCombat	fun interesting visual graphics interactive	not clear for the concept confusing repetitive too simple or easy
CodeAvengers	clear instruction step by step easy instructions or easy to follow materials or topics	long lessons or too many challenging nil

An analysis of the responses showed that, while 66 % of the students liked the game CodeCombat citing that it was fun, interesting and interactive and 25 % of the students noted that the game helped them to visualize, 25% of them mentioned that they could not relate the game to the concepts learnt in class, and that the game was too abstract and confusing to them. That is, there is a gap in relating the game to academic content and learning. About 37% of the students also found the game to be simple and repetitive.

On the other hand, 100% of the respondents indicated that the gamified tool CodeAvengers was very helpful in teaching programming concepts and programming skills in a structured manner. One major drawback cited was the long time taken with Code Avengers, but this need not necessarily be a disadvantage as learning does require time and practice. Nearly 20% of respondents wanted additional challenging activities with CodeAvengers, adding further support to the earlier inference that students were deeply engaged and wanted more of the learning experiences with CodeAvengers.

Continued Use and Reasons

In the same Reflection survey, we asked whether the workshop has helped them in their course, The Digital World, and increased their interest in the course. We also asked if they continued to use the online platforms after the workshop during this course. Figure 3 shows the results. Students who attended the workshop found that the workshop has helped them in their official programming course (Q2). Moreover, the workshop has increased their interest in learning the programming course (Q3). However, not everyone continues to use the online platform during the official course (Q4). We will present on students' reasons for this below.

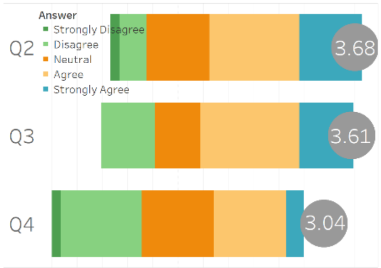


Figure 3: Students found the workshop has helped them in their course, The Digital World, (Q2) and increases their interest in learning The Digital World course (Q3). Only some, however, continue to use the online platform during the course (Q4).

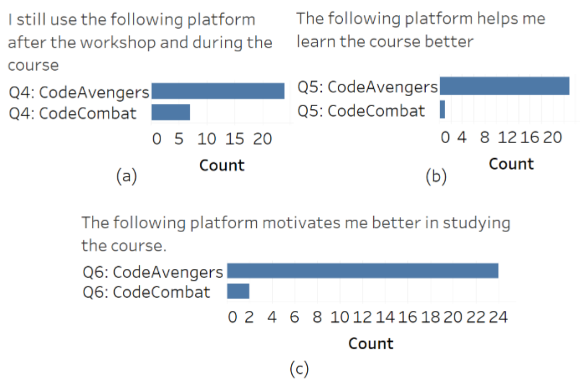
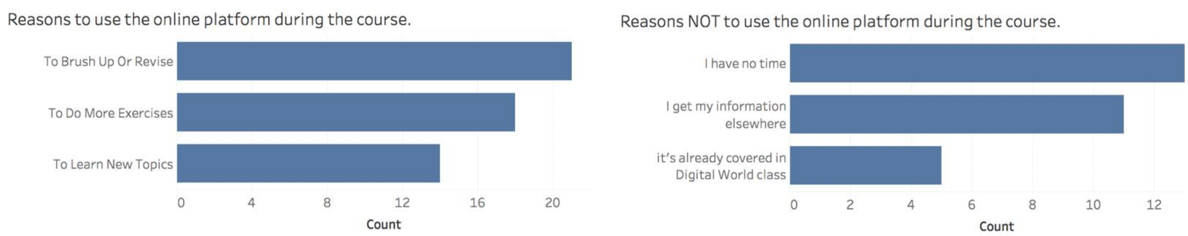


Figure 4: Students still use CodeAvengers after the workshop and continue to use it during the formal course (a). They found CodeAvengers helps them to learn better (b) and motivates them to study the course better than CodeCombat (c).

The results also show strongly students' preference toward CodeAvengers (
Figure **4**). They still used it after the workshop and during the official course. Compared to CodeCombat, more participants indicated that CodeAvengers helps them to learn the course better. Hence, these results seem to be consistent with the survey done at the end of the workshop (Table 3).

From Figure 5, we found that some students continue to use the online platforms after the workshop, using it for revision, practice and to learn new topics. This could be why students prefer CodeAvengers to CodeCombat, as CodeAvengers' interface makes it easy for students to do so, while CodeCombat's game-based interface makes it hard to revise any particular topic. The students who no longer use the online platforms mainly cite lack of time and being able to obtain information elsewhere as the reason. These results are also reasonable as we observe that the third term tends to have a high workload for many students.



(a) (b)

Figure 5: During the course, (a) some participants participants continue using the online platforms for revision and practice, (b) some participants report not using due to the lack of time

Learning Outcomes

Pre- versus Post-test

From the pre-test to the post-test, the mean score of the test increased from 0.103 to 0.405 (out of a normalized value of 1.0). A paired t-test suggested that there is a significant difference between the two test results with $p < 0.01$. Using the formula by Hake (1998), the learning gain was calculated to be 33.1%. Lastly, the number of students with mean scores greater than or equal to 0.5 increases from only three participants in the pre-test to thirty-four participants in the post-test. This shows that more students were able to write Python code at the end of the workshop. We found it is important to check on this result as students only learn Python for the first time in a very limited time frame, i.e. they spent only three hours each day in this five-day workshop.

Workshop Participants versus Non-Participants

Table 5: Mid-Term (MT) Exam Statistics from The Official Programming Course

	Attended Workshop	Did Not Attend Workshop
Mean	0.516 (↑)	0.455
Minimum	0.086 (↑)	0.029
25%	0.371 (↑)	0.314
50%	0.543 (↑)	0.486
75%	0.671 (↑)	0.568
Maximum	0.843 (↓)	1.000

Table 5 shows the statistics of the students' grade in The Digital World course for the Mid-Term exam (MT), and compares the results between those who attended the workshop and those who did not. For the students who did not, we used grades from students who reported that they had zero or little programming background at the start of The Digital World course. Results using independent samples t-test on the mean score of the programming questions suggest that there is no significant difference between the two group of students. This means that the workshop did not translate to a gain in academic performance as compared to those who did not attend the workshop. At the same time, looking at Table 5, we can see that those attended the workshop tend to have higher scores in the five-number summary statistics except for the maximum score.

Discussion

Learning Experience

Most students found the two online platforms, CodeAvengers and CodeCombat, easy to use. However, it seems that students find CodeAvengers slightly more motivating, and surprisingly, more challenging compared to CodeCombat. This challenging factor could be one of the sustained motivating factors for students as we see in the Reflection survey at week six. CodeCombat is more fun, but those who attended this workshop have The Digital World course in mind. Therefore, they wanted something that can help them in their official course. CodeAvengers seems to be the better platform for this purpose. Both the quantitative data from the end of workshop survey and qualitative data from the Reflection survey attested to this.

The qualitative data gave insights into why students preferred CodeAvengers for learning. Participants cited that the gamified platform was structured, sequential and progressive, relevant to the academic content, and easy to use. Although participants found CodeCombat easy to use and visually interactive, but they found it repetitive and harder to relate the game to the academic content of The Digital World. This observation seems to indicate that CodeAvengers was in the comfortable zone of proximal development of students (Anderson & Gegg-Harrison, 2013) whereas CodeCombat was too simple. According to the concept of zone of proximal development, students' learning happens when they are comfortably stretched; if too easy, students get disengaged and bored, and if too challenged, feel overwhelmed and dejected. In our case, students who preferred the gamified platform seem to be comfortable being challenged and some students even wanted more challenging tasks, and this suggests that the online platform needs to cater to diverse learners at both extremes as well.

An interesting observation was that students found CodeAvengers to be relevant and useful for academic learning while CodeCombat was difficult to relate to. This could be because our students are novice learners and novice learners typically need more structuring and scaffolding (Awbi, Whalley, & Philpott, 2015). Also, the gamified-learning used deductive teaching approach while game-based learning uses inductive teaching. Typically, it is found that novice learners find deductive mode of teaching and learning easier to follow than inductive teaching and inductive approach can be complex and abstract for them (Felder & Silverman, 1988). Transferability of knowledge through deductive approach is higher in deductive methods than inductive methods. As the workshop was standalone and conducted prior to the official programming course, students were left on their own to translate the workshop content to the programming course. Hence, one implication is that if we are to use the game-based platform in our teaching, we will need to scaffold students' learning to help them relate to the academic content, e.g. using reflection questions or other suitable activities.

We found that only 30% of participants continued to use the online platforms and this was the gamified platform, CodeAvengers. The reasons suggested was that this helped them to revise, practice and prepare for academic learning in The Digital World. This suggests two things – one is that initial perception and interest can be temporary and therefore we must be cautious in interpreting student perception right after exposure. It is good to also measure perceptions throughout the learning experience and at the end of the learning journey or even long after that. This is referred to as "situational interest" (Rotgans & Schmidt, 2011).

Also, in our context, it seems that game-based learning may lead to "surface- learning" and gamified learning leads to "deep learning" (Biggs, 1988). According to Biggs, deep learning refers to engaged, sustained and proactive learning for the purpose of learning. Surface learning is superficial and taking part in the learning activity for the sake of it or get through the course. The observation that students continued to use the gamified platform rather than the game-based platform over an extended period of time and on their own, when given a free choice indicates that the gamified platform was perceived to be more valuable and leading to sustained and self-directed learning. Hence, this implies that we need to see what sort of tools lead to scaffolding and engages students in deep learning.

Learning outcomes

We had found no difference in the mid-term exam scores between the workshop participants and those who did not participate in the workshop. However, the workshop participants reported in the survey that the workshop helped them to learn programming in the official course and increased their interest in learning the course (Figure 3). Hence, we can conclude that the workshop had a positive impact on the participants, even if it did not translate to a significant gain in their academic performance at the mid-term exams. On top of knowledge, learning outcomes also comprises of skills and attitudes. Given that the gamified online platform, CodeAvengers, added to the interest to learn, we infer that it is useful to use this in our teaching of programming to our novice learners.

The reason why the workshop did not result in a difference in the mid-term exam scores deserves some consideration. Firstly, the content examined in the mid-term exam was much larger than scope of the workshop, hence, the instruction given during the course could have helped to bring both groups of students to a similar academic level. The questions in the mid-term exams may have been too difficult and cognitively demanding, but assessing the questions is beyond the scope of the current study. Lastly, the workshop was run as a standalone event and not integrated into our course, The Digital World, which may have reduced its impact.

Lessons Learnt

The findings suggest that while games and gamification can be both engaging, they may engage students in different ways. While games can be fun, students may not be able to relate the gaming and fun element to the academic content. The context of game and learning may be distant that students are not able to link the two. This concept is called situational learning that learning happens in context. An implication of this is that as teachers, if we are to use games in teaching, we will need to build in opportunities for students to discuss and link the games to the actual lesson. Another inference is that perhaps the game may be more useful as a tool to interest learners in programming compared to being a teaching or scaffolding tool. Also, this game may be more useful for younger learners. It is also possible that the context of The Digital World course creates an academic environment that hinder people to play games. If game-based learning is to be used together with any academic course, it should be integrated together inside the course and some of the assessments should include achievements done in the game.

We also learnt that the perception surveys may be subject to situational interest and it is good to monitor interest and learning over time. Also, the results from this study must be taken in relation to the context. For instance, we cannot conclude our results to be saying that gamified learning is better than game-based learning. We need to see the contextual factors for instance, the level and complexity of the subject matter, the extent of time we have for learning, the mode of learning (face to face, blended), the background and prior knowledge of students, learning outcomes and purpose of learning, to name a few factors. We encourage our readers to consider their contexts in extrapolating our findings to suit the context and use a scholarly and evidence-based enhancement of teaching practices.

The analysis also indicates that it is critical to structure the content and introduce the various programming skills in a step by step manner in teaching programming skills to students who may not have sufficient programming background. This observation aligns with Vygotsky's concept of zone of proximal development which suggests that students' learning needs to be scaffolded – especially when students do not have sufficient prior knowledge, and they have to achieve a cognitive jump (Vygotsky, 1978).

The student responses had not mentioned any aspect of the gamified learning such as collecting badges etc as motivating factors and seemed to be drawn to the structured way of learning. This interesting observation indicates that, with well-structured and planned teaching tools/aids such as CodeAvengers, it is possible to interest the students in the actual learning of content by intrinsically motivating them rather than relying on extrinsic motivating factors such as points and badges, which may be short-lived.

Overall, what we have learnt is that it is important to use the right game/gamified tool to aid teaching of programming skills. We need to ensure that the game/gamified tools are pitched at the prior knowledge of students, it provides ample opportunities for the diverse learners catering to both the novice and advanced learners, and that the teacher designs and integrates the use of the tool in the actual lesson so that students are able to relate to the academic content. Since learning through such resources will take up additional time, teachers may also want to use flipped learning so that students could use the class time effectively.

Conclusion

In this study, we ran a one-week workshop to compare two kinds of online platforms, a game-based platform and a gamified online tutorial platform, to help students to learn programming. This was done prior to the students' formal programming course. We found that students need not play a game to be motivated. Participants preferred CodeAvengers, the gamified platform, as it is challenging, provided content in a structured manner and had exercises that help students in their revision for their programming course. Moreover, the way that these platforms are included in the official course may affect their usage. Lastly, the interface of the platform and the nature, either game-based or gamified platform, should be designed in such a way to fulfill the needs of how the students would use it. Hence, in our context, the gamified online platform had features that met their needs. All these considerations should be taken into account in the choice of online platforms by instructors.

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Do learning technologies contribute to reduce student drop-out? - A systematic review

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As technology is increasingly being used for teaching and learning in higher education, it is important to examine what tangible educational gains are being achieved. Reducing drop-out rates have been proposed as one possible beneficial effect of the use of learning technologies. It is unclear, however, whether the available evidence supports such claims. The aim of this study was to explore whether learning technologies applied in higher education contexts can contribute to reduce student drop-out rates, and under which circumstances do learning technologies influence drop-out? Method: Two independent searches were conducted in relevant databases; evaluated full-texts, quality rated the included studies, and synthesized the findings. Results: A total of 18 peer-reviewed studies were included. Based on the quality assessment, 10 studies were eligible to extended data synthesis. The assertion that learning technologies in higher education contribute to reduce student drop-out is only partly supported. Positive findings were in particular found in relation to pedagogical issues, e.g., individualized personal support. This is in line with previous research, indicating that it is not the technology itself, but how the technology is used pedagogically that matter to students.

Keywords: Learning technologies; Educational IT; Drop-out, Retention; Systematic review; Higher education

Background

Learning technologies have been introduced in university strategies and policies, and numerous initiatives have been implemented with the aim of creating more active and varied teaching and assessment methods (Lillejord et al. 2018) that provide students with more flexible and engaging learning environments (Kirkwood and Price, 2013). Helping students to engage in learning, the use of technology has been proposed as a means to reduce student attrition, and many expectations regarding how learning technology may improve teaching and learning have been articulated (Fossland 2015, p.8). It is unclear, however, to which degree the available evidence supports such claims. Kirkwood and Price (2013) argue that many general characterizations of technology-enhancement in education are unclear and often limited to the use of technology in itself. Claims regarding the benefits and effectiveness of educational technologies need further exploration. The aim of the present study was to explore:

Whether – and under which circumstances - learning technologies applied in higher education contexts can contribute to reducing student drop-out rates?

Materials and Method

Data sources and search strategy

Based on Littell, Corcoran & Pillai's (2008) guidelines for systematic reviews and meta-analysis the initial keyword-based search was conducted independently in October 2017 by second author and a university librarian for relevant empirical peer-reviewed studies published between 2007 and 2017. Databases included for this review were EBSCO HOST: ERIC (The Education Resource Information Center), CINAHL (Cumulative Index to Nursing and Allied Health Literature), British Education Index, Education Research Complete, Communication & Mass Media Complete, ProQuest: Australian Education Index, Education Database, PsycInfo, Web of Science: Social Science Citation Index, Scopus. The final search string consisted of combinations of subject headings Higher education and keywords referring to retention OR attrition OR drop-out OR turnover OR "at risk" "blended learning" OR "computer assisted instruction" OR "computer managed instruction" OR "courseware" OR "distance education" OR "electronic learning" OR "integrated learning systems" OR "intelligent tutoring systems" OR "online courses" OR "mobile learning" OR "virtual classrooms" OR "web based Instruction" OR "technology mediated" OR "online learning" OR "Educational IT" OR "technology enhanced learning" OR "technology supported learning" OR "Hybrid learning" OR "technology". To ensure a certain timeliness in relation to the technologies used in the studies, 2007 was chosen as our point of departure. All studies were screened independently by the use of Covidence according to our inclusion and exclusion criteria.

Only studies in relation to BA or MA- degree programs and courses which included use of technology in relation to reduce student drop-out were included. Disagreements were discussed until a negotiated conclusion was reached. The review included studies across geographical settings published in peer-reviewed English language journals.

Quality assessment

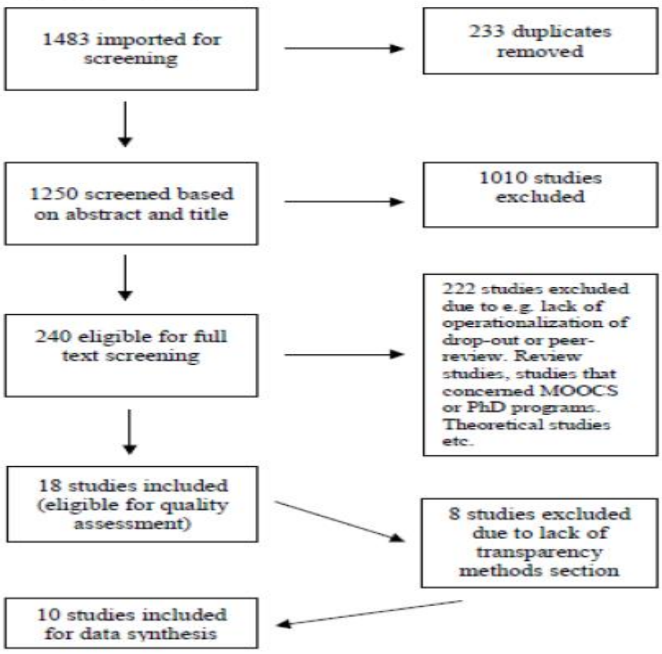
All studies included were subjected to a quality assessment by two independent raters based on a 20-item quality assessment tool for quantitative research studies based on work by Mager & Nowak (2012) Savin-Baden & Major (2010) and Tong, Sainsbury, & Craig (2007). Variations among studies, strengths and weaknesses of the research in relation to issues of validity, reliability, clarity in research question, transparency in the research method and the research design, and whether there is alignment between the research question and the study`s findings was identified (Cohen & Crabtree, 2008). Each quality criterion was assigned 0-2 point, yielding a total study quality score of 0–40 points with higher scores indicating higher study quality. Discrepancies between the authors were resolved during a process of consensus rating as recommended by Littell et al. (2008). Studies receiving at least 30 points, and of which at least 8 points must be obtained in "methods" were included in a subsequent data synthesis.

Data were extracted from all of the included articles (e.g., details of the contextual background e.g. discipline, study level, teaching format etc., definition and operationalization of retention, research design e.g. qualitative or quantitative, and key findings).

Results

The search of the electronic databases yielded 1483 hits. 18 studies were quality assessed. Study quality ranged from 9-40 points. Ten studies were found eligible for the final data synthesis (illustrated in Figure 1)

Figure 1. Flow diagram



The included studies were published between 2007 and 2017, with the majority of studies from the USA (n=8) and fewer from UK (n=1) and Australia (n=1). The definition of drop-out varied in the included studies, e.g. 1) the proportion of students who did not complete full courses or modules in a course (e.g. Liu & Stengel, 2011), 2) the proportion of students who obtain the grades lower than "C" (Wladis et al., 2017; Xu & Jaggars, 2011) or

3) the proportion of students who did not pass the exam criteria (e.g. Ashby et al, 2011). The majority of the studies were related to drop-out among BA-students (illustrated in table 1).

Table 1. Overview of studies included in the data synthesis

Study Year Country	**Disciplin Study level Participants (N) Age (Avg.) Gender**	**Course formats**	**Research design Definition of drop-out**	**Results**
Ashby, Sadera & McNary (2011) USA	Algebra, BA N= 167 Female: 58% Age: 25,5	3 formats: OO (38%) F2F (35 %.) Lectures and take home tests BL (28%)	Quantitative Exam Participation Pass: ≥ 70% Ongoing testing in all formats	Passed-score: F2F: 63% BL: 69% O: 85% recommended for exam: F2F: 93% BL: 70% O: 76%
Garratt-Reed, Roberts & Heritage*	Psychology, BA N = 866 Age: N / A Gender: N/A	Comparisons of two formats TECH: (n= 810) Lectures, group discussions, lecture recordings, written assignments OO: (n=56). video lectures, reflection diary, open and closed discussion groups, written submissions	Comparison/ Quasi experimental Mixed method (administrative data, SET, Compulsory assignments and grades Pass/ fail. Final grade, SET	Pass / fail F2F: passed: 96% O: passed: 91% SCORES: F2F Students achieved significantly higher exam scores compared to OO students
Griff & Matter (2013) USA	Anatomy and Physiology, BA N = 587 Age: N/A Gender: N/A	Comparison of two TECH formats TECH (Experiment) (n = 264) Adaptive learning system TECH (Control)Online quiz (n=323)	Experiment with control group Pre-test: 25 questions for all participants Post-test scores Dropout rate: number of admitted students / number of students who completed	Pre-test: No significant difference between. The two groups Average scores <50% Post-test: No significant difference between the two groups Dropout: No significant difference
Hughes (2007) UK	Pedagogy, BA n = 65 n = 254 (f2f control group) Age: N/A Gender: N/A	BL (experiment) 30% of the lectures were replaced with online tutoring and activities for the students. Special counseling, primarily online, for drop-out students 1st time (n = 15) 2nd time (n = 30)	Action research: BL course is tested twice and compared to the previous blended version of the course and similar f2f courses Log books. (weekly) Administrative data Non-attendance (not completed the course /	L courses with special support for students at risk had the lowest dropout rates (6% and 17% respectively) compared to dropouts in F2F courses (25% - 55%) and dropouts in BL courses without special support (25%).

		BL (pre-intervention) (n = 20) F2F (control group) (n = 254)	assignments, including interventions: online participation	
Liu & Stengel* (2011) USA	Statistics (n = 134) Quantitative Analysis (n = 129), BA Age: N/A Gender: N/A	Comparison of two formats: TECH .: Lectures with IClicker. Weekly online quiz (n = 58 + 67) F2F: Lectures, task solving without clickers. Weekly online quiz (n = 76 + 62)	Comparative experiment / Quantitatively Course completion Average performance during tests	Completion in Statistics course: TEK: 87.9% of the initially enrolled (n = 58) completed the course F2F: 69.7% of the initially enrolled (n = 76) completed the course Completion in Quantitative analysis Course: TEK: 80.6% of the initially enrolled (n = 67) completed the course F2F: 56.5% of the initially enrolled (n = 62) completed the course
Pittenger & Doering* (2010) USA	Farmaci BA og MA N = 1461 Average age: N/A Gender: N/A	Self-study (OO) with ongoing assessment, instructor feedback and weekly emails	Comparative / longitudinal (same 4 courses over 2 semesters) Mixed method (administrative data & questionnaires: IMMS and ARCS-based questionnaire Course completion Grades and increased motivation, Attention Relevance, Trust, and Satisfaction	Completion for the four courses: ≥ 95%. The primary factors that motivate students: well organized course structure with weekly emails, high quality learning material and relevance as well as flexibility and suggestions
Powers et al. (2016) USA	Psychology, BA n=730 Age: N/A Gender: N/A	Comparison of two formats: F2F: Videos and simulations, lectures and discussions BL: Once a week. The remaining time (equivalent to 30% of the original teaching time) is allocated to online exercises online in MyPsychLab and LMS	Quasi-experimental To compare learning outcomes across BL and F2F formats, the relationship between online homework and exam grades in the blended courses, as well as examining teacher and student preferences for delivery formats. Drop-out upon cancellation of the course	No significant difference in dropout rate in the two course formats Dropout rate: BL: 16.8% F2F: 14.8%. Primary reason for choosing the hybrid course: flexibility

Robb & Sutton* (2014) USA	Discipline = N/A, BA n = 388 Age: N/A Gender: N/A	Students in the experimental group (OO) received five motivational emails from the teacher during the course	Randomized experiment with control group (one semester, 12 courses) Quantitative data. Questionnaire regarding motivation (Course Interest Survey) Completion of course and final grade (≥C	Experiment group (n = 191) 58.6% of the group receiving motivational emails completed the online course, while 47.2% in the control group (n = 197) completed Students who received emails obtained significantly higher grades than students in the control group did.
Wladis, Conway & Hachey* (2017) USA	Business economics, Nursing, Rhetoric, Language, Social Sciences, Mathematics, Computer science, Sports, BA (n = 2330) Age: N A Gender: N/A	Comparison of two formats: OO/BL (n = 1001), F2F (n = 1329) 21 different courses (all courses offered in the same semester by the same teacher, respectively)	Quantitative Longitudinal (2004-2010) Completion of course with grade = ≥ C Independent variables: STEM vs. not STEM Mandatory, optional, 'distributional', severity (Lower level, Upper Level)	Lower level courses: Higher course completion O (49.9%) than F2F (42.2%) Upper level courses: Higher course completion F2F (77.8%) than O (73.7%) Avg. completion of courses: O = 58.6% F2F = 65.3% Significantly higher drop-out rate at optional OO-format courses as opposed to compulsory O-format courses
Xu & Jaggars* (2011) USA	English and Mathematics. Admission process n = 24,000, 23 universities Age: N/A Gender: N/A	Comparison of two formats F2F: Specifications not described. OO: Developed locally. Specifications not described	Register data, Longitudinal (4 years) Pre-exam drop-out (course fee paid) and grade at final exam (≥C)	

Themes

Comparisons of teaching formats

This review includes four studies that investigate whether the teaching format affects dropouts.
The teaching formats investigated were a) face to face (F2F) (no tech), b) blended teaching (BL), i.e., F2F & online, c) F2F complemented by online activities in class (TECH.), and d) online only (OO). In a study of 167 Algebra students, Ashby and colleagues (2011) compared three teaching formats: F2F, BL, and OO, and found no statistically significant differences in relation to the number of students who passed the exam. In a study of 866 Psychology students, Garratt-Reed and colleagues (2016) compared OO with a TECH format in relation to drop-out, grades and Students evaluation of teaching (overall outcome) and found that significantly more students

passed the TECH course (96%) than the OO course (91%). Using registry data on approximately 24.000 students, Xu & Jaggars (2011) compared dropout rates in F2F and OO introductory courses in English and Mathematics in 23 different HE institutions and found that the dropout rates were significantly higher among students participating in OO courses. In English and Mathematics, the dropout rates among OO-course participants were 19% and 25% respectively, compared to 10% and 12% among F2F course participants. The authors argue that the differences were primarily due to between-course differences in student characteristics rather than the delivery format. In a study of 2330 students, Wladis and colleagues (2017) explored whether particular delivery formats (F2F, BL, OO) were more suitable for specific course types than others, e.g., depending on academic discipline (STEM vs. non-STEM), whether they were optional or compulsory, and lower vs. upper level. Identical courses were offered in the different formats by the same teacher in the same semester, and repeated over a number of years (2004-2010). The results indicated that dropout were lower in the F2F format (65.3%) compared to the OO and BL formats (58.6%), but that there were significant distinctions. In optional online courses, drop-out were significantly higher compared to the compulsory online courses. In addition, students were more likely to complete a lower level online course (49.9%) than F2F (42.2%), while the opposite results were seen for upper level courses. For both F2F and BL/OO, the average course performance was generally better for upper level courses compared to lower level courses.

Due to the variability in the four studies, and a general lack of information on contextual matters, and knowledge about students' perception of the various teaching formats, the available evidence does not allow for clear conclusions regarding the association between delivery format and drop-out.

Comparison of teaching interventions

Six studies compared different teaching interventions aimed at increasing either student performance, motivation and/or active engagement. The interplay between content, technology, and pedagogy was thoughtfully considered in these studies, e.g. how various digital resources were used to solve specific learning tasks and/or challenges and how this influences student's learning. Of these six studies, four studies found a positive correlation between lower dropout rates and using learning technology.

Liu & Stengel (2011) compared TECH vs F2F in two different course modules, a) Statistics and b) Quantitative methods (n=263). They examined whether teaching involving use of clickers to answer multiple choice questions followed up by discussions with the teacher lead to an increase in the students' interest in the subject, a better performance, and reduced drop-out rates, when compared with teaching without clickers and feedback on the assignments during class. The results indicated that the completion rate was higher in the course modules where clickers were used (Course A: TECH. 87.9% vs 69.7%; Course B: 80.6% vs 56.5%).

Two studies were concerned with adaptive learning utilizing technology to deliver customized resources and learning activities to address the unique needs of each learner. The two studies revealed no associations between the technology used and drop-out. The study by Griff and Matters (2013) compared dropout in two groups, a) Anatomy and b) Physiology (n= 587); one in which the online assignments continuously matched the student's individual proficiency level and progression, and a control group which received assignments from a question bank selected by the instructor. Students in both groups increased their knowledge and no statistically significant differences were found in performance or dropout (mean difference: 7.6%). Powers and colleagues (2016) investigated drop-out rates among Psychology students (n=730) participating in two different teaching formats - a F2F and a BL course which included an adaptive learning element (MyPsychLab). The two courses ran in parallel, and the groups reviewed the same academic content. No significant differences in dropout rates between the two groups (F2F: 14.8 % vs BL: 16.8%) were found.

Three studies focused on motivational instruction and course designs to promote students' sense of belonging. The results of these studies revealed that even seemingly minor activities, e.g., sending encouraging e-mails, could contribute to reducing drop-outs. Robb & Sutton (2014) compared two groups of students (discipline not stated) in an online course. Group A (n= 191) received five motivational, non-personalized emails covering counseling on progression, reminders to review feedback, recognition of work performance, and encouragements to complete the course. Group B (n=197) received no e-mails but had access to the same information on a course platform. The drop-out rate was lower among students who received emails (41.4%) compared with those who did not (52.8%). Pittenger & Doering (2010) examined 1462 Pharmacology students' experience of online courses, which already were characterised by high completion rates (≥ 95%). A comparative analysis of four courses (administrative data & questionnaires) suggest that dropout rates are lower in courses with the following characteristics: well-organized course structure, weekly e-mails with suggestions for participation in the course activities and tasks, learning activities focusing on active learning, and flexibility in relation to carrying out tasks.

Hughes (2007) investigated a BL course program with 319 participating Early Childhood Education & Preschool Teaching students. Thirty percent of the lectures were converted to online activities and online guidance for students at risk for dropping out. The teacher monitored student activities via a learning management system, and special guidance (of administrative, technical, motivational or academic nature) was offered to students who were less active. The results indicated that the combination of proactive help and encouraging communication increased the number of students completing the course compared with a previous version of the BL course without support.

Summary and conclusion

Students at risk of dropping out appear to need more attention and tutoring, and opportunities for feedback appear to be essential. While teachers can provide this, it is challenging in classes with many students. To meet such challenges, technology is increasingly used as a remedial approach to improve students' motivation to learn and maintain their interest on the subject and/or provide a flexibility that allows students to focus more on the content they may have failed in and thereby reduce drop-outs. As an example, learning management systems can be used to identify areas in need of improvement and to facilitate improved teacher-student interactions, thereby assisting students in completing a course successfully (Lillejord, et.al. 2018). It is unclear, however, whether the available evidence supports such claims. The goal for the present review was to contribute to closing this knowledge gap. This was done by reviewing a segment of more recent empirical research. We asked whether – and under which circumstances - learning technologies applied in higher education contexts could contribute to reducing student drop-out rates.

Based on the studies synthesized, we are not able to identify an unambiguously positive correlation between the use of technology and lower dropout rates. Simply making teaching technology facilitated does not per se reduce dropout rates. Studies indicating a positive correlation between lower dropout rates and technology-based teaching mainly report on initiatives, in which learning technologies support teaching interventions aiming at activating and motivating students. We found it particularly interesting, that with even a relatively small effort, teachers appear to be able to influence student engagement and ultimately reduce student dropout as shown in Robb & Sutton (2014) and Pittenger & Doering (2010) studies. Here, the evidence suggested that minor initiatives, e.g., sending motivating emails to students to promote students' sense of belonging or using classroom responsive systems to posit questions and ask students to reflect on their response, and then discuss with their teacher, were effective tools to improve academic performance and reduce dropout. However, the generalizability of the findings may be limited due to the relatively small number of available studies.

Based on our findings, we recommend that higher education degree programmes focus on three aspects in terms of integrating technology in order to reduce dropout rates: Firstly, students should work actively and together; there should be interaction between teachers and students. Learning technologies can support such initiatives. Secondly, our study shows a positive correlation between regular motivational and guidance communication concerning the requirements of the course on the one hand, and student progression on the other. For example, one of the studies included in our review showed that the use of automatic emails with motivational messages, instructions and reminders from teachers to students resulted in significantly lower dropout rates compared with the dropout rates for students who did not receive these emails. Teachers can easily access such a tool. Thirdly, as the implementation of educational technology is often a top-down process rather than a result of teachers' demands, technology-enhanced learning is frequently also technology-focused (Damsa et al. 2015). Programs with the aim of promoting use of technology in teaching should therefore be aware of not only focus on technical training but also on motivating teachers to reflect on how technologies are implemented in relation to the course context and on the value of interaction with and between the students online. We found that scholarly approaches were rarely used when implementing technology in teaching. Several of the reviewed studies lacked pedagogical reflections regarding how technologies are implemented in relation to course contextual matters, and student factors that also may influence the learning process (see for example Biggs & Tang, 2011; Ellis & Goodyear, 2010; van Dinther, Dochy & Segers, 2011). Kirkwood & Price (2013) argue that teachers must reflect upon how technology interacts with approaches to teaching, and that pedagogy must guide the use of technology in teaching, rather than the other way round. Lillejord and colleagues (2018) note that despite much talk about the potential of technology to transform teaching and learning in higher education, teachers need to focus not only on the technical functions of on-line materials and activities but also seek to understand their students' perceptions of this aspect of the learning environment, and how successful it is in supporting student learning across a course.

Strength and limitations

The strengths of the present systematic review include a comprehensive selection process with independent literature searches, study selections, and quality assessments. We have synthesized the results, hoping that researchers, educational developers, and teachers will apply the knowledge in their own work. Some limitations should also be noted. First, the small number of available studies may limit the generalizability of the results. Second, our search strategy for this study was relatively narrow. Although language restrictions are not ideal, we chose to limit our search to studies published in English-language peer-reviewed journals, thereby possibly limiting the scope of this study. On a related note, we did not include the "grey literature", e.g., dissertations, conference abstracts. The search for grey literature is a less systematic process and grey literature studies are often of lower methodological quality, thereby risking compromising the validity of our findings.

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Predicting At-Risk Students for an Introductory Programming Course: A pilot study

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Some novice learners of computer programming are at risk of doing badly in their first programming course. In this pilot study, we develop a logistic regression model to predict at-risk students in our introductory programming course. The model is developed using students' high school grades on mathematics, features calculated from log data, and scores from a programming quiz. The model suggests that students who have lower mathematics grade, who submit their homework assignments late, and who have lower scores in the programming quiz are more likely to be at-risk. We discuss some implications of this result on our teaching and learning strategies in our course.

Keywords: Learning analytics, computer programming, at-risk students

Introduction

It is commonly accepted that learning programming is difficult for novice learners (Robins et al., 2003). Programming tasks tend to place several cognitive demands on learners, starting with the learning of language features, and ending with developing problem-solving skills (Linn and Dalbey, 1985). Thus it is not surprising that studies have reported that novice programmers lacked skills in reading and tracing code (Lister et al., 2004) and problem-solving ability (McCartney et. al., 2013; McCracken et. al., 2001).

In investigating the factors that determine students' programming ability, many studies have determined that ability in mathematics plays a role. For an introductory programming course (hereafter referred to as "CS1") aimed at Humanities undergraduates, Bryne and Lyons (2001) found that Irish Leaving Certificate Mathematics and Science grades had correlations with programming examination scores, with Mathematics having a weaker correlation compared to Science. In another Irish study, Bergin and Reilly (2005) found strong correlation between Mathematics and programming performance. Predictive models by Quille and Bergin (2018) included a feature on mathematics ability calculated based on high school exit examinations using data collected in Ireland and Denmark. In Botswana, Ayalew et al. (2018) found a moderately strong correlation between high school mathematics scores in and university programming performance.

Other studies have used in-course data such as log data from the learning management system (LMS) or other student-generated data to see what behavioural indicators are linked to programming ability. Behavioural features calculated from log data, such as time of submissions, number of submissions and total elapsed time were also calculated by Edwards et al. (2009). It was shown that students who started and finished their assignments earlier tended to get better grades in programming courses. Using statistical analysis, Willman et al. (2015) used time stamps on programming assignment submissions to derive features on student behaviour, such as the time of day of submission, submission counts and so on, and showed that students with the highest course grades tended to submit their work early and did not work at night.

Studies in other contexts and fields have used similar behavioural features. One feature calculated by Cerezo et al. (2016) from log data from an online course was the time taken by students to submit an assignment from the time it was first released. Results from clustering algorithms then suggested that students who take a longer time to submit their assignments did worse in the course. For an online course offered by a Korean university, a linear regression study by You (2015) showed that late submissions of tasks had a negative effect on the final course score.

Most educators want to identify students at-risk so that suitable interventions can be given in order to reduce the attrition rate and improve learning outcomes. One way of doing so would be to develop predictive models.

Since it has been shown that behavioural indicators can be extracted from log data and LMS data, predictive models have been built using such data to identify at-risk students. Ahadi et al. (2017) logged key presses in online programming exercises, and showed that the number of attempts on an exercise could predict performance on a final exam question. In a CS1 course, Porter et al. (2014), and a subsequent study by Liao et al. (2016) used answers from classroom response questions at the start of the term and showed that the predictive models built could predict end-of-course performance, thus enabling timely intervention for at-risk students at an early stage. Using data from a first-year engineering course, Pardo et al. (2016) suggested that decision tree models built from log data could be used to give personalized feedback. Log data from LMS have been used to build predictive linear regression and logistic regression in various non-computing courses within the same university, and it was shown that the models generated were course-specific (Connijn et al, 2016).

Some studies have tried to build predictive models on introductory programming by incorporating data from more than one source. Apart from high school mathematics scores, Bergin and Reilly (2005) included data such as class test scores and lab test scores in their linear regression models. Bergin et al. (2015) used data from students' background and instruments such as those measuring self-efficacy, use of learning strategies and so on to build machine learning models. Predictive models by Quille and Bergin (2018) included various features using data collected in Ireland and Denmark, including a feature on mathematics ability based on high school exit examinations, students' self-efficacy and various demographic features.

Undergraduate students in the Singapore University of Technology and Design (SUTD) take compulsory common courses in their first three terms. "The Digital World" (DW) is an introductory Python programming course taken in their third term. Following the third term, students declare their major and choose one out of four "pillars", namely Engineering Product Development, Engineering Systems and Design, Information Systems Technology and Design and Architecture and Sustainable Design. All four pillars have courses that require a good foundation in programming. Hence it would be advantageous to any SUTD undergraduate to acquire programming skills.

As part of the coursework for DW, students have to complete a weekly problem set. Currently, we have a few measures to help students who need assistance in completing their problem sets. These include having an undergraduate teaching assistant (TA) present in regular classes, and weekly consultation sessions manned by senior students. However, the weekly consultation sessions are not well-attended, and the TAs do not get a lot of questions. Both these measures rely on students taking the initiative to make use of them. It would be useful to identify at-risk students so that we may consider other possible interventions for them.

We have no systematic means to identify at-risk students in our introductory programming course. However, we do possess a lot of data on our own students, such as their scores in the assessment components and log data from their interactions with the LMS. Hence, the research question in this study is, is it possible to build predictive models using the data that we have to identify students at-risk?

Method

Context

The largest group of students that apply to SUTD do so with the "A-level" qualifications. In the A-levels, students typically have to take Mathematics and three other subjects. The choice of subjects determines what university courses they qualify for. A smaller proportion of students, not considered in this study, enroll with diplomas from the five local polytechnics. Most female students join SUTD after completing the A-levels at age 18, while male students will join at age 20 after completing National Service.

In DW, like many courses in the first year at SUTD, students are divided into cohorts of about fifty students in a classroom setting and meet for five hours per week, divided over three sessions. In each session, a short lesson is given, then students are given time to attempt a weekly problem set by themselves. Instructors and the teaching assistant then circulate around the classrooms to observe students' work and answer questions.

The weekly problem set contains three categories of problems. The "Cohort Problems" (CH) are questions that instructors typically use as lesson examples and students are given time in class to complete them. The "Homework Problems" (HW) are questions that students are typically expected to complete in their own time. Both these problems account for a small percentage of the course overall score. The last category, "Exercises" (EX), are optional problems that are ungraded. These questions are meant for students who want additional practice. This study does not use data on the Exercises. In each category, there are between five to seven questions. For each week, the problem sets are released at 0001 hrs on Sunday and are due 2359 hrs on Tuesday of the following week.

Students submit their programming answers to our online submission platform, Vocareum (2019), which then assigns a score to the answer based on the number of test cases passed. Vocareum is also a platform for students to receive automated feedback on their solution. After students submit their solution, we programmed it to display a description of the test cases passed and failed, enabling them to revise their solution on their own and then resubmit to obtain a better score. Students have unlimited chances to submit prior to the deadline for each question. Late submissions are possible for one week beyond the deadline with a 50% penalty on the scores. Vocareum also keeps a log of the usage by each student and this is what is used in this study.

Students also have individual assessments that form a larger proportion of their final score. We describe what was used for the student data in this study. The first is programming quizzes throughout the term. For the 2018 run of DW, they are conducted in-class and students are given one question to complete within 30 minutes. The mid-term exam and final exam have the largest weightage and these exams have two components, a written component (20% of the marks) and a problem-solving programming component (80% of the marks). Similarly, during these quizzes and exams, students submit their answers to Vocareum.

Building the dataset

We gathered data from the students who matriculated in 2017, who then began DW in January 2018. We drew our data from three sources:
1. deriving features from Vocareum log data in week 4
2. prior performance at A-levels for Mathematics and Physics
3. scores of the programming portion of the mid-term and the programming quiz at week 4

Deriving Features from Log Data

Students submit their programming assignments to the CH, HW and EX problems in the problem set to our submission platform, Vocareum. The time at which the "Submit" button is last clicked for each question is logged and thus we are able to calculate the following features:
- "CH Submitted", "HW Submitted" – the number of problems submitted in the corresponding category
- "CH Average Days", "HW Average Days" – the number of days between the problem set release and the point of submission, averaged over all the questions in each category
- "Week 4 Programming Quiz Time" – the time taken to complete the programming quiz in Week 4, in minutes
- "Week 4 Programming Quiz Score" – the score for the programming quiz, integers from 0 to 4

We chose the features for CH and HW as they would give us an indication of how diligent students were in completing the problem set.

The time taken for the programming quiz was chosen because we had noticed that some students were able to complete the quiz very quickly, while some students struggled to produce a solution even when the quiz ended. We also included the score from the programming quiz as an indication of the students' performance on this quiz.

As this is a pilot study, we chose data from Week 4 of the course because this is when we introduce advanced programming concepts such as nested for-loops and dictionaries, and we tend to notice more students having difficulties.

Prior performance at A-levels

As some studies had reported that students' prior performance in Mathematics and Science had an effect on CS1 performance, we included students' grades in Mathematics and Physics at the A-levels in our dataset. For these subjects, letter grades from 'A' to 'E' are awarded. Students who scored 'A' in Mathematics formed the largest group, so we decided on the following categorical features:
- "IS MATHEMATICS A" – whether the student had scored grade 'A' in Mathematics (coded as 1) or not (coded as 0).
- "IS PHYSICS A" – whether the students had score 'A' for Physics (coded as 1) or not (coded as 0, which includes students who did not take Physics as a subject at the A-levels).

Scores at mid-term exams

As an indication of the students' programming ability, we included their scores on the programming portion of the mid-term exam, normalized to between 0 and 1 using min-max normalization. To enable classification algorithms to be applied, we categorized the students as "Weak" or "Not Weak" based on their percentile rank in their mid-term exam scores.

- "MidTerm Part B Score (Normalized)" - their scores on the programming portion of the mid-term exam, normalized to between 0 and 1
- "MidTerm Weak" – coded as 1 ("Weak") if their mid-term part B scores are in the 40th percentile and below, and 0 ("Not Weak") if otherwise. This 40th percentile threshold was decided based on our analysis (described below) and is similar to the value chosen in the study by Liao et al. (2016).

Missing data and size of dataset

As this is a pilot study, our dataset is limited to students who joined us with A-level qualifications. There were also students who did not attempt the programming quiz. We excluded these students from the final dataset, thus the dataset has, in its final form, n = 261 records.

Modelling

To determine the features that best explained the variation in the dependent variable, "MidTerm Part B Score (Normalized)" , we first applied recursive feature elimination to select the best features for a linear regression model.

Following which, we divided our data into two sets, a training set (60%) and a test set (40%). We used the features that were determined earlier to train a logistic regression model, where the dependent variable was "MidTerm Weak". This model was then used to make predictions on the test set. The confusion matrix and its associated metrics were calculated.

The feature selection, model fitting and predictions were done using the "scikit-learn" Python module (n.d.). For each model, the p-values and the 95% confidence interval were obtained using the "statsmodels" Python module (n.d.).

Results

Linear Regression

The resulting linear regression model with three features is shown in Table 1. These features are the top three features ranked by the recursive feature elimination, and resulted in p-values of 0.001 or less. The 95% confidence intervals for these features do not include zero. Adding the lower-ranked features produced p-values larger than 0.05 and hence were not included in the model.

The R^2 score was 0.39, thus this model explains 39% of the variation in the dependent variable. This R^2 score is similar to scores reported in other studies employing linear regressions (Goold, 2000; Wilson et al., 2001; Bergin et al., 2005).

The coefficients are reasonable. The negative coefficient for "HW Average Days" suggest that students who take more time to submit their HW questions will do worse on the mid-term exam. The positive coefficients for the remaining features suggest that students who do better on their programming quiz and obtained A for A-level mathematics tended to do better at the mid-term exams. We visualized the data in Figure 1 which seems to confirm this trend.

Contrary to the results of Bryne and Lyons (2001), the feature "IS PHYSICS A" was not selected to be in the model. Putting this feature in the regression model resulted in a p-value exceeding 0.05. It is also not surprising that the CH features were not included as the cohort questions are used in classroom teaching and may not be indicative of individual student behaviour. Contrary to our expectations, the "Week 4 Programming Quiz Time" was not included in the model. This is probably due to test-taking behaviour where the majority of the students, regardless of ability, would want to make full use of the time that they are given in the test.

Table 1: Coefficients of the linear regression model

Feature	Coefficient	P value	95% confidence interval
Constant term	0.5331	<0.001	(0.438, 0.628)
HW Average Days	-0.0368	<0.001	(-0.045, -0.028)
Week 4 Programming Quiz Score	0.0347	<0.001	(0.017, 0.052)
IS MATHEMATICS A	0.0697	0.001	(0.030, 0.109)

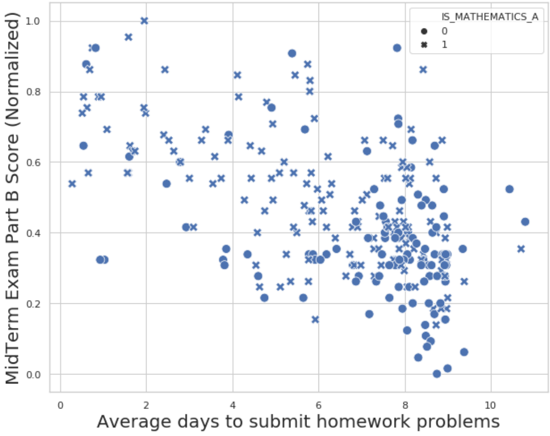

Figure 1. The distribution of MidTerm Exam Part B score against the average days to submit homework problems . This plot suggests that students who get A at A-level Mathematics tended to do better at the mid-term exams and submit their homework problems earlier.

Predictions using Logistic Regression

Using the features selected earlier, the logistic regression model built with the training set is shown in Table 2. The target feature is "MidTerm Weak" with the threshold of the 40th percentile of the "MidTerm Part B Score" separating the "Weak" and "Not Weak" categories. All the coefficients have p-values of less than 0.05, and the 95% confidence intervals for these coefficients do not include 0. We also found that any other features added to the model gave p-values of larger than 0.05, hence they were not included in the model.

We find that the coefficients are reasonable. A positive coefficient for a feature suggests that an increase in that feature results in an increase in the probability of being in the "Weak" category. Hence, the positive coefficient for "HW Average Days" suggests that students who submit their homework problems later have a higher probability of being classified as "Weak". The negative coefficients for the other two features suggests that having a higher quiz score and an A-grade at A-level Mathematics reduces the probability of being classified as "Weak".

Table 2: Coefficients of the logistic regression model

Feature	Coefficient	P value	95% confidence interval
HW Average	0.2511	<0.001	(0.1427, 0.3594)
Week 4 Programming Quiz Score	-0.2983	0.014	(-0.5357, -0.0610)
IS MATHEMATICS A	-1.3276	<0.001	(-2.0183, -0.6370)

The logistic regression model was used to make predictions in the test set. The resulting confusion matrix and the associated metrics are shown in Table 3. As we are interested in predicting at-risk students, the precision 0.70, suggesting that the model manages to predict 70% of the at-risk students correctly.

The recall is 0.74, suggesting that, out of the students predicted as "Weak", 74% of them have been identified correctly. Hence, a high recall value suggests that we have few false positives.

Table 3: Confusion Matrix by the logistic regression model

	Predicted Not Weak	Predicted Weak
Actual Not Weak	50	13
Actual Weak	11	31
	Precision: 0.70	**Recall**: 0.74

A Naïve Bayes model with the same set of three features obtained a precision of 0.65 and a recall of 0.71 on the test set. This suggests that the logistic regression model has a small improvement over a simpler predictive model like the Naïve Bayes.

Finally, to check that the threshold of the 40th percentile for the target feature "MidTerm Weak" was the best choice, we generated logistic regression models for thresholds of 20th percentile and 30th percentile and summarize the precision and recall obtained from these models in Table 4. It is clear that the 40th percentile threshold gave the best results.

Table 4: Checking the threshold for "MidTerm Weak"

Threshold for "MidTerm Weak"	**20th percentile**	**30th percentile**	**40th percentile (as in Table 3)**
Precision	0.56	0.57	0.70
Recall	0.22	0.64	0.74

Discussion

The set of three features that have been included in the models seem to suggest that a mixture of pre-course and during-course factors will predict at-risk students. Our study includes the performance of A-level Mathematics as a feature in the models. This is a similar result to other studies that have provided evidence that performance in high-school Mathematics is a factor that influences performance in introductory programming courses (Bergin and Reilly, 2005; Ayalew et al., 2018), and in contrast to the weak correlation reported by Watson et al. (2013).

The "HW Average Days" feature is interesting as a behavioural feature. The models in this study have suggested that the later the student submits the homework problems, the more likely the student will do badly in the mid-term exams. In our course, the homework problems are designed to be more challenging than the cohort problems. Furthermore, at Week 4, we observe that students are beginning to struggle to understand the concepts taught in DW, and have a high academic workload from other courses. Hence, it seems to us that this is an indicator of how well a student is coping with their studies – a student who is struggling with the workload will tend to submit their assignments later compared to one who is coping well. This is similar to other studies that found that students who submit their assignments early tend to do better, both in the introductory computing context (Edwards et. al., 2009; Willman et. al., 2015) and in other contexts (Cerezo et al., 2016; You, 2015). Thus, the time taken to complete an assignment could be an important feature that can be used to predict student achievement in any context.

The fact that the Week 4 Programming Quiz score is included as a feature suggests that simple quizzes earlier on in the course can give an indication on which students are at-risk. However, currently, in DW, it currently takes more than two weeks for the quizzes to be marked. Hence, students do not receive feedback in a timely manner, and students will not be alerted on time that they are at risk. In contrast, using strategies such as Peer Instruction allows feedback in a timely manner and have predictive value (Porter et. al., 2014).

This study has some implications for our instructional strategies. Since the weaker students tend to submit the homework problems later, we would have to consider how we could craft some of those problems to provide scaffolding to slower learners. Since they also tend to have lower A-level mathematics grades, we would have to consider how we might help students develop problem-solving abilities, for example, perhaps by using a sequence of practice tasks that scaffolds students towards a complex task (Denny et al.,2018). We would also have to consider how we might assist students to assess their own abilities, and provide feedback in time. One option for this is to provide questions targeting specific programming concepts (Zingaro et al.,2012) that can be marked automatically by deploying them on learning management systems.

This study has some limitations. The models generated in this study are based on only one week of log data for a particular batch of students. Hence, it is not known if the same conclusions can be drawn if log data is used from other points during the course. It is also not known if these models are applicable to subsequent batches of students taking this course. Also, we only incorporate one prior feature, students' mathematics grade at 'A'-levels, inside this analysis. However, we have observed that some students who join our course already have some programming ability that they might have picked up on their own. This could have a positive effect on their mid-term exam performance. Hence, future analysis could incorporate data from more than one batch of students, and include information on other pre-course factors such as existing programming ability.

Conclusions

In this pilot study, from log data in one week of our course, we have extracted students' behaviour features and built a logistic regression model. Included in this model are also students' A-level scores on Mathematics and their score in a programming quiz. We found that this model can predict at-risk students, defined by their performance in a mid-term exam, with a precision of 0.70. The analysis also suggests some improvements in our instructional strategies. This model is done using one week of data in one term of the course, hence, more work is needed if predictions are to be made over a longer duration.

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Practices and Challenges in a Flipped EFL Writing Classroom

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Despite the widespread use of flipped teaching across educational disciplines, there is limited understanding on its use in the teaching and learning of English as a second language (ESL) writing in intensive English (IE) programmes for pre-university students. Such programmes face at least three constraints: the students' low English proficiency, the shortage of time to bridge the English gap, and the necessity for academic English. This paper aims to explore practices and challenges of a flipped EFL writing classroom. In total, 38 students were given flipped writing classroom training. The participants watched video lectures on academic writing designed for the purpose of this study before the class, and then participated in interactive in-class learning activities. The study results revealed that the students performed the writing tasks significantly better in the post-test. The interviews with students showed that students favoured the greater time preparation, the immediate feedback, the increased opportunity to practise and interact, as well as the higher level of motivation and self-efficacy.

Keywords: Flipped classroom, English as a second language, writing, blending

Introduction

The global population of international students continues to rise, reaching almost 5 million in 2014 - more than double from the 2.1 million internationally mobile students in 2000 (Benson, 2015) and expected to hit 8 million by 2025 (Quacquarelli Symonds, 2018). With the surge in the number of students and the significant changes in the diversity of student population as well as the modes of curriculum delivery (Coffin et al., 2005), student academic writing continues to be at the centre of teaching and learning in higher education. Writing is one of the most difficult skills that English as a Foreign Language (EFL) learners are expected to acquire, partly due to the first language interference (Watcharapunyawong & Usaha, 2013). Although most EFL students studying in post-secondary institutions have a good grasp of the writing skills, their way of expressing their thoughts in English may not meet the expectation of western academic communities that they are entering (Myles, 2002). Moreover, Kern (2000) suggests that the abstract mental structures representing our knowledge of things, events, and situations can lead to difficulties when students write texts in a foreign language. Knowing how to write a discussion essay in Mandarin does not mean that EFL students will be able to do so in English proficiently.

Most importantly, writing is a demanding task for Second Language (L2) learners as their linguistic knowledge and lexical resources, for examples, may be limited. This limitation reduces their possibilities for expressing their ideas. To be able to write in a foreign language effectively, students need to "learn the orthography, morphology, lexicon, syntax, as well as the discourse and rhetorical conventions of the L2" (Barkaoui, 2007, p.35). L2 learners not only need to have vocabulary knowledge, but also need to have the grammatical knowledge at their disposal to be able to connect the words into proper clauses and sentences (Grabe & Kaplan, 1996). In addition to this language-related knowledge, L2 writers also need to have metacognitive knowledge of what makes a good text and be able to employ writing strategies suitable for each text.

According to Schoonen and Glopper (1996), high proficiency and low proficiency L2 writers could be distinguished by their metacognitive knowledge which includes task knowledge and strategy knowledge. Low proficiency learners spend a lot of time in accessing the low-level (linguistic) knowledge resources and subsequently have less time participating in high level processes of writing such as text structuring. However, if low proficiency learners have more fluent access to grammatical structures in memory, their cognitive processing load might be lower and therefore they can spend more time in enhancing the writing process as well as the quality of written text (Chenoweth & Hayes, 2001; Cumming, 2001; Grabe & Kaplan, 1996). In other words, when low proficiency learners need more time to deal with 'low order' problems of word finding and grammatical structures, they have little or no working memory free to attend to higher level or strategic aspects of writing, such as organizing the text properly or trying to convince the reader of their view.

As such, flipped classroom method may be useful for L2 learners, as class time is used to explore and apply ideas and practise language with their peers. All the lecture videos, grammar points and writing structures or revision can be done at home. Flipping the content allows learners to pause and rewind their lectures, and help them understand and learn the important concepts before class. When they come to class, they can participate in higher level aspects of writing. The flipped classroom is a teaching model where students do traditional classroom activities, such as listening to lectures, outside of the classroom, resulting in having more time for engaging practice activities in class. Students can study lesson materials and set whatever pace they are comfortable with. For example, students with low level of English language proficiency can view materials multiple times, while their peers with high level of language proficiency can breeze through everything more quickly. In a traditional classroom, students of various English proficiency levels all have to follow the same pace set by the teacher, and this is less than ideal for many students. In flipped classrooms, teachers are more involved in practice activities which are done in class, rather than given for homework. This allows teachers to see exactly where students struggle and adjust their teaching accordingly. For ESL/EFL classes, the flipped classroom approach is effective because it maximizes the amount of time students speak English in class and minimizes the amount of teacher talk time.

As pre-university intensive English courses tend to be short in duration; hence, teachers need to condense as much learning time as possible and flipped teaching might create more learning time and better use of classroom time. Research has reported that flipped classroom may enhance students' learning performance (Davies, Dean, & Ball, 2013; Fautch, 2015; Freeman et al., 2014; Han, 2015; Jungić, Kaur, Mulholland, & Xin, 2015; Marrs & Novak, 2004; Smith, Brown, Purnell, & Martin, 2015) but previous studies on flipped classroom seldom focused on EFL, especially the low proficiency learners. Therefore, the project reported in this paper aims to investigate the influence of flipped classroom on low proficiency EFL students' academic writing performance by identifying the benefits and the challenges of flipped classroom. It also aims to give insights into the ways the flipped writing approach can be utilised effectively in the ESL classroom at Higher Education (HE) level; particularly for low proficiency second language writers.

Background

Challenges facing EFL writing students

An EFL classroom usually consists of students who share the same language and culture in the same country; thus, this environment gives them exposure to English language only in the classroom. Outside of the classroom, students have limited opportunities to use the language, so English has no specific practical need for them (Souriyavongsa, Rany, Abidin, & Mei, 2013). Learners tend to acquire the language more slowly in an input-poor environment or language learning contexts, where they have little opportunity to hear or read the language outside or even inside the classroom (Kouraogo, 1993). This context is also found in EFL teaching environment in Malaysia.

Besides the different learning contexts which could either hasten or hinder the learners' acquisition of English, there are specific challenges that are pertinent in pre-university intensive English programs. These include:

(a) A widening gap between pre-university student levels of English and the minimum level of English required to cope with university studies. The wider the gap, the more difficult it is to bridge it.
(b) The time that pre-university students are willing to spend on Intensive English is often limited to a semester or two. The students are often in a hurry to get into their university course of choice as quickly as possible, and they overlook counting the cost of failing in terms of time and money when they are not sufficiently prepared to study in English.
(c) The problem of acquiring English as used in academia in contrast to learning English for general purposes. Most pre-university students have not been taught the former. All these impede their language learning.

First of all, many non English-speaking background (NESB) students who have gained the requisite proficiency IELTS scores of Band 6 or Band 6.5 appear to be linguistically under-prepared for academic study (Coley, 1999; McDowall & Merrylees, 1998). Complaints have been directed in particular at NESB students' inadequate academic writing skills (Kam & Meinema, 2005). Thus, if there is a gap between the first year NESB students who scored the minimal level of English and the level of proficiency required for successful academic pursuits, the gap between the pre-university NESB students and the minimum level of English is even greater. Another challenge of Intensive English Program is time. Elder and O'Loughlin (2003) suggested that three months of full-time intensive study in an English-speaking country were required for students to progress half of an IELTS overall proficiency band. According to Cummins (2000), the time required to achieve Cognitive Academic

Language Proficiency (CALP) for non English-speaking background (NESB) students takes at least five years' of study and the time for NESB low-level English proficiency learning an intensive program in a non-English-speaking country will even be longer. However, many low proficiency NESB students are not willing to spend too much time learning English. Johns (1998) and Leki (2007) report that NESB students avoided taking compulsory writing classes and perceived them as yet another unnecessary hurdle to jump through before they are allowed to progress into the mainstream courses. The third challenge facing the Intensive English Program is the disparity between the demand of 'academic literacy' and English for general purposes. While 'literacy' refers to the basic ability to read and write for daily functional and social activities and purposes, 'academic literacy' refers to the ability to use written sources critically to read texts with understanding of their discursive role in society as well as to write appropriate texts in order to learn and succeed in higher education (Weideman, 2003).

Intensive English programs for pre-university students thus face at least these three constraints: the students' low English proficiency, the shortage of time to bridge the English gap, and the necessity for academic English. For ease of reference, these may be labelled the gap constraint, the time constraint and the appropriacy constraint. For this reason, any Intensive English program should take into account these three variables - low proficiency, time constraint and academic English - in trying to raise the level and variety of students' English which will enable them to cope with their undergraduate studies. In order to address the problems and help the EFL low proficiency learners to raise their level of English language proficiency, this study used the flipped approach to increase the three dimensions of the writing process in Chenoweth and Hayes (2003) model as shown in Figure 1 below.

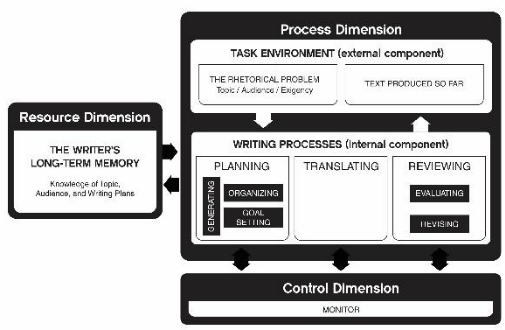

Figure 1: Chenoweth and Hayes Model of cognitive processes

In the Chenoweth-Hayes model, the resource level includes the long-term memory, the working memory, and other general purpose processes (Chenoweth & Hayes, 2001). The metacognitive knowledge and linguistic resources are also stored at the resource level. At the process level, writers translate their ideas into written language by accessing and revising the knowledge. The control level includes "the task goals and a set of productions that govern the interactions among the processes'' (p.87). The difference in writing proficiency, fluency or quality between the higher and low proficiency L2 writers depends on the availability and accessibility of their working memory at each level (Bereiter & Scardamalia, 2013; Chenoweth & Hayes, 2001; Kellogg, 1996).

Statement of the problem

In second language (L2) writing, L2 writers differ in terms of their degree of fluency, due to the three dimensions of the writing process – the resource, the process and the control (Chenoweth & Hayes, 2001, 2003) (see Figure 1). As mentioned in the earlier discussion, pre-university intensive English courses tend to be short in duration. The teachers need to condense as much learning time as possible, and flipped teaching might create more learning time and better use of classroom time. In a flipped classroom, teachers give students direct and explicit instruction or resources outside of the class time (Strayer, 2007) to allow students to spend more time on inquiry-based and experiential learning (Berrett, 2012). After accessing the information and resources at home, students can explore texts and interact with classmates and teachers. Instead of just spending the whole time sitting and listening to long instructions in class, students might now learn concepts and complete homework using lecture videos and other learning materials provided by the instructor outside of the classroom (Davies et al., 2013). Class time then is freed up for both the student and the teacher to attend to problem-solving, high-level thinking and writing activities. The purpose of using flipping is to give EFL low proficiency students more practice and more time to achieve a high level of academic English. The teachers teach the academic genre using flipping instruction method and help students build their resources such as academic terms and academic style. In class, they can guide the students into learning to think and write clearly, as clarity is an essential feature of academic writing.

According to Hung (2015), one of the benefits often cited for flipped teaching is that students are given ample chances to develop higher order thinking in Bloom's Taxonomy (Forehand, 2010) during in-class interaction with their instructors or peers, while low order thinking skills in out-of-class lectures are replaced with instructional videos without sacrificing learning content (Berrett, 2012). When well executed, this flipped classroom approach frees up the classroom time to give EFL learners the opportunities to interact in discussions that encourage critical thinking and writing. The flipped classroom gives teachers more time to teach students how to control the writing by monitoring the standard features of academic writing; clarity of thinking and writing, grammatical correctness, factual correctness, conciseness, and good argument. In this study, low proficiency learners can focus on the development of their high order thinking and work on the ideas and vocabulary needed for their writing in class instead of spending the class time on their low order thinking skills, such as learning the grammar needed for the writing or learning how to structure a particular kind of writing.

Method

Thirty-eight EFL students participated in the flipped classroom training. All participants were undertaking Intensive English Programme which is a post-secondary course at an offshore campus of an Australian University. They came from non-English speaking backgrounds and included students from China, Indonesia, Korea and Malaysia. Intensive English is a programme which aims at improving students' academic English skills. Those who did not meet the university language entry requirement are placed in the programme. Students whose Entrance Placement Test (EPT) or Versant English Placement Test (Versant EPT) scores are below 50% or if their International English Language Testing System (IELTS) scores are below Band 5.5 are required to take the Intensive English programme. Intensive English Level 4 is for students who score between 40-50% in the EPT or Band 4.5-5 in the IELTS. Therefore, all the students at IE Level 4 were at the same level. The Intensive English programme runs for 4 terms covering 5 components in each one. Students learn listening, speaking, reading, writing and grammar. Students who pass IE Level 4 are eligible to enrol in Foundation or degree courses at the university.

The sample of 38 low proficiency students came from 3 Intensive English (IE) Program level 4 groups in 3 terms. There were 13 in Group 1 (Term1), 15 in Group 2 (Term 2) and 10 in Group 3 (Term 3) respectively. The number of participants in each group was beyond the control of the researcher as it was based on the enrolment each term. However, the overall design, layout and learning materials of each group were identical. The details of participants in each group are elaborated below (see Table 1). All 38 students participated in the post-test while 6 participants from each group volunteered to participate in the interviews after the training. It was hypothesized that flipped writing training would have a significant impact on the writing performance of these low proficiency EFL students.

To maximize the opportunities for interaction and dispel passive learning, two-thirds of the course content was converted into 115 minutes of video lectures and the writing topics were recorded using Camtasia Studio 8. The screencasts were almost identical to how the topics would have been taught in the tradition classroom. Most videos were kept within 8 to 16 minutes, with only one being 20 minutes and 55 seconds as it was necessary to combine two writing lecture topics in the last video for the last training session. Videos were uploaded to Blackboard, a Learning Management System, for students' easy access to watch at their preferred time and place. For each video, the instructor also prepared corresponding handouts and exercises, which they could answer if they had a good understanding of the video lectures.

Results

There were three experimental sub-groups in total as the number of participants was in this study was beyond the control of the researcher. Table 1 shows the samples of participants in the experimental groups. There were 13 students in Group 1 (34.2%), 15 students in Group 2 (39.5%) and 10 students in Group 3 (26.3%).

Table 1: Samples of the study based on groups

	Frequency	Percent	Valid Percent	Cumulative Percent
Group 1	13	34.2	34.2	34.2
Group 2	15	39.5	39.5	73.7
Group 3	10	26.3	26.3	100
Total	38	100.0	100.0	

The means, standard deviations, skewness and kurtosis of the writing scores for both essays in the two experimental groups are shown in Table 2 below.

Table 2: Descriptive Statistics of the Experimental Group

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Discussion Essay Pre-test	38	5.0	10.0	7.816	1.0869	-0.680	0.383	0.328	0.750
Discussion Essay Post-test	38	10.0	17.0	12.987	2.2132	0.421	0.383	-0.951	0.750
Process Essay Pre-test	38	5.0	10.0	7.776	1.1951	-0.238	0.383	0.410	0.750
Process Essay Post-test	38	11.0	19.0	15.447	1.9686	-0.447	0.383	-0.564	0.750
Valid N (listwise)	38								

The first two rows of Table 2 illustrate the descriptive statistics' results of participants who completed the discussion essay, in the pre- and post-tests. In the pre-test, the mean of discussion writing scores is 7.816, SD=1.0869 with the lowest score being 5 and the highest score being 10. As can be seen in Table 2, 50% of participants had 7.0 to 9.0 points in the pre-test for discussion writing. However, in the post-test, the mean of discussion writing scores was 12.987, SD=2.2132 with the lowest score being 10 points, and the highest score being 17 points. It can be clearly seen that participants have made remarkable improvement in their discussion writing after the training using the flipped learning approach.

The last two rows of Table 2 show the descriptive statistics' results of participants who completed the process essay, in the pre- and post-tests. In the pre-test, the mean of process writing scores is 7.776, SD=1.1951 with the lowest score being 5 and the highest score being 10. As can be seen in the table, about 19 participants had 7.0 to 9.5 points in the pre-test for process writing. However, in the post-test, the mean of process writing scores increased to 15.447, SD=1.9686 with the lowest score being 11 points and the highest score being 19 points. In other words, participants who have undergone the flipped writing training have improved in their process writing greatly.

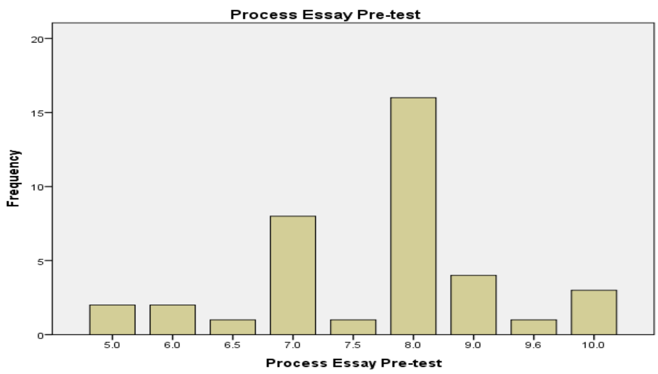

Figure 2: Graph of process essay pre-test results in the experimental group

There was a difference in the results of their post-test as shown in Figure 3 below. A majority of the students in the experimental group obtained 17 marks (23.7%) in the process essay post-test. This was followed by students obtaining 14 marks (15.8%); 15 marks (13.2%); 16 marks (10.5%); 12 marks and 18 marks (7.9%); 13 marks and 15.6 marks (5.3%); 11 marks, 14.5 marks, 17.5 marks and 19 marks (2.6%). These scores have shown that many students have achieved significant improvement in their process writing after undergoing the flipped writing training.

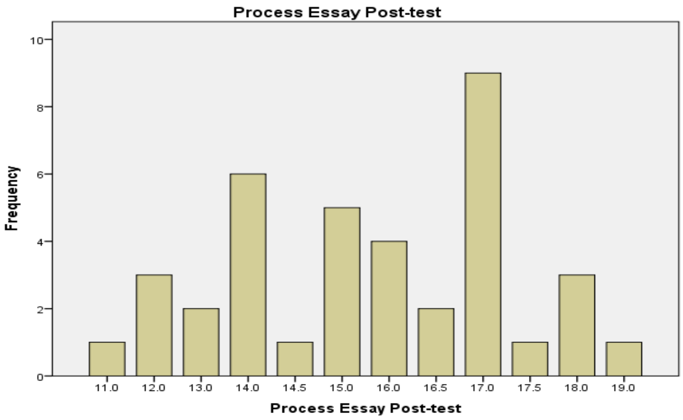

Figure 3: Graph of process essay post-test results in the experimental group

The performance of the participants in the experimental groups before and after completing the training was measured using the paired sample t-test and the differences were analysed. The result shows that there is a significant difference between the mean for process essay pre-test and post-test in experimental group (t(37): -21.062, $p < 0.05$). The students in the process essay post-test (Mean = 15.447, SD = 1.9686) had better results compared to the process essay pre-test (Mean = 7.779, SD = 1.1991).

To measure the discussion writing performance of a flipped writing training and structure in the experimental groups, the paired sample t-test was also used. They analysis shows that there is a significant difference between the mean for discussion essay pre-test and post-test in the experimental group (t(37): -14.099, $p < 0.05$). The students in the discussion essay post-test (Mean = 12.987, SD = 2.2132) had better results compared to the discussion essay pre-test (Mean = 7.816 SD = 1.0869).

In the present study, it was hypothesized that there would be a significant influence of flipped writing training on low proficiency EFL students' writing performance as well as the interaction between the essay types (discussion and process) and the experimental stages (the pre-test and the post-test). It was predicted that the low proficiency EFL students' writing skills would improve if they were taught writing using the flipped classroom approach. In order to test the hypothesis, a 2(stages) x 2(essays) analysis of variance (ANOVA) with an interaction plot was carried out on data. The main effect was significant, $F(1, 150) = 455.733$, $p< 0.000$, and it indicates that the participants' writing performance of both the discussion essay and process essay in the post-test was significantly different from their writing performance in the pre-test. Figure 3 shows the interaction between the stages and the essays in the research.

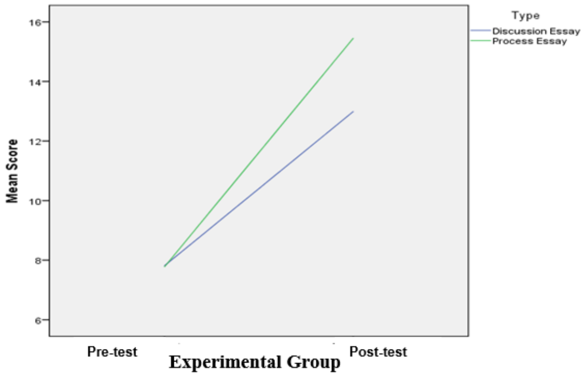

Figure 3: The interaction between discussion essay and process essay in experimental groups

As can be seen in Figure 3, the lines representing the two essays in the experimental groups show an upward trend. It indicates that the participants' writing in both discussion essay and process essays improved significantly after receiving the flipped writing training. As such, the relationship between the flipped writing training and writing performance is confirmed and the hypothesis was fully supported by the results. In other words, the writing performance of Low Proficiency (LP) EFL participants was significantly enhanced when they were provided with the flipped writing training in both types of essays. It is also found that the LP EFL participants improved more in the process essay (post-test) than they did in the discussion essay.

Upon the completion of the flipped writing sessions, an anonymous questionnaire was administered to them to gather information about the participants' perceptions of the flipped learning (see Table 3). The focus of the questionnaire was on the participants' perceptions of the flipped classroom. A 4-point Likert Scale allowed the participants to indicate if each statement was 1-False, 2-Mostly False, 3-Mostly true and 4-True.

Table 3: Students' perceptions of the flipped classroom learning

Students' Perceptions of the Flipped Classroom					
Item No.	Statements	False	Mostly False	Mostly True	True
1.	I have a positive attitude towards flipped classroom	2	0	18	18
		5.26%		94.74%	
2.	I feel more alone when watching the video	12	14	6	6
		68.42%		31.58%	
3.	I feel an increased workload that is stressful	14	11	7	6
		65.79%		34.21%	
4.	I experience strong peer-collaboration	6	4	7	21
		26.32%		73.68%	
5.	It feels like a distance course	14	14	3	7
		73.68%		26.32%	
6.	I appreciate learning from the video	2	1	16	19
		7.89%		92.11%	
7.	I am more motivated to learn writing in the flipped classroom	1	4	17	16
		13.16%		86.84%	
8.	I am satisfied with flipped classroom learning	1	1	20	16
		5.26%		94.74%	
9.	I feel that I have made good progress in learning writing in a flipped classroom	2	2	22	12
		10.53%		89.47%	
10.	I do not benefit from the flipped classroom	10	27	0	1
		97.37%		2.63%	

In response to the general perception of flipped classroom, most participants had strong positive opinions in relation to 6 statements which were Item 1, Item 6, Item 7, Item 8, Item 9 and Item 10 respectively. Thirty-six out of thirty-eight participants had "a positive attitude towards flipped classroom" (Item 1), were "satisfied with flipped classroom learning" (Item 8) and "appreciate learning from the video" (Item 6). Out of 38 participants, 34 of them felt that they "have made good progress in learning writing in a flipped classroom" (Item 9) and that 33 of them were "more motivated to learn writing in the flipped classroom" (Item 7). Thirty-seven of the students disagreed that they "do not benefit from the flipped classroom". While a majority of the participants also disagreed that they were "more alone" (Item 2) or that felt "an increased workload that is stressful" (Item 3), only a minority of them felt stressed due to the increase workload (34% in Item 3) and "more alone when watching the video (32% in Item 2).

Discussion

Based on the feedback from lower proficiency EFL students and their writing results collected before and after the experiment, it is evident that they responded positively to the flipped writing classroom approach. The overwhelming positive feedback points to the advantages and success of the flipped elements in the writing approach. Not only does the flipped writing classroom approach empower lower proficiency EFL learners, but also does it increase their confidence, contributing to a lowered cognitive load for the learners and potentially increasing their learning and performance. Thus, the results of this study are in line with previous findings. Farah (2014) examined the impact of using a Flipped Classroom Instructional Method on the writing performance of the twelfth grade Emirati female students and found that there were significant differences in the participants' writing performance. Leis, Cooke, and Tohei (2015) studied 22 students in an EFL environment and confirmed the results that using a flipped method in an English composition class was more effective in increasing the students' proficiency than in a traditional classroom. The same reasons for the successful learning of writing in an EFL environment were shared by Bouchefra (2017) whose study involved 54 students in an experimental group and found that the introduction of the Flipped Classroom approach helped the EFL students grasp the writing structure and concepts better. The findings in the present study also supports the previous studies on the effect of flipped writing classrooms on the EFL learners' writing proficiency (Afrilyasanti, Cahyono, & Astuti, 2016; Ahmed, 2016; Ekmekci, 2017; Soltanpour & Valizadeh, 2018).

The flipped writing approach used in this study allowed lower proficiency EFL learners to experience greater flexibility and greater autonomy over their own learning. Learner autonomy should be an essential goal for all learning as it resulted in an exceptional level of motivation (Cotterall, 2000). When students, especially lower proficiency learners, have a sense of ownership and the ability to take charge of their own learning, they will be driven by the motivation and power to improve their writing performance. There were increased opportunities for the students to prepare prior to coming to the classroom. Besides, they had more processing time between lessons to comprehend the learning materials, more interaction with the classmates and received more immediate feedback from the instructor so that they could complete the learning tasks with greater understanding in class. The classroom was the place where instructor could interact with students, scaffold their learning and give them more practice, enhance their critical thinking and engage in deep discussions with them. It was no longer a place of initial exchange of information but a place where learners, especially lower proficiency learners with limited understanding of the language, can explore new concepts and ideas beyond the superficial introductory of learning materials. Students can exercise more control over the depth, the direction and speed of their learning, which subsequently boost their self-confidence that is one of the most important elements for success in learning. Another advantage of the flipped writing classroom approach is that it is relevant to the contemporary students' learning needs and practices. Learners today are believed to be "Digital Natives" who expect fast-paced learning environment with shorter traditional instruction time in the classroom. Therefore, teachers or instructors ought to re-invent their teaching strategies and use technology creatively and effectively in enhancing their learning (Huang & Hong, 2016; Logan, 2015; Roehl, Reddy, & Shannon, 2013). Therefore, the hypothesis that flipped writing training could positively influenced writing performance of the EFL low proficiency was fully supported.

Although the majority of the participants were positive about the flipped writing approach; nevertheless, there were also some challenges associated with the flipped writing approach. One unexpected challenge was technology. Not all participants had a computer at home. Not all millennium learners are tech-savvy. They did not know how to access the videos via their mobile phones even though they all have a mobile phone. Some participants mentioned that they had to share the computer with their family members and it made their preparation before class difficult. To deal with this challenge, the lecturer could give the participants a briefing on how to access the videos via their mobile phones before the training in the future and overcome this limitation. Another challenge was the feeling of learning in isolation. One third of the participants mentioned that they felt more alone going through the lecture videos by themselves outside of the classroom. They also voiced their concerns of increased workload and stress as they had to deal with the materials unguided. They usually had to spend a lot of time trying to understand the content of the videos with their limited language ability. One way to ease their workload and stress is to spread out the training sessions from 2 sessions a week to once a week in the future. Another way is that the instructor could perhaps discuss with the students on how to divide their tasks, study in chunks, and improve their time management and study skills. Flipped writing approach requires both the students and the instructor to take the pedagogical shift, which takes time, before low proficiency students can fully engage in.

Other challenges were in-class related. More than half of the learners were shy in expressing their views and participating in a group discussion. Apart from having the language barrier, they were culturally different. Students from the Asian countries tended to be more passive and were afraid to make mistakes. They might also lack the vocabulary and knowledge in a particular writing topic. In view of this, the instructor could make the learning environment more relaxed and non-threatening and use various ways or strategies to get the students to speak up and express their own thoughts.

Conclusion

The study has confirmed that flipped writing approach is beneficial to low proficiency learners in improving their writing skills. Students have shown better writing performance due to the increased scaffolding, motivation and autonomy in their learning. The flipped writing approach enhances not only their learning and performance, but also the overall learning experience. Running a control group in the next phrase of the study will give us a deeper insight into how much these learners have actually progressed in comparison with learners who have not been given the flipped elements in the writing programme.

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Data Analytics for Student Profiling and Academic Counselling

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Data analytics can be used by universities and schools to have a deeper understanding of student and learning data. By leveraging on data analytics and dashboards, universities and schools can become more proactive in profiling students and anticipating their needs, personalizing approaches to supporting students in academic distress and optimizing the allocation of university's resources to efficiently and effectively counsel these students. In this paper, we outline the analytics framework that can be used on student data to derive insights, to readily observe and predict the students' academic progression and performance, to characterise the academic risk of the student, and to identify the at-risk students at an early stage. With the early alert system in place, these students can then be counselled and rendered student support to be lifted out of the at-risk zone.

Keywords: data analytics, dashboards, profiling, prediction, early alert, student support

Introduction

Data analytics is shaking up every sector in the world by harnessing and extracting meaningful insights from data (Henebery, 2019). Every time students interact with the university, they leave a digital footprint. This footprint, together with the student's background supplied during admission, is valuable data that can be effectively used for modelling/predicting student behaviour performance (Lester et al., 2017). Learning has become challenging in this current day environment filled with distractions (Garrison, 2010). It becomes even more challenging in the case where the students are working adults pursuing their learning and juggling their work and family commitments (Smith, 2017). Some of these students could potentially be at risk of discontinuing their learning or under-performing academically, thereby leading to increased attrition rates. Timely intervention and counselling provide an effective learning system, which could possibly help in reducing the attrition rate (Payne, 1973). An effective dashboard with data visualisation and analytics is helpful in quickly identifying the at-risk students and the reasons for their risk levels (Klerkx et al., 2017). Furthermore, these dashboards would provide simple interface to the end-users, viz., the academic counsellors and faculty, to use and reach out to the at-risk students. This way, the limited resources, such as funding, faculty time and students' time could be effectively utilised to transform the at-risk students and provide them with a conducive learning system (Beach, 2013).

Background Information

The School of Science and Technology (SST) is one of the five schools in the Singapore University of Social Sciences (SUSS). Currently, the School admits only part-time students in two admission exercises each year, one in January and the other in July. The majority of applicants are diploma holders from local[2] polytechnics and the rest are from junior colleges, statutory board academies and private education service providers. SUSS does not impose a strict Cumulative Grade Point Average (CGPA) cut-off unlike some of the other local autonomous universities. Most of SUSS's students are adult-learners and have to juggle many commitments at any one time (e.g. family, work and study). Thus, the attrition rate of students is significantly high. The objective of this project is to implement student intervention in a timely manner to enhance student experience and to improve students' chances of completing their studies. This has to be a concerted effort from a number of departments in the university, such as the Teaching and Learning Centre (TLC), Business Intelligence & Analytics (BI&A) department and the School.

[2] "Local" in this paper refers to Singapore.

Unique and Salient Features of SUSS and SST

The mandate of SUSS and SST is to provide high-quality life-long learning opportunities, adhering to the University and School's mission "to provide lifelong education, equipping learners to serve society". One of the admission criteria is that the applicants are required to have either a full-time job or at least two years of working experience. SST offers nine undergraduate programmes that are organised in three clusters, namely the Engineering, Built Environment and Information and Communication Technology (ICT) clusters. These programmes are:

- Engineering cluster: Aerospace, Biomedical and Electronics engineering programmes
- Built Environment cluster: Building and Project Management, Facilities and Events Management, and Human Factors
- ICT cluster: Mathematics, ICT and Digital Media

In addition, the School offers a Master by Research and an Industrial PhD programme. This project will focus on only the part-time undergraduate degree programmes.

In order to graduate, a student has to attain a minimum CGPA of 2.0 (out of 5.0) upon completion of the credit units (CUs) required for graduation, which are 130 CUs and 170 CUs for a basic degree and honours degree, respectively. When a student's CGPA drops below 2.0 for the first time, the student will receive an Academic Warning notification. If subsequently the student still scores CGPA below 2.0, then the student is given an Academic Termination and removed from the programme. In SST, the at-risk students were identified as the students with CGPA below 2.3. The identified at-risk students were given academic counselling by the Head of Programme (HOP)[3] through emails, phone calls and/or face-to-face meetings. Through interviews with more than 200 of these at-risk students, it emerged that their weak academic performance was due to poor time management and lack of administrative awareness, viz., academic progression, course requirements, available options, etc. These at-risk students were generally in the first three semesters of study and they contribute significantly to the attrition rate.

Peer tutoring has been shown to reduce the student attrition rate (Bryer, 2012). To further assist these at-risk students, SST set up a peer mentoring support network in 2018. This network was designed to help new students settle into university life. Senior students or recent graduates take the role of peer mentors and are matched with freshmen from their undergraduate programme for the first semester. The mentors provide signposting and provide survival tips to the freshmen. SST also has a peer tutoring scheme where academically strong seniors provide additional academic support to students in selected courses.

The current interventions are either pre-emptive, where peer mentors provide skills/information to guide the freshmen, or retroactive where students receive academic counselling after failing to attain the minimum CGPA. There are students who are not freshmen nor at-risk, but whose deteriorating CGPA may result in a lower class of Honours classification for them. These students are outside the current intervention radar and hence do not receive any academic counselling or support unless they are proactive in seeking help. This project studies the feasibility of using an early alert system to detect at-risk students across the entire CGPA range from 0 to 5.0, so that timely intervention and support could be rendered.

Business Intelligence & Analytics (BI&A)

The Business Intelligence & Analytics (BI&A) department was set up to provide information for data-driven and evidence-based decision making and planning in SUSS. This covers not only the digital warehousing of critical data, but also the twin functions of reporting and analytics, and these are achieved through training and project collaborations.

Teaching and Learning Centre (TLC)

The Teaching and Learning Centre (TLC) aims to promote excellence in teaching, supports the learning needs of students, and strengthens ties among faculty to foster a vibrant academic community. This study focused on the two student-facing functions of the centre, namely: meeting the learning needs of students through a range of

[3] HOP is the full-time academic faculty who oversees the undergraduate degree programme.

support measures such as resources of study skills and workshops and to share teaching tools, good practices and guidelines, and building a repository of teaching and learning resources.

Predictive Modelling for Academic Performance

In order to generate early alert signals for students who may potentially under-perform academically, the predictive model uses Semester Grade Point Average (SGPA) as the target and predicts how a student is projected to academically fare in each semester. Input variables used for prediction include students' demographics, work background, prior education and their academic performance in SUSS. Academic data is updated at the start of each semester while the other student's particulars were mostly collected upon admission to the university. Derived variables were computed using the collected variables to provide insights on students' learning pattern in and across semesters.

Table 1: Input variables for the model and dashboard

Demographic & Work Background (12)	*Collected*	Age at year of intake Residency status Gender Marital status Race Present employment status Industry Current designation level Gross annual salary Company sponsorship status Applicability of degree to work environment Relevant industry experience
Prior Education (8)	*Collected*	Ordinary level (O-level) English grade O-level Mathematics grade Final education category based on qualification Final education awarding institution Final education study mode Degree/polytechnic CGPA
	Derived	Whether Diploma is relevant Years since last study
SUSS Academic (17)	*Collected*	Discipline CUs exempted Restart status Transfer-of-Programme (TOP) status Minimum CUs required Previous semester's CGPA
	Derived	Years into degree Deferment status Ratio of CUs taken to Min CUs (indicates level of programme completion) Ratio of CUs withdrawn to CUs taken (relative proportion of courses withdrawn) Ratio of CUs taken for university core courses (UCOR) to CUs taken (relative proportion of UCOR courses taken) Ratio of no. of exam (EQP) courses taken to total no. of courses taken (relative proportion of courses with exam component) Total CUs withdrawn Total CUs completed Total CUs taken for UCOR Total no. of EQP courses taken No. of active semesters

A total of 37 variables, as listed in Table 1, were used as inputs to the models. The model selection mechanism is such that the model with the best prediction performance is retained and the rest are sieved out. To minimise over-fitting and to ensure that the model is generalizable, this study used the Construction, Validation & Testing (CVT) method for model building and selection. In this method, a construction dataset is used for model training and testing dataset is used for model testing. The final model selected is then applied onto a deployment dataset for scoring.

Since the past semester's data is used for model construction which will then be deployed on the current data, it is necessary to test if the model is stable over time. Therefore, in this study the recent one semester data is used as the testing dataset. If the model performance is consistent for both the construction and testing dataset, it indicates that data is relatively homogenous at different points-in-time and that the model built with historical data is applicable on current and future data. The five-step CVT procedure is as follows:

1. Conduct five-fold cross-validation using the construction dataset
2. Use the full construction dataset to construct a model and test it on the full testing dataset
3. Repeat steps (1) and (2) for various different models
4. Select the model with highest R^2 and lowest Mean Absolute Error (MAE) as the best model
5. Apply the selected model on the deployment dataset to obtain prediction scores

In this method, step (1) validates the model performance in a robust way while step (2) tests the out-of-sample performance of the model on unseen data. Ideally, a good model should be stable in its performance for both the validation and testing steps.

The procedure was applied on various models such as Linear Regression, k Nearest Neighbour (kNN), Neural Network and Decision Tree. The model that produced the best and also consistent results was considered as the optimal model for deployment. Scoring will be done using the new data in the up-coming semester to predict students' SGPA and compare it with the actual SGPA of the latest semester.

These predictions will be integrated and deployed into the Dashboard for Predictive Modelling of Student's Academic Performance, acting as additional information and providing early signs of potentially under-performing students so that targeted support can be provided.

Dashboard Construction

There are three overlapping dashboards created for the School, namely: Application Data (Figure 1), Student Profile (Figure 2) and Predictive Modelling of Student's Academic Performance (Figure 3). In addition, the dashboard consists of three layers of information; each successive layer allows the user to "zoom in" for additional details, views and perspectives. This is rather similar to how Eckerson (2010) categorised them – bottom layer as detailed reporting view (individual students), middle layer as multidimensional view (where one can explore or "slice and dice" the data) and top layer as summarised using a graphical view. The data are extracted from the data warehouse, which collects SUSS data, sourced from applications such as the University's Student Information Management System (SIMS) that allows users to generate information and insights for decision making. The data warehouse is currently developed to house the complete SUSS student data. It will also provide point-in-time snapshots to support users in their data needs.

The first two dashboards are built from factual data, in which the Dashboard for Students' Application Data provides an overview on all applicants of the School, their demographics and awarding institution, and the Student Profile Dashboard presents background information of admitted students, giving the School a comprehensive view of the current student population. On the other hand, the Dashboard for Predictive Modelling contains both factual and prediction data, allowing for extrapolation of students' future performance. These can be used together with students' historical performance data to understand association between past and future performance so as to design customised coaching.

Dashboard for Students' Application Data

Most student applicants are from the five local polytechnics. The secondary pipeline is junior colleges. Finally, there is a small group of applicants from statutory board academies and private education providers. The dashboard will enable the School and HOPs to visualise the number of applicants, places offered and actual enrolment of students, demographics of the applicants, prior education, programme they have applied, funding status etc. For instance, from the charts/graphs in the dashboard, the Dean and HOPs can determine if there is a healthy ratio of application-to-offer and offer-to-enrolment student numbers.

Figure 1: Dashboard on Student Application Data

Table 2 lists a few observations obtained from the dashboard and actions proposed or taken to address these issues.

Table 2: Observations from the Application Dashboard and Actions Taken

Observations from the dashboard w.r.t. Applicants' Data	Actions proposed/taken to address the issues w.r.t. Applicants' Data
Gender imbalance – there are significantly more male than female applicants	To market the programmes with female student ambassadors to overturn the impression that the Science, Technology, Engineering and Mathematic (STEM) industries are dangerous, dirty, demanding and dominated by men, to one that is professional, progressive and productive that women can have an important role to play
Age profile of applicants	Targeted marketing efforts focusing on Generation Y, Generation Z and the millennials through social media since they are more IT-savvy
Education background and awarding institutions	The School can collaborate with Institutes of Higher Learning (IHLs) that are major pipelines to the Schools' programme, in articulation pathways such as Through-train and Earn-and-Learn programmes

Student Profile Dashboard

The Student Profile Dashboard presents a big picture of all students in SST. Consolidated information of all students including those who have graduated, terminated and withdrawn from their programmes provide a holistic view of all past and present students, allowing the dashboard user to have an overview of the students' demographics and prior education and employment status. This dashboard also charts the students' academic progression, i.e., each students' CGPA in the latest semester.

From the dashboard in Figure 2, it can be observed, for instance, that there are 2,777 active students in the School across the nine disciplines/programmes. The dashboard allows the Dean and HOPs to monitor the number of admissions into each of the programmes, as well as to filter and focus on specific groups of students such as Continuous Education and Training (CET) students, Transfer of Programme (TOP) students, Restart students, and students within a certain CGPA range. With lifelong learning and CET becoming more commonplace, the School has to cater to demand-driven education and braiding workplace and in-class learning to scaffold and impart sector/profession specific, generic and transferable skillsets that matter (Deegan and Martin, 2018). Table 3 lists the observations and actions taken by observing the student profile dashboard.

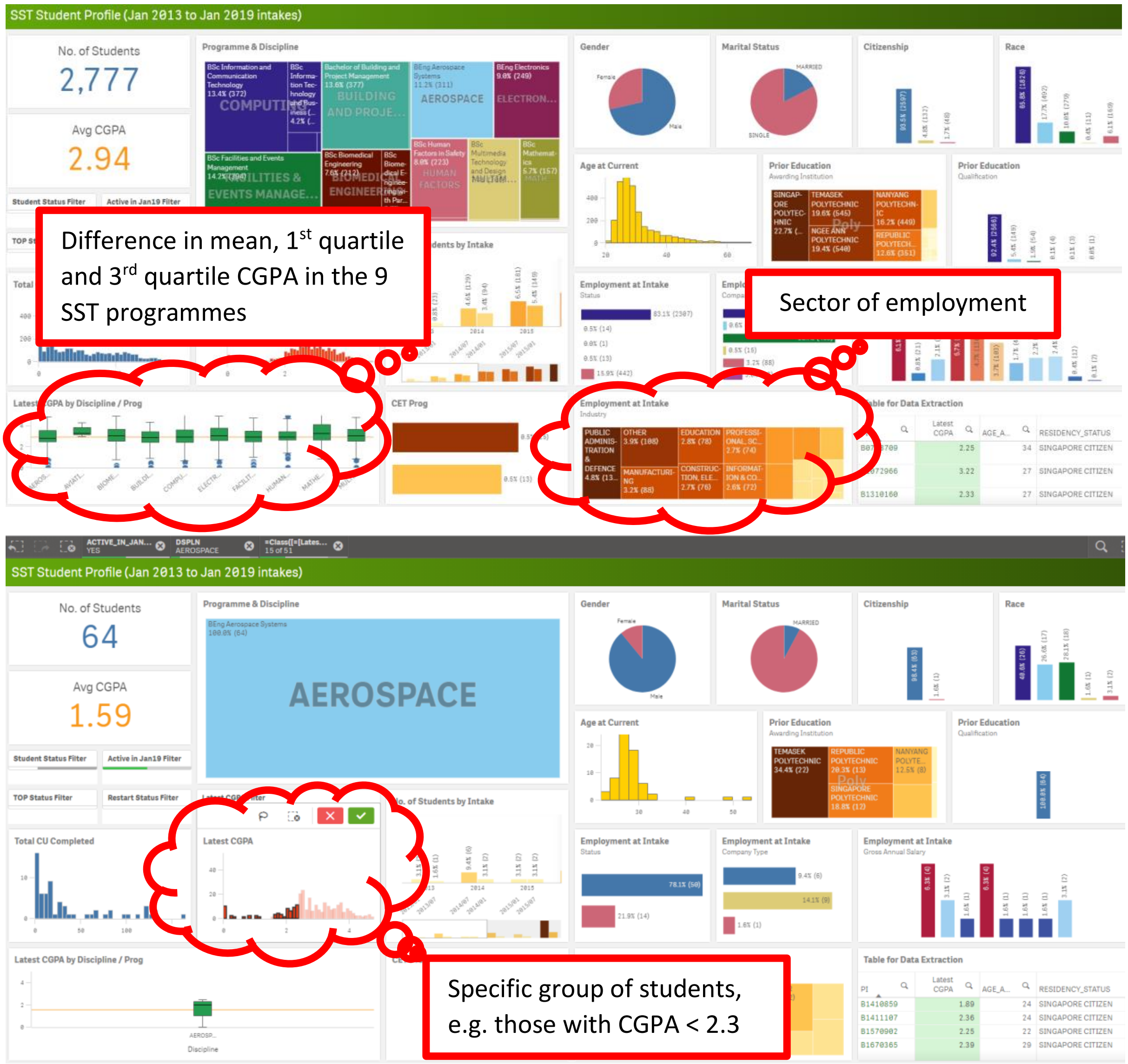

Figure 2: Dashboard on Student Profile

Table 3: Observations from the Student Profile Dashboard and Actions Taken

Observations from the dashboard w.r.t. Student Profile	Actions proposed/taken to address the issues w.r.t. Student Profile
Some programmes have a mean, 1st quartile and 3rd quartile CGPA that are significantly/comparatively higher than the other programmes	To review if the courses and assessments are lenient compared to other programmes.
The major sectors of employment can be identified at the school and programme levels	Outreach and marketing efforts can be more targeted; Training can be customized to integrate in-demand industry skills
Specific groups of students, for instance CET students, TOP students, Restart students, or students with a specific range of CGPA can be identified	These students can be identified and tracked for their academic performance, and intervention measures can be implemented

Dashboard for Predictive Modelling of Student's Academic Performance

For the model results to be readily usable by faculty members and staff, the results/predictions are integrated into the dashboard to provide early alert signals for potentially at-risk students. Charts and visualisations are able to compare students' predicted score against their actual latest CGPA/SGPA, and categorise such predicted change in CGPA/SGPA by whether there will be an improvement, deterioration or relatively constant trend (Figure 3).

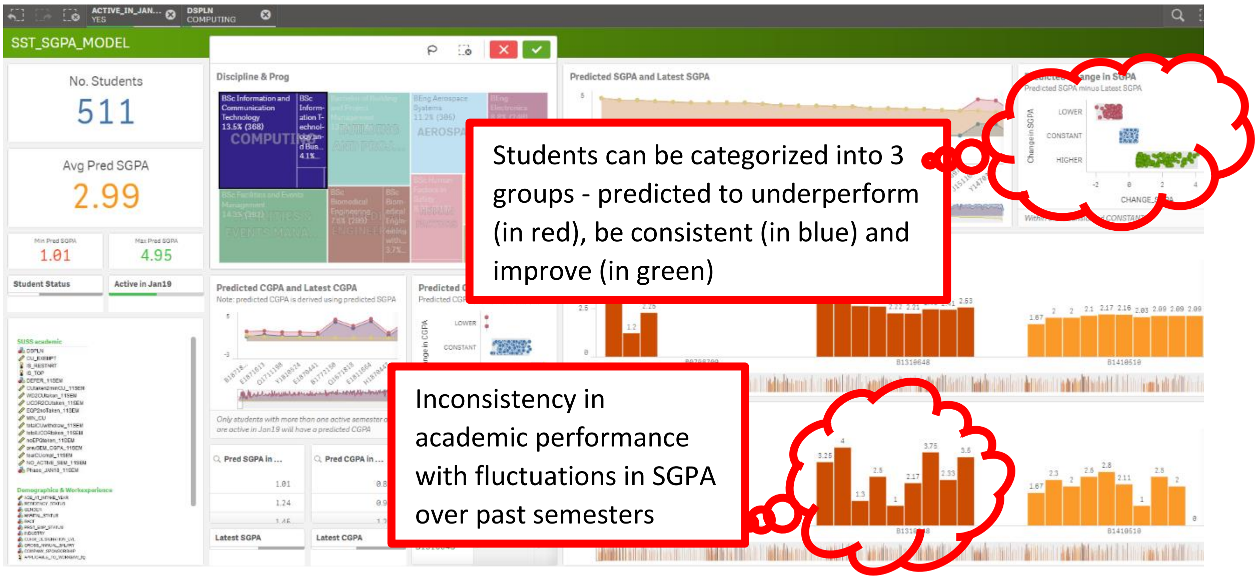

Figure 3: Dashboard on Predictive Modelling of Student's Academic Performance

Depending on the cases, customised advisory or encouragement notes can be sent to the respective students. To relate academic performance to learning pattern, the dashboard also displays students' historical grades, course withdrawal and failure information to provide insights on the potential factors or reasons for the predicted academic under-performance.

Comparison of predicted score across groups such as restart students versus non-restart students, or across different disciplines and programmes is able to provide a bigger picture on how these factors are related to academic performance (Figure 4). The filters allow the dashboard users to zoom in to a selected subgroup of the student population, for example, students who are at the verge of getting Academic Warning or those who are close to getting a First Class Honours degree award.

Figure 4: Dashboard on Relating Factors to Student's Academic Performance

By integrating the predicted SGPA into a dashboard, it translates raw data into visually appealing and easily accessible forms of graphical representations, allowing faculty members to generalise insights for timely and targeted support and early intervention. Compared to a static report or data file, the dashboard's dynamic and interactive features allow users to focus on a particular group of students, study their profile, historical academic performance and understand what could possibly contribute to their under-performance. By focusing on a subset of the data, customised support plan can be designed to address the specific case more effectively.

These the predictive modelling dashboard and Table 4 lists the observations from this dashboard and the corresponding actions proposed/taken.

Table 4: Observations from the Predictive Dashboard and Actions Taken

Observations from the dashboard w.r.t. Predictive Modelling	Actions proposed/taken to address the issues w.r.t. Predictive Modelling
Students with poorer English and Mathematics grades from their O-levels are more likely to fare badly in their degree studies	To partner with TLC to offer bridging and supplementary courses. On top of that, the School has initiated a student buddy and student mentor scheme. These initiatives will hopefully, get these students up to speed
To identify students who have recently dropped out, or are projected to drop out of a particular degree classification	To send advisory/encouragement notes to offer the students a friendly nudge, and to recommend them to attend courses customised by TLC
To identify students with inconsistent academic performance	To send advisory/encouragement notes to offer the students a friendly nudge, and to recommend them to attend courses customised by TLC

Conclusion

There are many benefits to having the dashboards, which enable users to access, interact and analyse up-to-date information to facilitate data-driven planning and timely decision-making. Anecdotal feedback/evidence has shown that students who have received counselling or participated in peer mentoring schemes have benefitted in terms of performing better in their studies and reporting a higher satisfaction level during their candidature. In addition, a better understanding of the students' in terms of their academic background, learning needs and learning preferences can aid the School to customise learning, enabling more students to succeed (Christensen et al., 2010).

Nonetheless, the dashboard is not without its limitations due to a multitude of factors, such as old data, non-reliability of data, over-fitting etc. One approach to circumvent these issues is to establish data governance structures, and to ensure data stewardship and cross-institutional agreement on data definitions (Wolf et al., 2016). Moreover, researchers have cautioned that dashboards and automated messages can be a double-edged sword and backfire to detrimentally affect students' mental health and stress levels, in addition to altering their behaviour in the wrong way (Straumsheim, 2017).

In fact, dashboards can convey snapshots of important measures, but they are poor at providing the nuance and context that effective data-driven decision making demands. Shapiro (2017) coined these drawbacks the importance trap, context trap and causality trap. We have to be cognizant that every dashboard, particularly for predictive modelling, is built on a set of priorities and assumptions about what is important, and it is essential that it is customised to the School's needs and with a nuanced and contextual understanding of the School and its environment. The fallacy of analytics is that it is often misconstrued as representing some sort of unbiased and dispassionate truth. To avoid equating "empirical" and "quantitative" with "objective", the user has to exercise judgement and discretion to reconcile and validate the information and interpretation from the dashboard.

The role of the Dean, HOPs or any programme administrator is unique and daunting in many ways. A well-designed dashboard will support the Dean and HOPs to draw on and understand information from a plurality of systems and processes (Wolf et al., 2016).

The School is unable to provide statistical data at this nascent stage of the project because it has been in a state of flux, converting from a private to public, autonomous university, and in the midst of doing so, intentionally heightening the academic standards of the programmes. In this case, the historical data will not suffice. Moving forward, and with the School and programmes at steady state, this can be tracked and studied in depth.

Last but not least, BI&A will be improving and refining the entire framework of learning analytics with more aspects of student data in order to enhance the reliability and precision of the predictive modeling for students' academic performance. By incorporating users' feedback and intervention that has been deployed to help students, the performance of such a student support system can also be tracked, evaluated and improved.

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Feeling supported: Enabling students in diverse cohorts through personalised, data-informed feedback

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Students entering enabling programs as an alternative pathway to University tend to have higher rates of attrition than their peers admitted via more traditional pathways. Students in enabling programs require high levels of personalised feedback to support their transition to study. However, the size and diversity of the enabling student cohort presents formidable challenges for instructors. The field of learning analytics offers a viable solution for scaling the communication of personalised, data-informed feedback to support student learning. This study describes the use of a novel learning analytics-based feedback system called *OnTask,* to provide personalised feedback and support to students in an enabling course at one Australian higher education institution. An end-of-course student survey (N=41; 17% response rate) was employed to gain insights into their perceptions of personalised, data-informed feedback messages. Using importance-performance analysis (IPA), the survey results indicated that this technology-mediated form of feedback exceeded students' expectations of learning support, as well as the enhancement of their overall course experience. The implications for using learning analytics and data-informed feedback mechanisms in teaching and learning are discussed.

Keywords: higher education, learning analytics, personalised feedback, diverse cohorts

Introduction

In response to the Australian government's push to widen access to university education, many universities have opened up alternative entry or pathway courses into degree programs. These pre-university enabling programs are designed to support students who cannot enter university due to inability to meet the academic program pre-requisites. Compared to students in undergraduate courses, students in enabling programs are more likely to come from low SES backgrounds, have a more diverse range of ages (20 to mid-seventies), have more limited educational experiences, low to very low levels of educational attainment and academic skills (Hodges et al., 2013). Accordingly, these students require high levels of support in order to help them navigate a rigorous academic environment to prepare them for study in their future degree program. Although outcomes have been found to be mostly beneficial for students with regard to university acclimation, reports have also pointed to low levels of engagement and high levels of attrition in these programs. This is due in part, to a range of challenges faced by students, such as poor study skills, a feeling of lack of belonging in the university community, and time pressures - especially for mature-age students who are juggling study, work, and family.

These challenges are not isolated to students engaging in enabling programs – however they are often more acute. Personalised support and guidance is essential to promote engagement and success (Hellmundt & Baker, 2017; Lane & Sharp, 2014). However, large class sizes and diverse cohorts make it challenging for instructors to provide personalised support to all students. A promising solution to this challenge lies in the field of learning analytics (Pardo, Poquet, Martinez-Maldonado, & Dawson, 2017). This study examines the impact of data- informed feedback through the use of learning analytics, to support students in enabling programs.

Background

Enabling programs –supporting diverse students to develop skills for learning at university

Pre-university enabling programs are foundational programs that allow students who otherwise would not have been admitted into university gain entry into university. The programs aim to equip students with the academic skills to succeed in future undergraduate studies (Klinger & Murray, 2011). Students in these courses include many first-in-family applicants with little knowledge about the experience and expectations of university (Habel, Whitman, & Stokes, 2016). Given the target enrolment, enabling programs share the same goal of helping students to develop key skills for learning at university, by immersing them in the culture of higher level learning, and developing language proficiency as well as critical thinking, research and study skills (Agosti & Bernat, 2018). While the outcomes of enabling programs have been promising (Cullity, 2006; Habel et al., 2016; Klinger & Murray, 2011; Lisciandro & Gibbs, 2016), many students fail to meet the standards and level of academic engagement required resulting in high attrition rates (Hodges et al., 2013). Tinto (2006) has discussed the challenges for first year students adapting to a new and demanding academic culture. These challenges are further exacerbated for those entering through alternative pathways, due to additional hurdles presented by language and cultural barriers, the juggling of family and work commitments, being first in family to attend university, all of which can result in heightened anxiety (Stokes, 2018).

Lane & Sharp (2014) argue that a key contributor to students' engagement and retention in enabling courses, is the quality of the student experience. In particular, an important part of the experience is the perception of instructor guidance and support (Hellmundt & Baker, 2017; Lane & Sharp, 2014). Stokes (2018) recommends the inclusion of a "supportive and informed enabling pedagogy" that "will assist students to gain knowledge, skills and confidence, and establish study practices for lifelong learning" (p.240). Ultimately, while universities may not have control over the student factors such as those described earlier, they do have control over the quality of instruction and support models.

Using learning analytics to scale up personalised feedback and support

Feedback and communication are important aspects in supporting students. Despite changes in the educational landscape over the last two decades, feedback remains a crucial factor for improving student learning (Harks, Rakoczy, Hattie, Besser, & Klieme, 2014; Hattie & Timperley, 2007; Hounsell, 2003). We define feedback as "a process in which learners make sense of comments about the quality of their work in order to inform the development of future performance or learning strategies" (Carless, 2018, p.2). This definition reflects the shift in an understanding of 'feedback as product', to 'feedback as process' (Boud & Molloy, 2013; Carless & Boud, 2018), and highlights the importance of student engagement with feedback in order to close the feedback loop. Students need feedback, not only on their performance (outcome feedback), but also on their learning process (process feedback) and where to direct their future efforts (Hattie & Timperley, 2007). Feedback influences self-regulated learning by making students more aware of how they are learning (i.e., monitoring), whether they are on the right track, and helping them to know how to adjust their learning strategies to reach learning goals, thereby leading to enhanced achievement (Butler & Winne, 1995). Developing self-regulated learning through feedback and support is an essential process for students entering enabling programs with limited knowledge about how to learn in an environment that demands greater independence in learning. Feedback also heavily influences the quality of student experience and learning progress (Robinson, Pope, & Holyoak, 2013; Weaver, 2006).

The provision and quality of feedback is impacted as the cohort size and diversity increases (Pardo, Poquet, et al., 2017). A possible solution to this challenge lies in the field of learning analytics. Learning analytics is defined as "the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs" (Siemens, 2013). With the broader use of learning technologies and growing awareness of how such technology mediated learning data can be used to bring new insights, it is possible to personalise feedback to students based on their learning data. Learning analytics can be used to automate the collection and analysis of student engagement data and transform these data into useful metrics that can be fed back in a personalised way to all students, either through visual dashboards, recommender systems, or personal emails from instructors or course coordinators (see Bodily & Verbert, 2017 for a review). These forms of feedback are considered personalised insofar as they are derived from an individual student's data, and facilitated at scale. For enabling students, such methods may serve as an external feedback loop to support their own monitoring of learning (Winne & Hadwin, 1998), facilitating an evaluative process about whether an adjustment of learning operations is needed. These learning operations could be learning tasks, specific learning strategies, or attendance at face-to-face sessions. Using feedback based on their own learning data, students who have been up-to-date with their assessments, consistent with tutorial attendance, or performing well on interim assessments would be informed about specific areas where they have done well, thereby boosting confidence and motivation for subsequent learning efforts. However, students who have fallen behind on assessments or attendance would receive data-informed feedback on where engagement could be improved, as well as specific recommendations for further action. The level of specificity is critical, so that students know how to act upon their feedback, thereby completing the feedback loop - this is key to feedback effectiveness (Jonsson & Panadero, 2018; Winstone, Nash, Parker, & Rowntree, 2017). Although student-facing learning analytics dashboards (LADs) have gained prominence as an approach to personalised, data-informed feedback, these highly visual systems have come under criticism (see reviews by Jivet, Scheffel, Drachsler, & Specht, 2018; Matcha, Ahmad Uzir, Gasevic, & Pardo, 2019). Ultimately, much research has pointed to LADs as falling short of the principles of effective feedback, namely, that feedback should be: specific or actionable; timely; clarifies expectations of performance; and conveyed in a supportive tone to foster positive motivational beliefs and self-esteem (Nicol & Macfarlane-Dick, 2006; Price, Handley, Millar, & O'Donovan, 2010; Shute, 2008). Essentially, effective feedback is sustainable, carried out in a regular cyclical process that encourages independent learning by developing students' self-regulatory skills in the longer term (Boud & Molloy, 2013; Carless, 2018), which LADs have thus far been unable to afford.

Recent developments in student-facing feedback systems have seen the emergence of more contextualised feedback informed by analytics – two of these systems which have received attention in the literature are the Student Relationship Engagement System, SRES (Liu, Bartimote-Aufflick, Pardo, & Bridgeman, 2017) and OnTask (Pardo et al., 2018). These systems differ from LADs in that students' learning data is further augmented by personal messages by the instructor to enhance the actionable takeaways of the feedback. As the collection of learner data is automated, and feedback is pushed to students' inboxes, a regular feedback process is facilitated, whereby students can receive timely feedback regarding their ongoing progress, act on the recommendations of the feedback to improve their engagement, and begin another cycle of the feedback process, ultimately optimising their engagement. In this sense, instructor-augmented, personalised feedback to students based on learning analytics may be better able to provide the kind of support to help students engage optimally in the specific learning context. Thus far, evaluations of the deployment of these systems have been positive – with qualitative student comments pointing to students' enhanced motivation and better knowledge of course expectations (Arthars et al., 2019), and quantitative results showing effectiveness in helping students to adapt their learning strategies (Lim et al., 2019), improving students' satisfaction with feedback, and enhancing academic performance (Pardo, Jovanović, Gašević, & Dawson, 2017).

The development of personalised feedback to students based on the automated collection of learner data is a significant innovation for education, positioning "one of the most influential aspects in the quality of the student learning experience, feedback, within the current research space of the EDM [educational data mining] and LA [learning analytics] communities" (Pardo, Poquet, et al., 2017). However, what is less known about this approach to feedback, is the extent to which students actually engage with it, as well as how well this approach meets students' expectations of feedback.

Aim and research questions

The present study aims to investigate the student perspective of personalised, data-informed feedback using OnTask. In particular, we use Importance-Performance Analysis, IPA (Martilla & James, 1977) to understand the strengths and weaknesses of this approach to feedback in the context of an enabling course. The study was guided by the following research questions:
RQ1. To what extent do students read their personalised, data-informed feedback?
RQ2. What are students' perceptions of the importance and performance with respect to the attributes of their personalised, data-informed feedback?
RQ3. How might students' action on their personalised, data-informed feedback be related to their perceptions of usefulness and impact on subsequent motivation?

Methodology

Context

This pilot study was carried out in an enabling course at an Australian University. Students seeking alternative entry into the University's degree programs are required to complete the 13-week course. In 2018, OnTask was piloted in the mid-year iteration (235 students) to then roll-out to the larger (600+ students) cohort in subsequent years. This system was implemented to support students to transition with their studies in their first semester as a university student. The course introduces students to the context of tertiary learning and develops a range of academic reading, writing and key research skills as the basis for future study. The course includes information on: organisation of resources and time, note-taking, student university systems (including course sites and discussion boards), and exposes students to university policies, services, teacher-student communication and career guidance. The course was conducted in blended format, with a weekly lecture (1 hour) and tutorial (2 hours). Students were expected to prepare for weekly tutorials by doing weekly readings which were available in the course site. An important aspect of the course design involved explicit scaffolding of students through this course so that they may apply the skills and knowledge learnt to future courses. Assessment comprised four summative assignments. To help students perform well in these assignments, they were strongly encouraged to access the relevant assessment information from the course site.

OnTask - personalised, data-informed feedback at scale

OnTask (Pardo et al., 2018) is a learning analytics-based application that facilitates the collation of information about students and their learning from various sources, such as activity data from the learning management system, records of lesson attendance, and course performance. The platform allows instructors to develop "if-then" rules to generate personalised messages to all students in their course, and to deliver these as emails. An important feature of OnTask is that, unlike more generic student-facing reporting systems, instructors can choose the specific rules and metrics to provide more contextualised feedback (Pardo et al., 2018).

OnTask is open-source software (see https://www.ontasklearning.org/tool/). This tool was integrated into the institution's Moodle learning management system (LMS), to create a seamless link with the Moodle course database and store all students' interactions with the LMS. Instructors access the application within their course site and decide on the relevant metrics for feedback to students. A full description of the workings of OnTask can be found on the OnTask website[4]. In the current study the course coordinator used OnTask to support students' out-of-class (online) engagement. Based on previous cohorts, specific trigger points in the course were identified, for which feedback messages could be sent to students to promote engagement with course content and activities. Trigger points included engagement with the course site, assignment submissions, and ongoing assessment performance. Individual student data from these trigger points were used as the basis for creating personalised messages to each student. Over the course of the semester, students received 11 personalised, data-informed feedback messages (referred to as 'check-in's for students) in their student inboxes (see Figure 1).

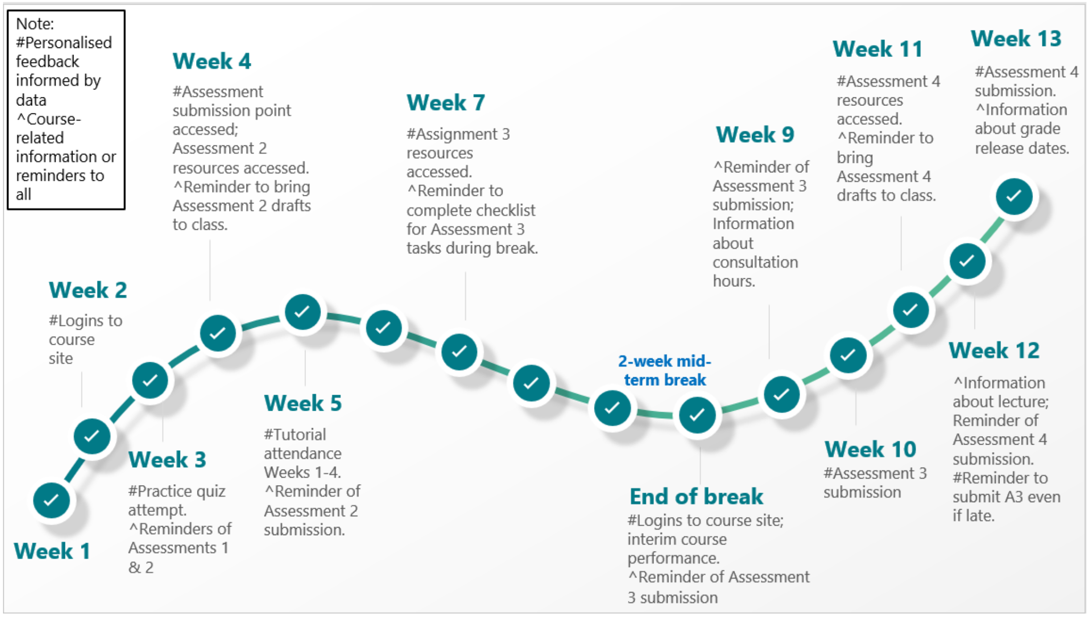

Figure 1. Supporting students with personalised, data-informed feedback via OnTask

Thus, a student who had not accessed Assessment 4 resources would have received this message in Week 11:

> *Hi [Student name],*
>
> *Please be sure to use the helpful resources online for the final A4 essay. There is an Assessment 4 resources folder under the Assessments tab online [URL] that has the important template, student examples and other helpful information in it. A study tip: set some goals or make a plan for how you are going to tackle the final A4 assessment so you are not rushing it at the end. Next week (week 12) also be sure to have drafts of your intro and conclusions ready to show in class! Only two weeks of classes left! Nearly at the end - be sure to keep up attendance for these last two weeks to help you finish strongly.*
>
> *Kind regards, [Instructor]*

[4] https://www.ontasklearning.org/wp-content/uploads/OnTask-Brief-Description-v1.pdf

Data collection

Ethical approval for this study was obtained from the institution's human research ethics committee. A self-report instrument was designed to gather information about students' perceptions of their personalised, data-informed feedback which was received via email. The 21-item survey comprised two parts. The first asked students about their reactions to their feedback emails: how many feedback emails (referred to as "check-in's" by the instructor who sent the emails) they received over the course, and how many they read. Items were included to know the extent to which students acted on their feedback (1 item), the impact on their motivation (1 item), and the helpfulness of the feedback (1 item). The second part of the survey assessed students' perceptions of the importance and performance of the quality attributes of their received feedback, using a 5-point Likert scale (1 = Strongly disagree, 5 = Strongly agree). These items were informed by Nicol and Macfarlane-Dick's (2006) principles of effective feedback for self-regulated learning, such as timing, feeling of support, and helping students to improve their work. Examples of the items are:

> 10a. It is important for me to receive timely feedback about my progress.
> 10b. The feedback emails provided timely feedback about my progress.

The survey was administered in-class at the end of semester. Students were informed that completion of the survey was voluntary. Although the survey asked students to provide their student IDs, this was not mandatory. A total of 41 usable surveys were returned, yielding a 17% response rate. Of these, 34 respondents provided their student IDs which were able to be matched with demographic, program, and course performance data.

Data analysis

Data were analysed using IBM Statistics SPSS 25. To answer RQ 1, simple frequency analysis was conducted on responses to the question "Of the feedback emails you received, how many did you read?". To answer RQ 2, paired samples t-tests and importance-performance analysis (IPA) were conducted, to identify the strengths and weaknesses of this implementation of personalised, data-informed feedback. Originally used in marketing research, the IPA technique (Martilla & James, 1977) solicits customers' perceptions of the importance and performance of defined attributes of service quality, identifying specific quality areas that are performing well, and areas in need of improvement. The model positions the assessed attributes within a 2x2 grid, where the vertical axis represents the level of perceived importance, while the horizontal axis represents perceived performance, of the attribute. The graphical space is divided into four quadrants by lines demarcating the mean importance and performance ratings of all the assessed attributes (see Patiar, Ma, Kensbock, & Cox, 2017). Finally, to answer RQ 3, correlational analysis was performed on the three items pertaining to student action on feedback, perceived helpfulness of the feedback, and subsequent motivation to learn.

Results

Sample characteristics

Survey respondents ranged in age from 18 to 51, with a mean age of 24 (SD = 8.00). Slightly above half of the respondents (55%) were female. These demographics were reflective of the course cohort for the semester. Although information regarding other demographics for the cohort for the semester under study were not available, we rely on the student profile for the preceding semester in order to understand the current sample characteristics. A large proportion of students in the program were recent high school graduates (53%), and a sizeable proportion entered with work and life experience (35%). A small proportion of students had gone through trades education (8%). As more than 80% of the present sample were from this fee-free, open-access program, all these characteristics point to a cohort of students with very diverse backgrounds and a range of educational experiences.

An independent samples t-test was carried out on final course grades between completers and non-completers, to examine for self-selection bias. This analysis was based on the 34 respondents who provided valid student IDs, which meant that 7 respondents could not be matched for grades information. The analysis found that survey completers scored significantly higher in their final course grades ($M = 71.1$, $SD = 15.1$), compared to non-completers ($M = 38.8$, $SD = 26.4$), $t(72.704) = 10.13$, $p < .001$. The mean final course grade for the whole cohort was 43.5 ($SD = 27.5$, $Md = 40.0$). This implies that the survey tended to be completed by higher performers, a point to consider when interpreting the results of this study.

RQ 1. To what extent do students read their personalised, data-informed feedback?

The majority of respondents (n = 25, 61%) read all their received feedback. Approximately 37% (n = 15) read less than half their feedback emails and 1 respondent (<1%) reported not having read any of the feedback emails. This result indicates that students were reading the vast majority of feedback provided.

RQ 2. What are students' perceptions of the importance and performance with respect to the attributes of their personalised, data-informed feedback?

Table 1 provides a summary of the relative perceived importance and performance of each quality attribute of the feedback. The three most important attributes of personalised, data-informed feedback were: *Instructor support* (M = 4.51, SD = .75), *Improved work* (M = 4.34, SD = .99), and *Improved overall course experience* (M = 4.29, SD = .90). The top three performing attributes of the feedback were: *Instructor support* (M = 4.39, SD = .80), *Improved overall course experience* (M = 4.12, SD = .95), and *Timely feedback about progress* (M = 3.95, SD = 1.00). Notably, *Instructor support* and *Improved overall course experience* were ranked highest on both importance and performance. From the paired t-test analyses, it was observed that three out of the seven attributes were significantly rated lower in performance than importance: *Fostering independence* (t(41) = 3.59, p = .001), *Improved work* (t(41) = 3.48), and *Fostering efficient study* (t(41) = 3.39, p = .002). These were all small effect sizes (all eta-squared values were between .22 to .24).

Table 1: The difference between importance and performance of students' personalised, data-informed feedback attributes (n = 41)

Survey item	M (SD) Importance	Performance	*t*	*p*	*eta*^{2}
Q6a. It is important for me to receive feedback that will help me improve my work.	3.90 (1.00)		3.48	.001	.23
Q6b. The feedback emails helped me improve my work.		4.34 (.99)			
Q7a. It is important for me to receive feedback that will help me to be more independent in my studies.	3.73 (1.05)		3.59	.001	.24
Q7b. The feedback emails helped me to be more independent in my studies.		4.22 (.94)			
Q8a. It is important for me to receive feedback that will allow me to complete my study more efficiently.	3.76 (1.04)		3.39	.002	.22
Q8b. The feedback emails allowed me to complete my study more efficiently.		4.15 (.96)			
Q9a. It is important for me to receive feedback that will allow me to complete my study more effectively.	3.88 (1.10)		1.60	.118	.06
Q9b. The feedback emails allowed me to complete my study more effectively.		4.10 (1.00)			
Q10a. It is important for me to receive timely feedback about my progress.	3.95 (1.00)		1.92	.06	.08
Q10b. The feedback emails provided timely feedback about my progress.		4.22 (.94)			
Q11a. It is important for me to receive support from my instructor.	4.39 (.80)		1.04	.30	.03
Q11b. The feedback emails made me feel supported by my instructor.		4.51 (.75)			
Q12a. I believe that communication regarding reminders and support will improve my overall course experience.	4.12 (.95)		1.42	.16	
Q12b. The feedback emails improved my overall course experience.		4.29 (.90)			
Grand means	3.96	4.26			

Importance-performance analysis (IPA)

Figure 2 shows the position of the feedback attributes as perceived by students, in the four quadrants. Two attributes fell into the quadrant “Keep up the good work”, with *Instructor support* (Q11) as the highest, followed by *Improved overall course experience* (Q12). Three attributes fell into the quadrant “Low priority”: *Fostering effective study* (Q9), *Fostering efficient study* (Q8), and *Fostering independence* (Q7). *Timely feedback about progress* (Q10) sat at the borderline between “Concentrate here” and “Low priority”, suggesting that students’ expectations of this attribute of feedback were not quite met, but at the same time, it was relatively less important for students compared to other attributes. Only the attribute *Improved student work* (Q6) was in the “Possible overkill” quadrant. Overall, the result of this analysis indicate that students had positive experiences of nearly all their personalised, data-informed feedback attributes, and that, to a lesser extent, they were not expecting feedback to foster independence, and to foster efficient and effective study.

RQ 3. How might students’ action on their personalised, data-informed feedback be related to their perceptions of usefulness and impact on subsequent motivation?

This analysis focused on the three items in the survey which sought to know students’ action on their feedback, how helpful they found it to be, and the extent to which it enhanced their motivation in the course. While students felt positively about the helpfulness of their personalised, data-informed feedback (M = 4.02, SD = .96), and were somewhat more motivated as a result of the feedback (M = 3.88, SD = 1.1), they were less likely to act on the information provided in the feedback (M = 3.7, SD = 1.03).

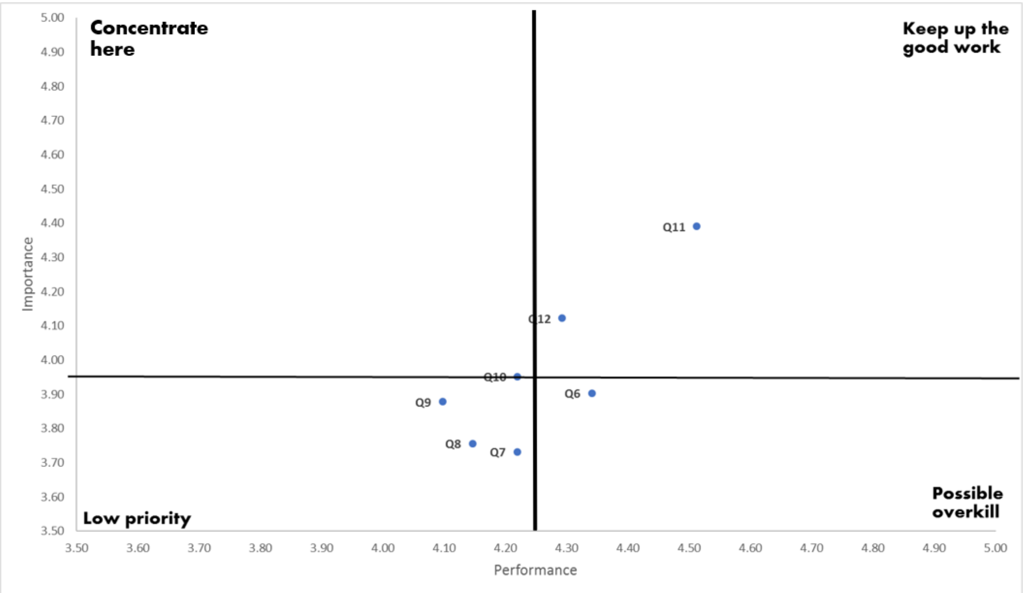

Figure 2. IPA grid showing students’ perceptions of their personalised, data-informed feedback

The correlational analysis (Table 2) shows a strong relationship between students’ self-reported action on their data-informed feedback and subsequent motivation to learn (r = .71), as well as perceived helpfulness of their feedback (r = .81), all p < .05. As well, there was a strong relationship between perceived helpfulness of feedback and subsequent motivation to learn (r = .90). These were all large effects (Cohen, 1992, pp. 79-81).

Table 2: Correlations between students’ action on feedback, perceived helpfulness of their data-informed feedback, and subsequent motivation

Survey item	Q3	Q4	Q5
Q3. I acted on the information provided in the feedback emails.	.	.707**	.813**
Q4. The feedback emails made me more motivated to learn in the course.		.	.901**
Q5. The feedback emails were helpful for my learning.			.

$^{**}p$ < .01

Discussion and conclusions

Students' recipience and perceptions of personalised, data-informed feedback

It is important to identify if feedback mediated by technology is read by the intended audience. The survey analysis found that more than 60% of respondents had reportedly read all their personalised feedback, and more than 95% of respondents reported that they had read at least one feedback email. Thus, this mode of delivery can be considered a viable channel to communicate personalised, data-informed feedback to students. At the same time, the finding that a proportion of students read fewer than half of their emailed feedback messages should also be considered. It is possible that students actively read their feedback messages in the first few weeks of the semester, but as workload and other pressures increased, they may have stopped attending to it. Future studies will aim to examine how students interact with their feedback emails, in order to further optimise student engagement with technology-mediated feedback.

While students read the majority of their personalised, data-informed feedback and found it to be helpful for their learning and motivational for sustained engagement, the extent to which they reportedly acted on their feedback was much less. A reason for this conflicting result is that students may not have enacted their feedback immediately but may have made a mental note to review the recommendation at a later point. The strong positive correlations between students' reported enactment and perceptions of their feedback may support this hypothesis. Given that the majority of students in the course were from the open-access Foundation Studies program, they may not have had much opportunity to gain strong academic skills, due to the diversity of their backgrounds or other life circumstances. In terms of impact on self-regulated learning (Butler & Winne, 1995), the information in students' personalised feedback—for example, that they had not yet accessed assessment resources—may have prompted students to set more specific goals for themselves; these goals are critical to informing study strategies, in this case, to access the assessment resources within the week, in order to find out the next steps to complete the assignment on time. This then set in motion a process of monitoring, to ensure that these new goals are being met. Armed with greater control over their learning, they were subsequently more motivated to learn, signifying an increase in affective-emotional engagement (Fredricks, Blumenfeld, & Paris, 2004; Kahu & Nelson, 2018). This engagement is a psychological response which is elicited when students engage in academic activities (Blumenstein, Liu, Richards, Leichtweis, & Stephens, 2019).

The IPA highlighted the strengths of this form of technology-mediated feedback, particularly for enabling students. Foremost, instructor support emerged both as a highly valued as well as a high-performing attribute in this context. Also highly valued and high-performing was the quality of feedback being able to improve the overall course experience. These results provide further empirical evidence of the importance of instructor support as a critical enabling pedagogy (Lane & Sharp, 2014; Stokes 2018). As shown from the demographic data, enabling students enter the pathway program with limited educational experiences, as well as little knowledge of what to expect in terms of learning at university. The regular emailed feedback and support messages sent personally by the instructor were intentionally crafted to equip students with knowledge of how to engage optimally in this new academic environment. For example, to support students' preparation of their second assessment, the annotated bibliography, feedback was given to students based on activity data in the LMS relating to this assessment, such as the information page, template, and examples. Students received a personalised message tailored according to whether they had accessed the resources: those who had done so were acknowledged and provided further recommended actions to ensure a timely submission, while those who had not, were pointed to the resource and encouraged not to delay reviewing the documents.

Implications for using learning analytics to support student learning

Overall, this study has found that students in the enabling course valued their personalised, data-informed feedback, and in particular, they perceived it as adding significantly to supporting their engagement in the course, as well as improved their overall course experience. Although the attribute "timely feedback about my progress" (Q10) was sitting at the border of the quadrant "Concentrate here", this attribute still performed rather highly. These positive perceptions of students toward their personalised, data-informed feedback in the form of instructor emails demonstrate Blumenstein et al's (2019) principle of translating and applying learning analytics for the classroom, namely, to ensure the presence of the 'human element', as the student-instructor relationship is an important precursor to student engagement. Thus, personalised, data-informed feedback should emphasise the care of the instructor toward the student, and written in such a way that shows it was a personal communication from the instructor herself.

Limitations

We acknowledge that this pilot study is not without its limitations. As noted in the results, there was a self-selection bias, with higher-performing students responding to the survey, and a low response rate. In order to capture the perceptions of students from a variety of abilities, and to obtain a more in-depth understanding into how students engaged with the emails and how they enacted the feedback, focus groups will be conducted.

Conclusion

Overall, students noted the feedback and support emails delivered through OnTask was a positive and effective process for supporting their learning. Given that this approach to feedback did significantly impact on students' perceived support and overall course experience, and the system facilitates instructors to scale up feedback, it is well considered as a worthwhile approach to personalised feedback provision in enabling courses. The technology-mediated approach allows instructors to easily scale personalised feedback and support to each and every student in a diverse cohort. The results of this study provide preliminary evidence that personalised, data-informed feedback enabled by technology can enhance support as an enabling pedagogy.

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E-learning: Working-adult Students' Attitudes and Performances

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This paper's objective is to examine how the working-adult students' attitudes influence their e-learning performances. This research study involved two cohorts of students in the Principle of Project Management course at the Singapore University of Social Sciences (SUSS). The research methods comprised a questionnaire survey and analysis of their learning assessments. In the first study, the Exploratory Factor Analysis (EFA) and Pearson Correlation were used to determine the factors and their items that influenced the students' e-learning attitudes. The second study involved determining the students' familiarities with technology as used in teaching and learning. Students indicated their usage frequency for daily, weekly and monthly accesses. In the third study, the repeated measures ANOVA (ANalysis Of VAriance) and comparison of average scores were used to compare the students' performances in four different assessments. Subsequently, the results were used to compare the students' performances in the traditional face-to-face learning and the online virtual classes. Conclusions were made on the students' e-learning attitudes, their familiarities with technology and comparison in the learning performances between the traditional classroom learning and virtual learning. Results from this study will contribute to the e-learning strategic development in the SUSS.

Keywords: Working-adult students, attitudes, e-learning, learning performance

Introduction

Online learning, or e-learning, and Information & Communications Technology (ICT) are now a strategic part of Singapore's effort to improve education and upgrade our workforce. It is particularly suited to working-adult education as institutions of higher learning (IHLs) offer flexible educational programmes to the working-adult population. The Singapore University of Social Sciences (SUSS), being the sixth autonomous university of Singapore, leverages e-learning to provide lifelong learning and disciplines with social impact and applied degree pathway (Davie 2017).
Using digital technologies, all six autonomous universities of Singapore now provide our working-adult population access to higher education programmes. The Singapore Government continually ensures that improvements are made to strengthen the infrastructure and university network capacity. However, e-learning still faces several challenges. One challenge is to gauge the students' e-learning attitudes, their familiarities with technologies and finally, their performances in their various assessments. This is an attempt to continuously improve e-learning quality and make e-learning more responsive to working-adult students.

The current research examined the students' e-learning attitudes, familiarities with technology and their assessment performances in the "Principles of Project Management" course.

Literature Review

In the paper by Ngampornchai and Adams (2016), the authors were interested in the undergraduate students' acceptance and readiness for e-learning in a Northereastern Thai university.

They designed their questionnaire based on two theories. The first one was the UTAUT (Unified Theory of Acceptance and Use of Technology) by Venkatesh et al. (2016). The second one was the TAM (Technology Acceptance Model) by Moore and Benbasat (1991). These theories provided the theoretical foundations for the questionnaire construction.

Of particular interest are the findings from the survey on the familiarity with technology among the students. They found out that most of the students own smartphones and notebook computers. Only 23% of them own desktop computers.

In the second paper, Chun and Lee (2013) proposed and listed six areas that affected student attitudes to blended learning. These were attitudes toward learning flexibility, online learning, technology, study management, online interaction and classroom learning. These six types of attitudes help to determine the student's adaptability towards blended learning. Ultimately, students needed to be surveyed before the researchers could establish a certain readiness for blended learning. Chun and Lee (2013) structured these as hypotheses in their research on readiness for blended learning. Although the authors did explain what blended learning was all about, they were not able to provide a better classification such as that as shown in Figure 1: Classification and definition of e-learning courses (Gavril, et al. 2017).

For the third paper, Neuhauser (2010) compared two sections of the same course that were taught in two difference modes: face-to-face classes and online via asynchronous means. The purpose was to determine whether there were any differences in the students' test scores, assignments, participation grades and final grades. The author examined the students' gender, age, learning preferences and styles, media familiarity, effectiveness of tasks, course effectiveness, test grades, and final grades. Her study showed no significant differences between learning preferences and styles and grades in the two groups. She concluded that equivalent learning activities can be effective for online and face-to-face learners.

In their paper, Cooper et al. (2017) proposed the Expectancy Value Theory (EVT) as a framework that can be applied to active learning. Their proof of concept has prompted us to adopt the EVT as the basis for a theoretical foundation in the design of our questionnaire survey. Active learning plays an important role in e-learning. Yet we do experience much student scepticism about active learning. Using interviews and analyses, they checked for students' self-efficacy in active learning, value of active learning, and potential cost of participating in active learning. The results showed positive changes in the EVT components and increased engagement in active learning. These are the values which we hope our students can imbibe.

Some definitions

Traditional classroom

The traditional classroom is based on the teacher-centric model. The teacher is regarded as the knowledge dispenser, more of the "sage on the stage". The students are generally passive listeners. It is efficient in terms of delivery of the course contents but it inhibits classroom interaction.

Virtual class

A virtual classroom is an environment meant for online learning. The environment can be web-based and accessed through an LMS. It usually requires an executable file. In a virtual classroom, the teacher and the students participate in synchronous instruction. They normally log into the virtual learning environment at an agreed time. They can communicate with one another, view presentations or videos and interact amongst themselves (e.g. by chat or whiteboard). They can also engage with other resources in work groups (Rouse 2010).

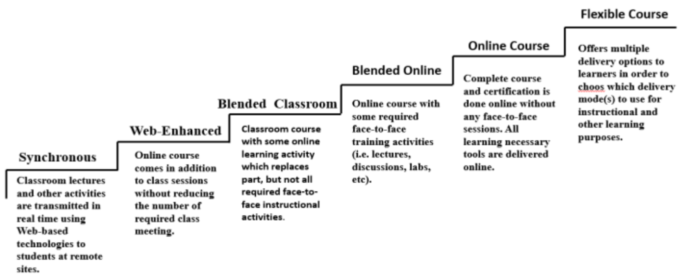

Figure 1: Classification and definition of e-learning courses (Gavril, et al. 2017)

Figure 1 above shows a classification on the distinction between synchronous or virtual class and blended or online course (Gavril, et al. 2017). At the lowest end, it is a synchronous session and is just an online delivery of the contents. At the highest end we have a flexible mode with the choice of delivery mode. In between are different levels of "blendedness".

Research Method

Research Questions

1. What are the relationships of the e-learning attitudes of students and items of the Expectancy Value Theory like motivation, attainment, intrinsic, utility and cost?
2. In the familiarity with technology area, how do the students rank the use of typical software tools / technology that are used for teaching and learning, e.g. eBooks (or etextbooks from publishers) and iStudyGuide - or interactive study guide developed internally by SUSS?
3. Is there a difference in the students' assessment performances whether they were taught in the traditional face-to-face classroom mode or the online virtual class mode?

Questionnaire Design

The questionnaire was designed in five parts. Part 1 covered the Expectancy Value Theory (EVT) with five sub-parts for Motivation, Attainment, Intrinsic, Utility and Cost. Each component in Part 1 comprised three questions. Part 2 comprised three questions on Constructivist versus Traditional learning. Part 3 comprised four questions on Change Management. Part 4 comprised four questions on technical support for e-learning. The bi-polar scale is chosen as the students do not have to choose a sociable desirable scale like "Highly disagree" or "Disagree" or "Neutral" or "Agree" or "Highly Agree". Instead, a simple bi-polar scale from 1 to 7, with "7" being the most extreme, will make the questionnaire easy to use (Hirst 2016). There were altogether 26 questions from Part 1 to Part 4.

Part 5 of the Students' Questionnaire Survey is about Familiarity with Technology. It has been modified from Son, Robb, and Charismiadji (2011). This part aims to obtain feedback from students on the frequency of usage of the various software tools/technology they use in the SUSS. The feedback ranges are on a 6-point Likert scale: 1 - "Never", 2 - "Several times a month", 3 - "Once a week", 4 - "Several times a week", 5 - "Every day" and 6 - "Several times a day".

The technologies listed in Part 5 are iStudyGuide, eBook, Search Engine, Google drive/One Drive, Forums, text chat, voice chat, video chat, Computer Games, Web Video, Photo-focused web, blogs. The Interactive Study Guide (iStudyGuide) is a summary of the course and it includes course overview, learning outcomes, assessment components and subject matter. It may contain videos, lesson recordings, audio clips and formative assessments (Learning Services Cluster, Singapore University of Social Sciences 2017a). These technologies were selected as they were widely used for e-learning.

Administering the Questionnaire Surveys

The paper-based questionnaire survey was administered to the two student cohorts (i.e. July 2018 semester and January 2019 semester) on 16 October 2018 and 16 April 2019, respectively, during the last 15 minutes of the last lecture. This method was found to be more efficient and responsive than the online version as we had a captive audience. In an online version, the students would probably procrastinate their replies until they forgot about them. The responses to the two questionnaire surveys for the students were encouraging. The students' participation rates in the two questionnaire surveys were 53% and 40.3% for the two cohorts respectively.

Data Analysis

The data obtained from the student inputs to the questionnaire surveys were entered into an Excel file. Thereafter, the IBM SPSS software (version 25) was used to process the data and obtained the factor.

Results

Questionnaire Survey

The attitudes of the students towards e-learning, in terms of motivation, constructivist learning, change management, and technical support were investigated using the results of the questionnaire survey with the July 2018 and the January 2019 cohorts of students studying the course in SST101e Principles of Project Management. Altogether 260 students participated in the survey (i.e. 132 out of 249 students in the 1st cohort and 128 out of 318 students in the 2nd cohort). This represented 45.9% of the combined two cohorts of students – i.e. 260 students. The results were entered into an Excel spreadsheet file and the IBM SPSS software (Version 25) was used to carry out EFA (Exploratory Factor Analysis) on the data. Processing was done using Maximum Likelihood and Oblimin with Kaiser Normalization.

The focus was on analysing the students' attitudes with respect to the EVT (Expectancy Value Theory). This theory was first developed by John William Atkinson and expanded by Jacquelynne Eccles in education in 1983 (Eccles 1983). Essentially, the students were surveyed on their e-learning attitudes in motivation, attainment, intrinsic, utility and cost.

Table 1: Expectancy Value Theory

S/No.	Value	Explanation
1	Motivation	What spurs the student to e-learn despite the unfamiliarity with the technology
2	Attainment	Importance for identity or self
3	Intrinsic	Enjoyment or interest
4	Utility	Usefulness or relevance
5	Cost	Financial, time, effort or stress

The first analysis revealed three factors but with many items that were overloaded. Altogether ten items were deleted because of double or triple loadings. Thereafter, a second analysis was performed and this resulted in only one factor with the following items:

Table 2: Output of EFA on Students Questionnaire Survey data

Mean	Item identified	Std. Deviation	Analysis N
5.35	Motivation	1.291	260
5.37	Attainment	1.212	260
4.70	Intrinsic	1.638	260
4.75	Utility	1.580	260
5.03	Motivation	1.407	260

(Reliability: Cronbach’s alpha = .809 for N = 5)

This factor showed that some relationships exist amongst the various items. Two aspects of motivation (i.e. coping well and confidence), attainment, intrinsic and utility are the items that greatly influenced the students’ attitudes toward e-learning. The cost item (i.e. time, effort and expenditure) did not matter to the students.

Further, in order to see the relationships amongst the five items, a Pearson Correlation analysis was carried out (LibGuides: SPSS Tutorials: Pearson Correlation 2019). Pearson Correlation measures the degree of the linear relationship between two variables. A linear relationship can mean that the relationship is characterised by a straight line. For example, there is a linear relationship between a person’s age and his income. The older he gets, the more his income will grow. Correlation ranges from -1.0 to +1.0. Pearson correlation is given by the letter r, for example, r = .55. As such, there is no such correlation as +1.20 or -1.8, for example. Both of these will indicate mistakes.

The following table summarised the results:

Table 3: Pearson Correlation Table for the 5 items in Factor)

Expectancy Value Theory components	Test	Motivation1-coping	Motivation2 - confidence	Attainment	Intrinsic	Utility
Motivation1	Pearson Correlation	1	.686**	.324**	.450**	.399**
Motivation2	Pearson Correlation	.686**	1	.350**	.471**	.486**
Attainment	Pearson Correlation	.324**	.350**	1	.365**	.388**
Intrinsic	Pearson Correlation	.450**	.471**	.365**	1	.801**
Utility	Pearson Correlation	.399**	.486**	.388**	.801**	1

(In carrying out the Pearson Correlation tests, N = 260 and p = .000)

Table 3 shows the Pearson Correlation values for the five items (Motivation1, Motivation2, Attainment, Intrinsic and Utility). Motivation1 refers to the student's confidence in coping with the downloaded documents for e-learning. Motivation2 refers to the situation when the student feels confident doing e-learning. The Pearson Correlation tests showed that the students ranked items like "utility", "intrinsic" and "motivation1 – coping" and "motivation2 – confidence" have strong correlations as | r | > .5. The other item on "attainment" has medium correlation with the other items (Table 4).

Table 4: Strengths of Pearson Correlations

Pearson Correlation Coefficient (r)	**Strength of correlation**	**EVT value 1**	**EVT value 2**
.801	| r | > .5 => large / strong correlation	Utility	Intrinsic
.686	| r | > .5 => large / strong correlation	Motivation2	Motivation1
.486	.3 < | r | < .5 => medium / moderate correlation	Utility	Motivation2
.471	.3 < | r | < .5 => medium / moderate correlation	Intrinsic	Motivation2
.450	.3 < | r | < .5 => medium / moderate correlation	Attainment	Motivation1
.399	.3 < | r | < .5 => medium / moderate correlation	Utility	Motivation1
.388	.3 < | r | < .5 => medium / moderate correlation	Utility	Attainment
.365	.3 < | r | < .5 => medium / moderate correlation	Intrinsic	Attainment
.350	.3 < | r | < .5 => medium / moderate correlation	Attainment	Motivation2
.324	.3 < | r | < .5 => medium / moderate correlation	Attainment	Motivation1

What this mean is that "usefulness and relevance" are strongly correlated to "enjoyment and interest" whilst "coping with e-learning (motivation1)" is strongly correlated with "confidence (motivation2)".

Familiarity with Technology

The questionnaire survey also provided data where we can assess the technology competencies of the students.

Table 5: Comparison of the popularly used software tool/technology

1st Student Cohort			2nd Student Cohort		
S/No.	Software tool / technology	Mean	S/No.	Software tool / technology	Mean
1	Text Chat	1.05	1	Text Chat	12.02
2	Search Engine	0.89	2	Search Engine	8.69
3	Photo-focused Web (e.g. Instagram)	0.88	3	Photo-focused Web (e.g. Instagram)	6.06

Table 6: Comparison of the least frequently used software tool/technology

1st Student Cohort			2nd Student Cohort		
S/No.	Software tool / technology	Mean	S/No.	Software tool / technology	Mean
1	iStudyGuide	0.17	1	Voice Chat	3.86
2	Computer Games	0.35	2	Computer Games	4.16
3	eBook	0.41	3	eBook	4.60

There is a similar pattern amongst the two student cohorts. They agree on the top three software tool/technology that were most frequently used (Please see Table 5). For the least frequently used software tool/technology, they agreed on Computer Games (Please see Table 6). Somehow, the students might have given up playing computer games when they needed to work, study and even looked after their families. Their responses might or might not be true but that is not the intention of the questionnaire survey. The results in Tables 5 and 6 showed that the questionnaire survey for the Familiarity with Technology part was largely consistent over the two student cohorts. [N.B. Please note that the means are calculated from the usage frequency and the percentage of occurrence. An example is given in the paper by Ngampornchai and Adams (2016), p 8.]

Performances in Assessments

SST101e Principles of Project Management is a 5-credit unit course. This means that the course will last for six weeks with three hours of teaching/learning per week. For the part-time students, they are required to attend lectures one night per week. Typically, this is from 7 pm to 10 pm. For the SST101e course, half of the course will be conducted in the traditional face-to-face classroom lecture mode (Tclass). The other 3 sessions will be conducted via online virtual classes (Vclass). During virtual classes, students need not be present on campus. They can be located anywhere – at home, in the office, or even overseas – as long as they have a PC connected to the Internet.
Before attending the lectures, either in the traditional mode or in virtual classes, they need to read the textbook and complete the MCQs (Multiple-Choice Questions) Pre-Class Quizzes. There were three of such Pre-Class Quizzes (PCQs). In addition, they will be grouped into small groups to work on an assignment. This is the Group-Based Assignment (GBA). At the end of the course, they need to take the Online Quiz (OLQ) which comprised MCQs for the whole course. The final assessment is the 2-hour closed-book Examination (EXAM).

Table 7 summarized the weightages for the various assessments

Table 7: Weightages of the various assessments

Assessment	**Description**	**Weight Allocation (%)**
Pre-class Quiz	Pre-class Quiz (3 quizzes of 2% each)	6
Quiz	Online Quiz	8
Assignment	Group Based Assignment (GBA)	16
End-of-Course Assessment	Written exam (closed book)	70
TOTAL		100

Each assessment in Table 7 comprised the Tclass and the Vclass components. The Tclass component represented the students' marks obtained from contents taught during traditional face-to-face lectures. The Vclass component represented the students' marks obtained from contents taught during online virtual classes. In this way, we were able to compare the students' performances in contents taught during the traditional face-to-face lectures versus those taught during online virtual classes. Please see Figures 1 and 2 for the results of the repeated measures ANOVA (Grande 2015) for the two student cohorts.

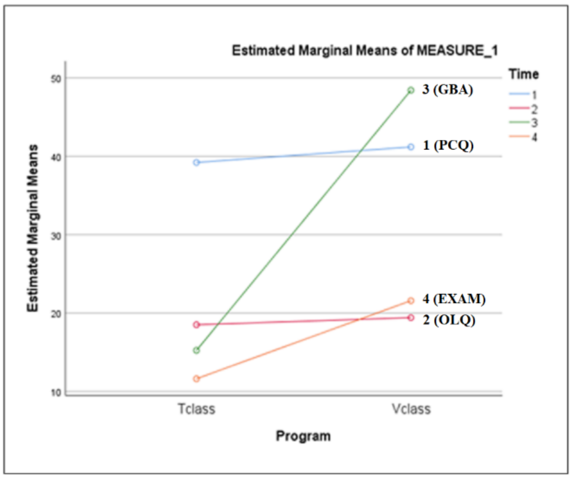

Figure 1: Comparison of Assessment Performances (July 2018 Semester)

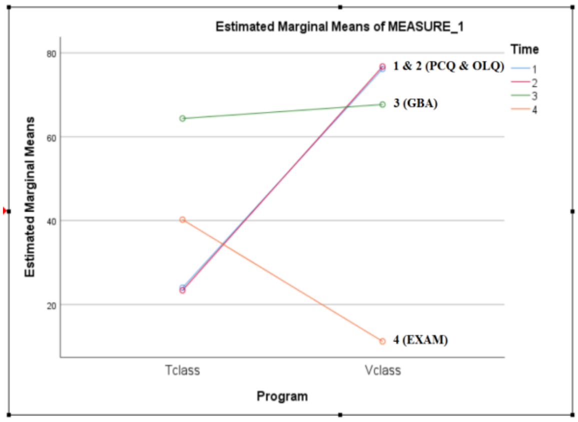

Figure 2: Comparison of Assessment Performances (January 2019 Semester)

From Figure 1, it appears the Vclass results for the Pre-Class Quizzes and the Online Quiz were very close to those from the Tclass (i.e. 1 and 2 are almost level). But the results for both the GBA and the EXAM showed that the Vclass results were very much higher than those from the Tclass. However, the scores for the GBA and the EXAM have to be benchmarked to the 50% level (i.e. half of the course are taught in Tclass and Vclass equally). Tables 7 and 8 showed the results after the GBA and EXAM scores were benchmarked to the 50% level.

Table 8: Comparison of average marks for the Tclass vs Vclass cases (July 2018 Cohort)

Questions set on contents:	**Group-Based Assignment (GBA)**	**Benchmarked to 50% (GBA)**	**Examination (EXAM)**	**Benchmarked to 50% (EXAM)**
Taught in the Tclass (i.e. traditional face-to-face classroom lectures)	24% N = 252	50/24 * 15.42 = 32.12	35% N = 237	50/35 * 12.25 = 17.50
Taught in the Vclass (i.e. online virtual classes)	76% N = 252	50/76 * 48.85 = 32.14	65% N = 237	50/65 * 22.76 = 17.51
Differences		32.14 – 32.12 = 0.02		17.51 – 17.50 = 0.01

Table 9: Comparison of average marks for the Tclass vs Vclass cases (January 2019 Cohort)

Questions set on contents:	**Group-Based Assignment (GBA)**	**Benchmarked to 50% (GBA)**	**Examination (EXAM)**	**Benchmarked to 50% (EXAM)**
Taught in the Tclass (i.e. traditional face-to-face classroom lectures)	75% N = 314	(50/75) * 50.33 = 33.55	26% N = 328	(50/26) * 11.93 = 23.94
Taught in the Vclass (i.e. online virtual classes)	25% N = 314	(50/25) * 16.78 = 33.56	74% N = 328	(50/74) * 37.53 = 25.36
Differences		33.56 – 33.55 = 0.01		25.36 – 23.94 = 1.42

Tables 8 and 9 summarized the assessment scores of the two student cohorts in the GBA and the EXAM. The assessment scores in both the GBA and EXAM were analysed and the average scores obtained by the students in those questions taught during the traditional face-to-face sessions (Tclass) and the virtual classes (Vclass) were separated.

In the GBA case, the difference between the Tclass and the Vclass scores were less than 1. In the EXAM case, the difference between the Tclass and Vclass scores were 0.01 and 1.42 for the July 2018 and the January 2019 semesters, respectively. The differences were small (i.e. less than 2). These mean that there is little difference between the assessment scores between contents taught in the face-to-face lessons and those taught in virtual classes for the two student cohorts in the two semesters.

The comparison results showed that the performance scores obtained by students who were taught in the traditional face-to-face classroom environment were similar to or very close to those taught in the online virtual class environment. These were reflected in the assessment scores in the two student cohorts of July 2018 and January 2019.

Discussion and Conclusion

The result of the EFA indicated that only one factor determined the attitudes of the students towards using e-learning. This factor comprised items from the Expectancy Value Theory (i.e. Motivation, Attainment, Utility, Intrinsic, except the cost). This factor was an acknowledgement by the students that they value the soft skills aspects of learning. From the Pearson Correlation analysis, it can be seen that the students ranked these items in the following order: Utility, Intrinsic, Motivation and Attainment.

In the survey on the Familiarity with Technology, the two student cohorts rated the following three software tools/technology as being most frequently used: text chat, search engine and photo-focused web (e.g. Instagram). For the least frequently software tools/technology, the lowest three were iStudyGuide, Computer Games and eBook for the 1st student cohort and Voice Chat, Computer Games and eBook for the 2nd student cohort. Out of the three software tools/technology, the two student cohorts have Computer Games and eBook as their least frequently used software tools/technology.

These two developments further showed that the two student cohorts were similar in the use of the software tools/technology. Text chat, search engines and photo-focused web were used very frequently not only when they are studying but also when they communicate socially with their friends. What was surprising was that they did not use computer games and eBook more frequently. Most probably, they have gone past the age of playing computer games. These students might not have the time to play computer games as they worked and studied. Some of them even have families to support.
Perhaps most disappointing of all is the low usage of eBook or even e-textbook by extension. Although there are differences between eBook and etextbook, they share common characteristics like being digital publication that can be read on computer, e-reader, or other electronic devices (Retterbush 2010). Some differences can be in their format, e.g. eBook can be in a proprietary format whilst etextbook can be in the PDF format. Etextbook is regarded as the digital "textbook".

Perhaps the students have been so used to using the printed version of books that they need time to adjust to using digital books and e-textbooks for study. This is a big concern to the SUSS as using e-textbook is the new direction of the university (Learning Services Cluster, Singapore University of Social Sciences 2017a). From the standpoint of efficiency, cost reduction and convenience, it makes sense to provide e-textbooks to the students. With more book publishers providing the digital versions of their textbooks and other reference books in the form of eBooks, it makes sense to promote the wider use of eBooks and e-textbooks. The students can also download the eBooks and e-textbooks quickly and start learning early. With effect from January 2019 semester, only the e-textbook version will be made available to the students. The print version is still available but only for purchase.

For the second research question, the research authors had expected the students to rank the iStudyGuide and eBook highly in their familiarity with technology. Unfortunately, they ranked them very low in their familiarity with technology questionnaire survey.
Only slightly less than half of the student numbers participated in the Questionnaire Surveys. One reason could be that the attendance in lectures or virtual classes was not compulsory. This might not be a good policy as by skipping lectures, they demonstrated a lack of self-discipline in their study habits.

As for the third research question, the results of the research study showed that there was no difference in the students' assessment performances whether they were taught in the traditional face-to-face classroom mode or the online virtual class mode. This was not surprising. There were reports that no significant differences in learning outcomes were observed between face-to-face and online learning (Arbaugh 2000; Clark 1999; Dobrin 1999; Navarro and Shoemaker 1999; Trinkle 1999; Werhner 2007).

It is heartening to know that our working-adult students are valuing the intangible benefits of learning especially with the results of the questionnaire survey. The survey has shown that they put values like "Utility, Intrinsic, Motivation and Attainment" from the Expectancy Value Theory as the important items in the factor to embrace e-learning. Secondly, this research has also shown that our students have a high familiarity with technology that is used in teaching and learning. Thirdly, the research has also shown that our students learn just as well in virtual classes and in the face-to-face classroom environment.

As the Singapore University of Social Sciences (SUSS) moves towards digital learning, more has to be done to ensure that both our students and lecturers learn and teach well regardless of the instructional mode or technology. Technology comes and goes but there is a need to make sure that our students can continue to learn well. After all, "I do not think that education, like some other industries, will be replaced by robots and computers. A teacher cannot be replaced, a principal cannot be replaced," said by Singapore's Minister for Education, Mr. Ong Ye Kung, on the 17 May 2019 (Yip 2019).

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Using TEL for TEL: Building confidence of sessional staff to enhance their students' experience

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Sessional staff capacity building, and the role this plays in overcoming internationally recognised challenges for the provision of quality Technology Enhanced Learning (TEL), continues to present a priority for the Higher Education (HE) sector. These sessional staff undertake approximately 40% of the teaching in the Griffith Business School and yet their contribution to quality learning and teaching has largely been unmeasured. This paper describes the backgrounds and experience of sessionals, their career aspirations, and their desires for professional learning and support to enhance the quality of their teaching. This is the first step in a five-stage project adopting an evidence-based approach using TEL to improve the TEL capabilities and confidence of sessional staff. The results of the survey described in this paper (N=47) show that many sessional staff are focused on careers in academia and are motivated to participate in professional learning that leads to formal qualifications. They express interest in engaging in this learning through face-to-face and online formal workshops, informal networking events with each other and faculty, and access to online support resources. The premise for this study and the model introduced, represents an adoptable and adaptable opportunity for the wider HE sector to more effectively deliver sessional staff professional development.

Keywords: sessional staff, professional learning, BLASST framework, TEL, professional development

Introduction

Commonly referred to in Australia as sessional staff, peripatetic tertiary teaching staff are predominately employed under the categories of casual or non-fixed term, are not guaranteed employment from one teaching period to the next and as such may teach into multiple discipline areas and across institutions (Baik, Naylor, & Currin, 2018, BLASST, 2015). This study builds on the recommendation for further investigation and evidencing of good practice for professional learning and recognition stemming from Australian Learning and Teaching Council's Recognition, Enhancement and Development (RED) resource (Percy et al., 2008) and the Australian Government Office's Learning and Teaching project Benchmarking with the BLASST Sessional Staff Standards Framework (BLASST, 2015; Luzia et al., 2013). It examines the sessional staff contribution to the delivery of teaching and learning in a large Australian business school which operates across multiple campuses, including fully online mode, and consists of 6 departments. In addition, to support the delivery of quality teaching and learning experiences for students, this study provides a snapshot of the role that institutional-based professional learning opportunities have traditionally played in the development and enhancement of sessional staff teaching skills (Harvey, 2017).

This first stage of a five-stage project aims to build on the recommendations and findings from these two reports to create a better understanding of who are the sessionals utilising technology enhanced learning (TEL) strategies teaching into business courses, and what support they feel they need in order to do their job well. This is important as 40% of teaching in the Griffith Business School (GBS) is conducted by sessional staff, who come from diverse backgrounds with each sessional bringing a unique combination of skills, knowledge, work and life experiences, and reasons for taking on this role (Anderson, 2007). The overall aim of the wider study is to improve the capabilities and confidence levels of sessional staff, and for this to have a positive impact on their students' learning experience, thus improving the quality of teaching and learning across business schools.

This aim will be achieved through:

- Creating a snapshot picture of sessional staff in the GBS through an initial survey, regarding their background, and training and support needs.
- Benchmarking the current state of support and training for sessional staff, using the BLASST framework and developing an action plan to improve in areas identified as failing to address the criteria

- Developing a suite of professional learning opportunities, including online resources and support mechanisms based on responses to the survey and in line with the Griffith Learning and Teaching Capabilities Framework
- Trialling the suite over a period of 12 months; measuring levels of uptake by our sessional staff, and gaining evaluation feedback
- Conducting a further survey to gain feedback on the effectiveness of the different opportunities provided and evaluating the effectiveness of the professional learning plan. This will include analysis of number of attendees at events, no of successful applications for awards and citations, no of staff completing central unit workshops and formal courses and any indicators of flow-on to student experience such as improvements in Student Evaluation of Courses and Student Evaluation of Teaching, engagement levels in tutorials and workshops

Sessional staff, as well as those in continuing roles, need to be aware of the diversity of our students and have the skills and confidence to work with this diversity. Additionally, our students need to engage in the virtual learning environment on a regular basis, and hence our sessional staff need to have the skills and confidence in this area to empower them to provide effective and relevant learning experiences for their students. Our sessional staff are the heart of our university and, in the context of this study, are also our learners, and we are contributing to their lifelong learning. The 2019 EDUCAUSE Horizon Report (Alexander et al., 2019, p.17) commented that "institutions that address the needs of all faculty through flexible strategic planning and multimodal faculty support are better situated to overcome the barriers to adoption that can impede scale". This study adds to the current literature and has relevance to institutions world-wide by detailing one such multimodal approach to the support of sessional staff/adjunct faculty that can be adopted and/or adapted by others.

Literature review

The RED Report noted universities need to promote sustainable initiatives at all levels of the institutions (Percy et al, 2008) and the BLASST project built on this by building a framework to enhance the quality of teaching and learning of sessional staff through a reflection of current practice and consideration of how this can be improved. The BLASST Framework includes the three Key Principles of Quality and Learning; Support for Sessional Staff; and Sustainability (Luzia et al., 2013). Crimmins, Oprescu and Nash (2017) similarly found that the professional development needs of casual academics were focussed around four key themes: specific topics for professional development; ongoing support; resources; and career advancement opportunities. They further noted that integration into academic culture on both a formal and informal basis was an important need.
The significant role of sessional staff has been well documented, as has the risk this reliance places on institutions with main issues identified as the lack of assurance and enhancement of the quality of teaching and consequently student experience (eg Harvey, 2017; Hitch, Mahoney, & MacFarlane, 2017, Ryan, Groen, McNeil, Nadolny, & Bhattacharyya 2011). Ryan et al. (2011) add that this risk lies more with the policies and processes adopted by an institution to manage sessionals, than in the sessionals themselves. There have been widespread calls for more systematic and holistic approaches to professional learning and this paper describes the way in which a Learning and Teaching support team are approaching this. The approach being taken builds on the principles of the BLASST framework and its aim to encourage "professional development about quality learning and teaching, and about supporting and sustaining good practice when working with sessional teachers in higher education" (Harvey & Luzia, 2013, p1.)

A wide range of strategies have been suggested to support sessional staff and enhance the quality of their teaching including online support; delivery of professional learning programmes through partnerships between central learning and teaching units and faculties; a multi-layered approach; peer observation and mentoring; provision of advice on marking assignments; facilitating critical thinking and reflective practice; developing a teaching style; and professional development in online teaching skills (Harvey, 2017, Hitch et al., 2017, Matthews, Duck & Bartle, 2017; Saroyan & Trigwell, 2015). This suggests that offering a range of opportunities, from which sessionals can choose, is an effective approach to meeting the challenges of their diverse needs and goals.

There have also been repeated calls for collection of more and better information about the composition of the sessional staff workforce as this will enable more personalisation of support (eg Andrews et al., Harvey, 2017) and this paper contributes in a small way to that call. This will also contribute to the literature through a holistic approach to professional learning and development of a model to support sessionals and staff in other roles in these endeavours.

Methods

The survey, developed for this study, includes questions drawn from the BLASST framework, particularly their questions at the individual level of responsibility, for the three Principles included in the framework: Quality of Learning and Teaching; Support for Sessional Staff; and Sustainability (BLASST, 2015). Additional questions were developed specifically to meet the aims of this study. The survey was created and administered in Microsoft Forms with invitations to participate being sent via email to all sessional staff in the GBS. The questions were a mix of multiple choice, Likert-type and free response and were designed to produce a profile of sessional staff in including:

- Their current levels of knowledge of, and satisfaction with, professional learning sessions and resources offered by GBS and the central Learning and Teaching unit of our university
- Details of further training and support they would like to receive
- Demographic information related to their work experience

Simple counts are provided for multiple choice and Likert type questions whilst deductive thematic analysis was conducted for the free response. The overarching study has gained Human Ethics approval from the Griffith Human Ethics Committee (GU ref no: 2019/378). Forty seven responses were received from a possible pool of 199, resulting in a response rate of 27%. Responses were received from a cross-section of the sessional staff population with responses from staff in each Department.

Results

Staff were asked what training/professional learning sessions they have attended; and whether they felt they received sufficient professional learning support within GBS to undertake their role effectively. These results are compared in Table 1, indicating that the majority of respondents did feel well trained (68%) although only 30% felt they were also well supported. Of the 13 staff who indicated they had not attended any training or professional learning session, 8 indicated they do feel well trained, suggesting that they are more experienced staff who no longer feel they need training. Analysis of the individual responses further indicates these are a mixed group with eight being aged 35 or over; 5 PhD students and 3 experienced industry professionals looking for a change of career; and their experience as a sessional ranging from 18 months to 23 years.

Table 1: Training and support attended and satisfaction levels

	Yes I feel well trained and supported	I feel well trained but could benefit from additional support	I don't feel well trained or supported at times	Other
Sessions run by GBS	2	1	1	1[b]
Sessions run by GBS and central L&T unit;	1	4	1	1[c]
Sessions run by central L&T unit	1	3	3	0
Sessions run by my Department	1	3	0	0
Sessions run by my Department; GBS, central L&T unit	2	3	2	0
Sessions run by my Department; GBS, central L&T unit, GBS L&T staff & external to uni	1	0	0	0
Sessions run by my Department;GBS, central L&T unit & external to uni	1	0	0	0
Sessions run by GBS, WOW[a]	1	0	0	
Other	0	0	0	1[d]
I haven't attended any training/professional learning sessions	4	4	4	1[e]
Total	14	18	11	4

Notes
[a] WOW Centre for Work, Organisation and Wellbeing
[b] Adequate training is available but I do not attend much
[c]Whilst I feel confident in my role as a sessional, over the many years there has been very limited training opportunities. As such I think by providing multiple options for training with a view to seek opportunity for promotion or at the very least, opportunities to convene courses, would be beneficial

[d]TESOL Cert IV
[e] I have attended a 1-1 session with central LMS support to learn to use video recording for an online course and it was very good No, and I really don't like this survey much. It is not just GBS it is the whole L&T strategy at Griffith - there is no strategy, although Learning Futures unit has been here for a while, but who is responsible for a coordinated effort across the depts.
[f] Supported well

A further question asked about the training they have received within GBS and who has provided that training for them, as shown in Table 2, with respondents being able to choose multiple options. Fifteen respondents mentioned multiple ways they had received training, with just two respondents noting they had received training from all four levels of support. Of the nine respondents who noted they had received training from a peer, only one noted this as their only source of training. The fact that 25% noted they had received no training is a concern.

Table 2: Training received within GBS

Initial training session when I commenced	15
Training and support from my Course Convenor	28
Training and support from my Head tutor	6
Training and support from a peer	9
I haven't received any training	12

Staff were asked what styles of professional learning opportunities they would be interested in receiving and were able to choose all options that applied to them. Respondents generally noted multiple options with 21 noting two or three options, 17 noting eight or nine options and only 4 noting just one option. The most popular options were half day workshops, online resources, formal education qualifications and informal coffee and chat with all of these being selected by at least 50% of respondents.

Staff were also asked about their current levels of knowledge of, and interest in a range of resources, professional learning opportunities, and recognition schemes that are available across the university, as detailed in Table 4.

Table 4: Knowledge of, and interest in, resources and opportunities

Category	Item	A	B	C	D	E	F
Central recognition	Higher Education Academy Fellowships	4	13	17	6	6	1
	Learning and Teaching Grants and Awards	1	13	18	7	6	2
	Learning and Teaching Citations	4	20	11	5	6	1
Central Professional Learning	Graduate Certificate in University Learning and Teaching	2	14	18	6	5	2
	Peer Evaluation of Teaching scheme	1	10	19	5	11	1
	Teaching for Learning workshops	1	10	19	13	2	2
	Teach Online MOOC series	2	30	9	3	2	1
Central resources	Central L&T website	2	11	20	10	3	1
	Learning and Teaching Capabilities framework	2	28	12	3	1	1
	Learning & Teaching Capabilities Reflection Tool	2	29	13	1	1	1
	Explore Learning and Teaching (ExLNT) website and resources	2	32	6	4	2	1
GBS L & T resources	SBSessional Staff Induction booklet	3	18	11	9	4	2
	GBS Sessional Staff Learning and Teaching handbook	3	23	13	6	1	1
	GBS Community site	4	21	12	6	3	1
GBS recognition	Teaching Excellence Recognition Scheme (TERS)	2	14	18	6	5	2

Note: Column headings are
A I haven't heard of this but it is not something I would be interested in anyway B I haven't heard of this but would like to know more
C I know about this and am interested in participating D I know about this and have already participated
E I know about this but am not interested F no response

For all items, the majority of respondents noted that they were interested in knowing more or participating in that opportunity. The centrally run Peer Evaluation of Teaching Scheme is the item respondents were least interested in, whilst Teaching for Learning workshops were the professional learning opportunity most participated in. Knowledge levels vary greatly across the items with the number of staff knowing about an item ranging from just 12 (26%) for the ExLNT website to 33 (72%) for the central L& T website.

A series of questions from the individual level of the BLASST framework (BLASST, 2015) were included in the survey to gauge current perceptions against the three principles. The responses, as shown in Table 5, indicate staff are much more positive about their engagement with the university, than about the provision of support and opportunities. The response regarding maintaining communication (85% agree or strongly agree) compares favourably with a similar survey from UTAS (Brown, Kelder, Freeman, & Carr, 2013) who noted 76% of respondents indicated they had regular contact with staff responsible for units they taught.

Table 5: BLASST questions at the individual level

As a sessional staff member:	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
I actively engage with ongoing professional development in learning and teaching	4	4	8	15	15
I maintain my professional role as a teacher and a disciplinary expert.	0	1	0	16	29
I maintain communication with departments and other staff members as necessary.	1	3	3	20	19
I am provided with the opportunity to become familiar with policies and procedures that affect my work.	2	7	9	19	9
I am provided with the opportunity to provide feedback to my departments/ unit convenor/ subject coordinator	2	11	6	14	13

The demographics of respondents shows a diverse range with 21% aged 18-34 (n=10), 66% aged 35-54 (n=31) and 13%>54 (n=6). Twenty-one respondents identified as being a current PhD student, with 2 of these also being experienced industry experts; only one of these was over 54 years, with four being 18-34, and 16, 35-54. As noted in Table 6, 62% noted they had between 1-5 years' experience; 24% 6-10 years' experience and a further 9% >10 years' experience, with similar numbers noted for length of time at GBS, indicating most staff have only worked at this institution. Twenty-one respondents (47%) indicated they hope to work as a sessional at GBS for at least 6 years, and this was particularly so with respondents in the 35-54 age bracket with 48% indicating they wished to work in this capacity for >10 years, suggesting a stable and loyal workforce.

Table 6: Experience and aspirations as a sessional staff member

	Completed sessional work any uni (no of years)					Completed sessional work GBS (no of years)					I would hope to work at GBS as a sessional academic for (no of years)				
	<1	1-5	6-10	>10	nr	<1	1-5	6-10	>10	nr	<1	1-5	6-10	>10	nr
18-34	0	7	2	1	0	0	8	1	1	0	1	6	2	1	0
35-54	1	18	7	3	2	4	18	4	2	3	3	11	1	14	2
>54	0	3	2	1	0	0	4	1	1	0	0	3	2	1	0

Further details of career aspirations were also investigated, as described in Table 7, with 64% (n=30) aspiring to a role as a research fellow or lecturer at Griffith university. Some of the responses to this question do contradict those shown in Table 6 as only 5 respondents noted that they considered being a sessional as a long-term role.

Table 7: Career aspirations

	Research fellow or lecturer at GBS	Research fellow in any university or research center	Research fellow or lecturer at another university	Sessional/ tutor as a long term role	Currently looking for alternative work	Semi-retired but want to keep engaged in the profession	Other
PhD student	15	1	3	0	0	1	1[a]
Completed PhD and aiming for full time role in academia	9	0	0	1	0	0	1[b]
Exp. industry professional looking for a change of career	5	0	0	1	1	2	1[c]
Exp. industry professional supplementing my income	1	0	0	4	0	0	0

Note:
PhD students include 2 experienced industry professionals, one looking for a change of career and one to supplement income
Completed PhD include 1 experienced industry professionals, looking for a change of career
[a] Not clear yet depending on the opportunities after my graduation from PhD
[b] Your survey Q22 is not set up correctly to tick all that apply. (Other respondents did not seem to have this issue)
[c] I have been a sessional tutor long term within GBS, and would like to continue to grow and build a career within academia, however due to the limited opportunities to convene, and due to the lack of respect from other permanent staff within the business school (this has been moreso within the last 5 years), I am now considering changing my profession.

Four short answer questions were included to gauge perceptions of the specific areas of training and support sessionals felt they needed from GBS and the university. Results from these questions were combined and deductive thematic analysis conducted to align with the three Principles from the BLASST framework. Sample responses are included in Table 8 to indicate the range of topics mentioned. For Quality Learning and Teaching main areas of concern were centred on gaining appropriate skills and knowledge and improving student engagement; for Support for Sessional Staff the issues centred on collegiality and mentoring from permanent staff; and for Sustainability, access to, and encouragement to complete, formal qualifications.

Table 8: Areas of training and support needed

BLASST Principle	Indicative comments
Quality Learning and Teaching	Specific topics noted for training included: Engaging my students, active learning; Various planning and delivery techniques; Design and delivery of online teaching; theory and practice of adult teaching *How to apply all available IT resource to help us improving quality and efficiency of our works*
Support for Sessional Staff	*More involvement in departmental issues - we are often the last to know and are not invited to attend departmental meetings* *More collegial interaction opportunities!* *As sessional tutors we don't often get asked for our opinion regarding what has worked and what hasn't work in the course. The students get to have their opinions heard via the SET/SEC surveys, but us tutors are in the class and we never get asked for our opinion.*

Sustainability	*As a sessional convening only one course, training is not part of my paid position. There is lack of motivations to attend training in unpaid personal time, especially as there is no extrinsic benefit to me such as promotion/ permanent employment etc. If I attend training or not I don't see there will be any change to my sessional employment situation.* *Sessional staff who are not PhD students, have little or not access to staff other than their immediate Convenor/s and as such it limits career development opportunities. Access to more formal qualifications opportunities, or at the very least, information about what is available and considered valued within the school, for future and ongoing employment.*

When asked about changes within the university, if any, have impacted on your role most during the last few years, 23 valid responses were received. Seven responses were "not applicable" or 'Not sure" with two respondents noting they were new to the university and one noted "None that I'm aware of." Only one positive change was noted "The amount of training that has improved" and two positive comment that "I have been lucky that I have great supervisors and convenors such as ... and .... who have actively encouraged me to research teaching methods on my own to improve how our teaching teams manage these students". ; "Griffith IT support are FANTASTIC!" The remaining 22 comments came under three main themes of students, employment conditions and policy and procedural changes, with five respondents covering multiple themes. Indicative comments for each of these three themes are included in Table 9.

Table 9: Changes impacting role

Students	*Students without the necessary background knowledge or skills (or necessary prerequisites) to achieve well. There is an increasingly high attrition rate and fail rate in one of the online courses, despite the additional support provided.* (2 other similar comments) *Since 2012 have noticed a significant decline in numbers of students that attend workshops and lectures (only about 10-20% show up most weeks).* *The greater number of international students in our programs, and the lack of training/preparation for this.* (1 other similar comment) *Treating students as customers and too eager to please them.*
Employment	*Due to either Uni policy or GBS policy, sessional staff are not allowed to convene courses. How can a sessional staff member grow and develop as a higher education teacher when opportunities like this are not even available?* (one other similar comment) *the casualisation of the work force; the number of unpaid hours are significant, these include consultation times, moderation sessions, and marking that goes beyond 45 minutes per student.* *Poor communication between some conveyors and sessional staff*
Policy and procedural change	*It is not a change, but just the general 'last minute' nature of teaching allocations. As sessional staff we are often left with the courses that no one wants to teach and we told only weeks before teaching starts, often leaving insufficient time to develop appropriate resources.* *Trimesters have reduced the contact hours with students.* (1 other similar comment) *Assessment turnaround is compressed.*
Multiple	*Lack of IT support to convenors,* (1 other similar comment) *casualisation of the workforce where people's incomes and in jeopardy every trimester (people unable to plan their life leading to increased stress)* *When the Department employs less external sessionals without PhD degree and started to involve more PhD alumni and PhD candidates in teaching. I could get more teaching experience. Another thing is the HEA Fellowship program that is linked to the Graduate Certificate of University Learning and Teaching.* *I have worked in so many different roles so it is hard to say, but there seems to be a lot less admin support but a lot more admin to do and especially all the technology so everything is done electronically, but they are things that we don't do often so I learn one system and by the time I do it again I have either forgotten or there is a new system.* *Changes in how academics are hired into continuing positions, changes to the hiring of sessionals (competitive) and changes to the delivery modes of teaching*

Analysis and Discussion

The responses to the survey provide a picture of a diverse cohort of sessionals, the majority of whom as looking for a long-term role at GBS be this as a sessional or in a continuing appointment. It is important to note that these aspirations do mean different professional learning opportunities need to be provided, as noted by one respondent "*Recognise that not all sessionals are PhD students, some have graduated and are making a career as academics who have sessional work as at least a part of their load. This Professional Sessional role is one that is not consistently recognised across the GBS and often not considered when offering training and support."* Further investigation will need to be undertaken to determine how best to support these difference approaches. May, Peetz & Strachan (2011) developed a casual teaching staff typology with seven categories. 1. Post graduate student – academic orientation 2. Post graduate student – industry orientation 3. Industry expert – industry orientation 4. Industry expert – academic orientation 5. Academic aspirant 6. Casual by 'choice' 7. Retiree. Our respondents mainly fall into categories 1, 3, 4, 5 with no retirees. Understanding the needs and aspirations of each of these groups will be a first step in developing personalised learning opportunities for these diverse groups. Further investigation will follow-up to determine whether this means there are no sessional staff in our school who fall into categories 2, 6 or 7, or those people did not respond to the survey.

Whilst generally satisfied with the level of support and training available to them, our sessionals are seeking further opportunities in a range of topics and through a variety of formats ranging from formal workshops to online resources and informal networking sessions that focus on a specific topic. Some of the main areas of interest for future workshops and events are in increasing student engagement and participation, developing skills to plan and facilitate teaching sessions, and a range of assessment and marking topics. Offering a range of events at times and places that suit different groups of sessional will thus be important. Formal qualification is also a priority for the majority of respondents with 13% already having already participated in this program and 68% interested in participating (Table 4). This was reinforced in the question regarding preferred styles of professional learning where 51% noted this as a preference.

The low levels of interest in the peer evaluation of teaching program noted in Table 4, contrasts the recommendations of Matthews et al. (2017), suggesting that the benefits of this program need to be more widely promoted. This is also the case for many other opportunities listed in Table 4, indicating that providing overviews and explanations of how these can be used of these with links all in one central and easily accessible location, will be a key component of support.

We need to be aware that many of our sessionals are looking for a career in academia, and provide support to help them achieve this. Although ultimately this is their responsibility, institutions can provide the resources and encouragement, through formal qualifications, collegial mentoring and opportunities to work with experienced academics on L& T projects. As the majority of respondents indicated that they aspire to a long-term career at our institution, in either a sessional or full-time capacity (Tables 6 and 7), there does appear to be justification in supporting them through paid professional learning and encouraging them to complete formal qualification in learning and teaching, which are currently offered to staff at no cost.

Development of a Professional Learning Suite

The overarching theme through all of the responses is that sessional staff are looking for ways to improve the quality of their teaching and TEL. They want to know if they are doing a good job, how they can maintain and improve this quality to stay employed and progress their career in academia. They are looking for opportunities to demonstrate their capabilities and for continuing support from all areas and levels of the university to enable them to achieve these goals. Comparing these goals to the BLASST principles, we have developed a model through which a holistic approach to professional learning and support will be developed, as shown in Table 10.

Table 10: Model for professional learning and support

	Now	Short term	Long term
Quality Learning and Teaching	How do I know I am doing a good job?	How do I maintain quality in a changing environment?	How can I improve the quality of my teaching and learning?
Support for sessional Staff	How can you support me to undertake my role in an effective and professional manner?	How can you support me maintain quality?	How can you support me improve the quality of my work and progress in my career?
Sustainability	How can I continue in my current role?	How can I progress to more senior sessional roles?	How can I further my career as an academic?

Whilst, in this version the questions are framed for the individual sessional staff to empower them to have responsibility for their professional development, future work will also develop the model to include questions that need to be addressed at different levels of the university. We will extend the levels of the BLASST framework (Department, Faculty and Institutional) to include Learning and Teaching support units at both Faculty and Institutional levels as these are areas who are usually, and certainly in our case, the main providers of professional learning and support for our sessionals.

Expanding on the cell from Table 10 titled "How do I maintain quality in a changing environment?", as an exemplar of how a sessional could choose to use this model, the following are some of the resources and opportunities a sessional staff could tap into:

- Discussion with their supervisor on any new content or approaches that are being incorporated into their course
- Attending workshops and webinars on new educational technologies being integrated by the institution

As a result of this survey analysis, a set of Design principles for the suite of learning opportunities, support and resources have been developed that will link to each of the questions raised in the model described in Table 10.

- Provide a range of opportunities that go beyond workshops
- Include networking and informal events
- Integrate opportunities for collaboration, learning with and from permanent academics
- Include easily accessible resources
- Promote engagement with recognition and reward schemes

The measures of success that will be adopted for the implementation of this suite of professional learning opportunities and resources include:

- Number of attendees at each event
- Number of sessional staff who attended at least one event
- Participant evaluation of events
- Interaction levels with provided resources
- Number of successful applications for Learning and Teaching Awards and Citations
- Any overall improvements in SET results for sessional staff
- Any overall improvements in student attendance and engagement levels in tutorials and workshop

Further Research and Conclusions

In our own context, future research will centre on finalisation, then trialling of a suite of professional learning opportunities that will meet the diverse needs of our sessionals and enable ongoing improvement in the quality of technology enhanced teaching and learning. We will also consider ways in which staff in different roles in our school need to provide on-going support for sessionals and how they can be supported in this. To enable this we will further develop, then implement the model for professional learning and support, proposed in Table 10. A detailed evaluation of the effectiveness of this approach will also be conducted in response to the call from Saroyan

and Trigwell (2015) for more research into measurement of the impact of professional learning on student learning and why some sessionals gain more from engaging in professional learning than others. The implications for the wider sector are to consider adopting and adapting the model in different institutions and contexts.
This study, the first stage in a five-part project has captured a snapshot of the sessional teaching staff cohort in an Australian business school and the professional learning preferences that they purport to find most beneficial to their skill development in the area of learning and teaching. The data collected via the survey in this study offers empirical evidence that whilst sessional staff are keen to improve the quality of their teaching, they are looking for more support and inclusion from GBS. They wish to flexibly access more targeted professional learning opportunities that are recognised by GBS or lead to formal qualifications and that will support them in their goal of further employment and/or career development. We conclude that there is an appetite for the development of a Professional Learning Suite that caters specifically for the diverse needs of business school sessionals and may be accessed flexibly.

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Profiling Language Learners in the Big Data Era

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The educational data revolution has empowered universities and educational institutes with rich data on their students, including information on their academic data (e.g., program completion, course enrolment, grades), learning activities (e.g., learning materials reviewed, discussion forum interactions, learning videos watched, projects conducted), learning process (i.e., time, place, path or pace of learning activities), learning experience (e.g., reflections, views, preferences) and assessment results. In this paper, we apply clustering to profile students from one of the largest Massive Open Online Courses (MOOCs) in the field of Second Language Learning. We first analyse the profiles, revealing the diversity among students taking the same course. We then, referring to the results of our analysis, discuss how profiling as a tool can be utilised to identify at-risk students, improve course design and delivery, provide targeted teaching practices, compare and contrast different offerings to evaluate interventions, develop policy, and improve self-regulation in students. The findings have implications for the fields of personalised learning and differentiated instruction.

Keywords: Big data, learning analytics, learner profiles, k-means clustering, online, language, IELTS.

1. Introduction

Big data are defined as “large data sets that may be analysed computationally to reveal patterns, trends, and associations, especially relating to human behaviour and interactions” by the Oxford dictionary. As opposed to traditional data sets that are usually the result of long and intentional planning by the researcher, Big data are often automatically created by the interaction of users in every organisation at every size, and in every niche. This increase in the volume, velocity, variety and veracity referred to as the four Vs of Big data (Gantz & Reinsel, 2012) on user data has provided the opportunity for companies, governments, and individuals to record and analyse information pertaining to a user’s individual, psychological and behavioural characteristics. This information can assist in constructing groups, referred to as profiles, of users who have similar characteristics. Profiling has been used in a wide range of domains such as medicine (Liu, 2018), banking (Schewe et al., 2002), marketing (Boe et al., 2001) and politics (Arian et al., 2017) to derive insight from large data sets.

With the recent advances in technology, education has grown from being a commodity of the few to being massified for the “transmission of skills” to being “universal” for a global population that needs to adapt to accelerated social and technological changes (Trow, 2007). Using video lectures at their core, Massive Open Online Courses (MOOCs) have emerged as an affordable solution in Higher Education to disseminate knowledge (Christensen et al., 2013). These days MOOCs have established themselves on the educational scene as a viable option for providing formal or informal training at scale. As the name implies, one of the defining characteristics of a MOOC is having a large number of students enrolled into the course from anywhere in the planet. With technologies reaching nearly “every corner of the world” (World Bank, 2018) enrolled students are very diverse across many demographic dimensions. A benefit of online education is that it captures students’ data and their performed learning activities via e-learning systems, providing the ability to get detailed analytics and insights about the students and their learning process. In a recent trend, profiling methods have been applied to data collected via MOOCs (Ferguson & Clow, 2015; Khalil & Ebner, 2017; van den Beemt et al., 2018; Kovanović et al., 2017; Khosravi & Cooper, 2017). These works have been very promising providing insight on the diverse needs of the student population. Consequently, profiling students has been recognised as a desirable approach in the Big data era that can contribute to the facilitation of a more tailored learning experience for individual learners (Khalil & Ebner, 2017).

In this study, we first derive learning profiles for one of the largest language MOOCs existing to date (Cook, 2018), the IELTS Academic Test Preparation course developed by the University of Queensland and offered on the edX platform, which had approximately 272,187 learner enrolments in its first run between 2015-2016. The studied data set includes information about the students’ demographics (e.g., age, gender, race), learning activities (e.g., learning materials reviewed, discussion forum interactions, video-lectures watched, assessment items submitted) and learning process (i.e., time, place, path or pace of learning activities). As our work is more focused on the way students learn rather than their race, gender or age, these specific demographic traits have been omitted. We then, referring to the results of our analysis, discuss how profiling as a tool can provide meaningful benefits for different stakeholders involved in higher education. This will be especially helpful when trying to personalise or differentiate instruction.

2. Related Work

Profiling has a long history of being used in education even before the Big data era. For centuries, students have been profiled and consequently "educated in batches". In the 1970s, a range of competing and contested theories emerged that aim to profile learners based on their "learning styles" (Coffield et. al 2004, Kirschner, 2017). These theories invited teachers to use survey instruments to assess the learning style of their students and to adapt their teaching methods to best fit the needs of their students. Similarly, in language learning most, if not all, attempts to profile learning in the language field have heavily relied on surveys. One of the first to profile students was Stern (1975) who examined language learning strategies to profile the "good language learner". Later Oxford (1990, 1995) with her SILL (Strategy Inventory for Language Learning) profiled students based on the use of strategies. Another example includes a study by Muñoz and Singleton (2007) who created profiles of "*exceptional learners*" in speaking. Other studies have looked at profile differences between learners of different languages. For example, surveys show that users enrolled in less commonly-taught languages (e.g. Russian) have different profiles from those enrolled in commonly taught languages (e.g English). The former have, in general, previous knowledge of another language, study more for personal reasons rather than for complying with curricular demands and are older on average than the latter (Brown, 2009; Magnan, Murphy, Sahakyan, & Kim, 2012). In another less commonly taught language worldwide, Japanese, learners are asked about their instructional preferences to configure their own profile via survey so they can make a better use of the Strategy Inventory for Learning Kanji (SILK, found at http://kanji-silk.net).

With the emergence of data from MOOCs and large on-campus courses, development of student profiles has attracted the attention of researchers. In a highly cited study, Kizilcec, Piech, and Schneider (2013) found four profiles of engagement: *completing* (users completing most assessments items), *auditing* (learners who mostly watched video-lectures and did few assessment items) , *disengaging* (completed assessments only at the beginning of the course) and *sampling* (explored the content the first week). This study was later replicated by Ferguson and Clow (2016) bringing to attention the fact that despite rigour in methods, when analysing online behaviour some profiles can be similar across MOOCs and some cannot. In blended learning, Lust et al. (2013) used profiles to identify groups of *no-users*, *intensive users*, *selective users* and *limited users*. Brooks, Epp, Logan, & Greer (2011) found *minimal active learners*, *disillusioned learners*, *deferred learners* and *just-in-time learners*. Mirriahi, Liaqat, Dawson, & Gašević (2016) identified *minimalists*, *task focused*, *disenchanted* and *intensive learners*. Other studies show instructional preferences (instructor-led vs self-directed), attitude traits (Watson, Watson, Yu, Alamri, & Mueller, 2017) while Lynda (2017) used profiles to perform peer-assessment. In an engineering course, Khosravi and Cooper (2017) found sub-populations of students with extreme patterns of engagement: the *"overly engaged participants"* and the *"infrequent participants".* Corrin, Barba, and Bakharia (2017) found five different learner profiles of students when help-seeking in MOOCs: *low engagement students, assessment-focused -low grades, passive engagement, active engagement, assessment-focused- high grades*. Reidsema et. al (2017) analysed the learning pathways of students in a large flipped engineering course and Kizilcec, Pérez-Sanagustín, and Maldonado (2017) profiled students who focused on specific strategies (help-seeking, goal-setting and strategic planning) of Self-regulated learning.

To the best of our knowledge, to date there are only two studies that have attempted to describe language learners on a large scale. Türkay (2017) used demographic information and self-reporting surveys of 100 online courses to discover motivational differences between English language learners (ELLs, learners who self-identify as *non-fluent* in English) and non-English language learners (non-ELLs, students who identify themselves as *fluent* in English). ELLs are "more motivated to earn a certificate" despite reporting a lack of interest in earning credit and are also said to be eager to engage with the online community despite their participation in forums being lower than that of non-ELLs. In a different study, Martín-Monje (2018), found that learners' favourite learning object in a MOOC was video-lectures and then, based on the combination of use of learning objects (article, video or book), that most learners were "*viewers*", who accessed content but did not submit tasks. In this paper, we focus on profiling students from one of the largest language learning MOOCs by taking a methodological approach that deals with multiple learning variables at the same time.

3. Research Methodology

In this section, the research methodology is presented. In Section 3.1 the IELTS MOOC is described. Section 3.2 describes the course assessment. In Section 3.3 student demographic data is explained. Section 3.4 describes the student event logs and grade data tracked by edX. Finally, Section 3.5 explains the profiling approach used to determine and analyse the different student profiles.

3.1 Course Overview

The IELTS Academic Test preparation course launched by The University of Queensland in edX in November 2015 is analysed in this paper. Each section of the course is divided into chapters, one for each language skill: Listening, Speaking, Reading and Writing. These chapters correspond to the sections of a real IELTS Academic test: Listening, Reading, Writing and Speaking. Each chapter then comprises video lectures that explain strategies to master the micro-skills assessed in the sections of a real IELTS test e.g (skimming, scanning, identifying paraphrases and references). Each chapter also includes practical exercises in various formats to put into practice the strategies explained.

3.2 Course Assessment

While the receptive macro skills (Listening and Reading) can be assessed objectively through the edX platform, the productive macro skills (Writing and Speaking) require each participant to compare their own performance against a set of rubrics. These factors have implications for the assessment tasks throughout the course which are reflected in the assignment policy that assigns 48% to Listening (24% for activities and 24% for the practice tests), 48% to Reading (24% for activities and 24% for practice test), 2% for Speaking self-assessment and 2% for Writing self- assessment.

3.3 Participants

A total of 272,187 users from 212 countries around the world enrolled in the course between November 2015 and November 2016. The overall median age of learners was 29, with most users falling into the age range 26-40 years old (60.7%) followed by a group aged under 25 (29.8%) and finally 41 and over (9.5%). The self-reported data also show that 50.8% held a Higher Education degree, 27.5% an Advanced degree (Doctorate, Master's or Professional degree) and 19.7% a High School diploma or less. To focus our analysis on students who made a serious attempt towards completion of the course, we limit our analysis to data from students who received a final grade of at least 20%. Therefore, the analysis includes data from 22,164 students.

3.4 Data Organisation

Data were obtained through the edX platform itself. Table 1 contains the list of features that was created for each student and provided to the k-means algorithm (see Section 3.5). The features have been grouped together as shown in Table 1. Some features represent aggregate counts (e.g. number of forum posts) while others require data pre-processing (e.g. average time between sessions and average number of chapters completed per session). The features have been selected to encode visitor frequency (average number of sessions per week), time spent on task (average session duration), how learners viewed and reviewed video (number of plays, number of pauses), and how learners completed course content (average number of chapters completed per session). The average number of sessions spent on each chapter is included to give an indication of how learners were distributing their time on these four skills.

Table 1: Features created for each IELTS course learner

Feature types	Descriptions
Sessions	s_1 = average session duration time, s_2 = total number of sessions, s_3=time between sessions.
Video interactivity	v_1 = number of plays, v_2 = number of pauses, v_3 = number of video seeks, v_4 = number of times a transcript was viewed.
Community engagement	e_1 = number of forum posts read, e_2 = number of comments posts, e_3 = number of forum votes
Content	c_1 = number of sessions which include access to chapter 1 (Listening), c_2 =number of sessions which include access to chapter 2 (Speaking), c_3 =number of sessions which include access to chapter 3 (Reading), c_4 =number of sessions which include access to chapter 4 (Writing)
Assessment	a_1 = number of problems attempted, a_2 = first summative assessment, a_3=second summative assessment
Final Grade	g_1 = 1st quartile, g_2 = median, g_3 = 3rd quartile

3.5 Profiling Approach

As per previous studies (e.g. Khosravi & Cooper, 2017), k-means clustering was used to find student Learning Profiles. K-means clustering is an unsupervised algorithm capable of finding groups of students with similar characteristics. It takes as input a matrix, each row representing an individual, and aggregates associated features as columns in the matrix. The selection of appropriate features is very important and is known as feature engineering. The features included in this study have been specifically designed to reveal learner similarity from a personalised learning perspective. The k-means algorithm requires that the number of clusters (i.e., student profiles) be provided as a parameter. The clustering algorithm was run 100 times to select the solution with the highest likelihood. To determine an appropriate value for the number of clusters in the data set the elbow method was used. The elbow method computes the sum of within-cluster variances which can then be plotted in a curve. The most prominent turning point in the curve suggests the best number of clusters. Within this paper each cluster is referred to as a student profile and analysed.

4. Data analysis

This section analyses the learner population which took the IELTS Academic Test preparation course launched by The University of Queensland in edX in November 2015 by applying the methodology presented in Section 3. The results obtained from running k-means reported five clusters also known as profiles. These clusters are ordered from C1 to C5 in descending population size as shown in Table 2.

4.1 Cluster-based analysis

A short description of the resulting clusters is provided below. All of the reported numbers refer to average values for the entire cluster and not any individual.

Strong starters, weak finishers (C1): The largest cluster, containing 38.86% of the analysed population, gave more emphasis to the first section presented in the course (Listening), visiting it more than other sections and getting high scores only in the corresponding formative assessment, then exhibiting a gradual decrease in participation and a sharp drop in grades. They did very well in the formative assessment of the first section where strategies (e.g identifying paraphrases or predicting words and situations) in a listening context were provided. In turn, they performed relatively well in the corresponding summative assessment. In comparison with other chapters, they had a higher level of engagement with the content of the first chapter. These learners rarely engaged with the online community and had a very low average number of forum reads (2.49) and even a lower average number of forum posts (0.06) - meaning that many members never posted.

More content, less assessment (C2): The second largest cluster, containing 19.36% of the analysed population, had the particularity of engaging well with the content spread throughout the course by visiting each of the four sections (skills) uniformly and making high use of the video features (e.g pauses, seeks, speed changes, show transcripts). Despite this, they did not seem very interested in the practice tests that represent the summative assessment for each section, but only in the formative tasks for the two receptive skills (Listening and Reading) which were assessed objectively (in multiple choice format). Both their average number of sessions and their average session length were high throughout the course. They were also prompt to return between one session and the next (290336 s). Their forum reads are less than moderate (4.45) with a very low number of forum posts (0.12).

More assessment, less content (C3): The third largest cluster, containing 17.87% of the analysed population, has the lowest level of engagement; members of this cluster had the lowest average number of sessions (9.08) with the lowest average session length (1258.33 s) and the lowest average number of video plays. Their community engagement was also lowest of all clusters both in their forum reads (1.25) and their forum posts (0.03). Interestingly, they scored high in the first summative assessment presented in the course (Listening). This might indicate that this group had minimal interest in the content of the course and in their short time spent on the course mostly focused on the assessment.

Very high engagement, moderate performance (C4): The fourth largest cluster, containing 16.03% of the analysed population, has the highest number of sessions (41.30) with the highest rates of video interactivity (e.g video seeks, video speed changes, show transcripts) of all the groups. They also interacted steadily with the content in each section of the course. Having the highest average session length (2561.59 s) and the lowest average time between sessions in comparison with other clusters, learners in this cluster were quicker to come back to the course than the other clusters. They had the second highest average grade; they performed highly in the formative (and objective) assessment of the receptive skills (Listening and Reading), moderately well on the summative assessments of both Speaking and Writing which are subjective (open answers format) and constitute only 4% of assessment overall (2% for each productive skill). Compared to other clusters, their participation in forums was neither high nor low: reads (4.45) and forum posts (0.14).

High engagement, high performance (C5): The smallest cluster, containing only 7.87% of the analysed population, belongs to those learners who got the highest scores of all. They outperformed the other clusters in nearly all the features performing very well across the formative and summative assessment throughout the four skills and exhibited other positive characteristics in assessment-related events such as check progress, show answers and attempt problems. They had the highest number of play and pause videos counts as well as other video features (e.g., seeks, stops, show transcripts), indicating that they were more actively involved learners while watching the videos. They displayed a very high number of sessions (39.07) with the highest average session length (2604.16) though their average returning time between sessions is not the highest among other clusters. They have the highest number of forum reads (13.06) and forum posts (0.48) among all of the clusters.

Table 2: Using k-means to cluster the class population across features described in Table 1

label	Size	Sessions		Video Interactivity				Community engagement			Content				Assessment engagement			Grade		
		s_1	s_2	v_1	v_2	v_3	v_4	c_1	c_2	c_3	c_1	c_2	c_3	c_4	a_1	a_2	a_3	g_1	g_2	g_3
C1	38.8%	2128	18	104	57	24	7	2	0.02	0.01	20	7.5	2.6	1	372	0.57	0.05	0.29	0.38	0.44
C2	19.3%	2566	35	304	152	80	17	4	0.06	0.02	20	16	22	10	634	0.31	0.08	0.31	0.41	0.5
C3	17.8%	1258	9	41	19	9	2	1	0.01	0.01	6	3.1	2.3	1	84	0.75	0.22	0.21	0.24	0.31
C4	16.%	2561	41	331	168	89	22	6	0.06	0.04	22	18.9	24	11	789	0.77	0.64	0.67	0.77	0.86
C5	7.8%	2604	39	410	176	82	20	13	0.23	0.31	21	19.5	20.7	12	921	0.81	0.76	0.80	0.89	0.95

Figure 1 visually illustrates how the five clusters compare against one another across some of the main features obtained through the edX platform.

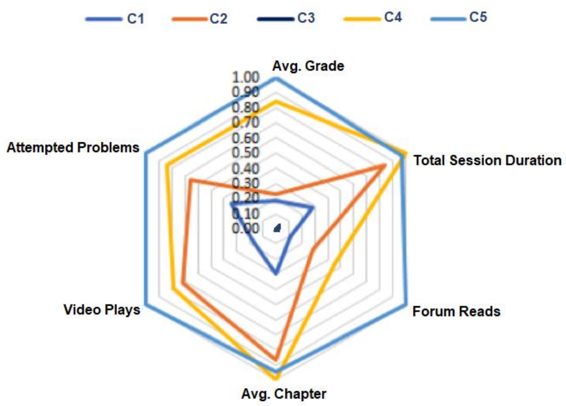

Figure 1: A visual illustration of how different clusters compare against some of the main features that were introduced in Table 1

5. Benefits of Profiling Students

In this section, we discuss the potential benefits of profiling for different stakeholders. The benefits that arise from profiling students are mainly due to the affordances provided by the clustering algorithm (i.e. k-means). The important properties of the k-means clustering algorithm include the ability to find groups of similar students even when a large number of features are provided to the algorithm and the ability to assign each student to a profile. These two properties allow statistical summaries to be calculated for each cluster, which aids in the interpretation and naming of profiles. Some of the main benefits of profiling are discussed below.

Identifying at-risk students: Methods of identifying at-risk students with the aim of utilising retention strategies have been well studied in the literature Marbouti et al. (2016). Profiling students at early stages in the semester to identify disengaged students can be used as a viable option for identifying at-risk students (De Paepe et al., 2016). In our study, students assigned to C1 may be considered as at-risk students.

Improving course design and delivery. The profiles provide detailed information regarding the engagement and performance of students throughout the course, which may be used towards improving the design and delivery of a course. For example, a high number of pauses or seeks on some videos across one more clusters may suggest that students find the content of the video challenging or confusing. This information may be used towards re-evaluating the quality and consequently updating that video. Profiles can also provide insightful information in terms of course delivery. For example, in our study, the students associated with the *"More assessment, less content"* profile seem to aim to attempt assessment items without first going through the associated learning material. Once this phenomenon is identified, it is possible to change the course delivery mechanisms to minimise this behaviour. For example, the assessment items can be embedded in the learning material to encourage students to review the learning content before attempting the assessment items.

Provide targeted student interventions. Profiles may be used to provide targeted interventions for students associated with each cluster based on their behaviour or learning needs. For example, an instructor may wish to share optional additional advance learning material with students in the "*High engagement, high performance*" cluster while providing more support material and words of encouragement for students in the "*Strong starters, weak finisher*" cluster.

Comparing offerings and evaluate interventions. Profiles can be used to visually compare and contrast different courses or different course offerings. For example, it is possible to visually compare profiles of two offerings of the same course to determine how the clusters are similar or different in terms of students' engagement and performance. This may be used as a mechanism to evaluate interventions. For example, if the two offerings are using a different set of learning material (e.g. videos), it is possible to evaluate and visually determine which set of videos have led to better engagement and performance.

Developing policy. Based on reports of learning profiles from across an institute, university administrators may have a global view of the effectiveness of an action or an intervention, which may lead to the development of policies. For example, in the 2015-2016 offering of this IELTS course, access to assessment items was available to both paid and non-paid users. In the 2016-2017 offering of this IELTS course, access to assessment items was only available to paid users. Comparison of the profiles across many MOOCs that have tried out features to be included or excluded for non-paying users may enable university administrators to develop policy around access.

Promoting self-regulation. Sharing the profiles with students enables them to be aware of their strengths and weaknesses so that they themselves can suggest the best mechanisms to overcome their flaws, decide which paths to take and even become knowledgeable enough to create their own cognitive tools.

Table 3 shows how diverse stakeholders within an educational ecosystem are able to use student profiles for a range of tasks.

	University Administrators	Program Administrat.	Instructors	Learning Designers	Educational Researchers	Students
Identify at-risk students	**X**	**X**	**X**		**X**	**X**
Improve course design and delivery			**X**	**X**	**X**	
Provide targeted student interventions, scaffolded instruction and feedback			**X**	**X**	**X**	**X**
Compare offerings and evaluate interventions		**X**	**X**	**X**	**X**	
Develop policy	**X**	**X**			**X**	
Promote self-regulation			**X**		**X**	**X**

Discussion and Conclusion

This paper presents learning profiles of language test-takers as a means to identify who they were, not in terms of traditional profiling features such as age or country of origin (that may be misleading when assisting a learner) but in terms of actual behaviours when learning. Of particular interest are those behaviours which reflect weaknesses or needs during the learning process. They should be interpreted as a call to action for educational stakeholders to intervene.

Our results, reiterating findings from past studies (e.g. Ferguson & Clow, 2015; Khalil & Ebner, 2017; Khosravi & Cooper, 2017), suggest that learners are very diverse in terms of their approach, behaviour and performance. 38% of the analysed population were profiled as "*strong starters, weak finishers*" due to their high engagement at the beginning of the course and low engagement towards the end of the course. 19% of the analysed population were placed in the "*More content, less assessment*" profile as they primarily focused on watching videos and reviewing notes without engaging with the assignments. In contrast, 18% of the analysed population were placed in the "*More assessment, less content*" profile as they show no interest in the content and moved straight to the tests. 16% of the analysed population were profiled as having "*very high engagement, moderate performance"* and finally 8% of the analysed is profiled as having "*High engagement, high performance*".

In general, it can be said that the higher the engagement, the higher the grade. For example, clusters C5 and C4, which achieved the highest grades, also recorded the highest figures relating to features such as number of sessions, number of chapters covered, video plays and attempted problems. Of particular importance is cluster C2 which, despite having good engagement with the whole course, did not seem to be especially interested in assessment. In contrast, cluster C3 showed minimal interest in the content and focused their efforts mostly on the practice test. Learners in C3, were mainly using the MOOC to practise their IELTS skills and prepare for the official IELTS test with little motivation in obtaining a certificate from edX.

While some of the student clusters share some traits with others from past studies (e.g those highly engaged learners) due to the nature of the course there are also distinctive learner characteristics that stand out in this study. Student characteristics exhibited in each learning profile were the result of learning behaviours revealed throughout the course. This way of profiling students makes it a suitable fit to advance the field of personalised education. Technology designers, educators and administrators all together may harness data captured by learning profiles to improve mechanisms that support those learners who fall behind, keep encouraging those who are doing well and keep all the others in between on track. Given the diversity among learners, we discussed how profiling as a tool can provide benefits for university administrators, program administrators, instructors learning designers, educational researchers and students. These benefits include identifying at-risk students, improving course design and delivery, providing targeted teaching practices, comparing and contrasting different offerings to evaluate interventions, developing policy, and improving self-regulation in students.

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Exploring Nursing Students' Perceptions of Educational Experience and Satisfaction in a Blended Learning Course

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This survey study aims to investigate nursing students' perceptions of educational experience and satisfaction in a blended course. The modified Community of Inquiry (CoI) and satisfaction questionnaires consist of 5-point Likert scale items, were administered to 224 nursing students. Nursing students were found to have good educational experience (social, cognitive and teaching presences) and satisfaction in this blended course.

Keywords: Blended learning, cognitive presence, community of inquiry, educational experience, satisfaction, social presence, teaching presence

Introduction

The advancement of digital technology in the healthcare sector has prompted higher institutes to re-design their courses and deploy instructional strategies to engage the millennial nursing students in learning that is relevant to the healthcare workforce. These learners are digital natives that exhibit characteristics such as learning confidently with digital technologies and forming online social learning communities easily. In order to engage the millennial learners, blended learning which combines the face-to-face and online learning is commonly adopted by institutes. Blended learning was reported to be much favoured over fully online learning (Cheung & Hew, 2011; Wang, Author & Hu, 2017). It was highlighted that students in a typical blended course have more control over their learning through asynchronous online learning alongside the face-to-face instruction to engage them and help them experience quality instructor-student interactions in the classrooms. The deliberate design of face-to-face and online instructions have been reported to promote multi-level interactions between learners and resources, learners and instructors as well as amongst the learners themselves. This multi-level interactions have potentially led to meaningful learning outcomes (Okaz, 2015). However, there are two pedagogical challenges in implementing blended learning in institutions (Chan & Author, 2014). These challenges were the increased complexity in the instruction of the tasks and the lack of institutional support. It was also reported that the implementation strategies used by institutions varied from change management process to using framework or guidelines. Further research into successful implementation strategies, design of tasks and framework of bended learning is still needed.

In the study, blended learning for nursing students was implemented for several years in a particular school. It is timely for the school administrators, course leaders and instructors to review what the students' perceived educational experience and satisfaction are, and whether to scale up the blended learning for more courses in the near future. In the training of the next generation of nurses, nursing courses should also provide a meaningful educational experience supported by the latest digital technologies, such that the experience gained and satisfaction derived in nursing as an educational or career choice can translate into their personal and professional development in the workplace. This study is guided by two research questions:

- What are nursing students' perceived educational experience in terms of teaching, social and cognitive presences in a blended course?
- What are nursing students' perceived satisfaction after attending a blended course?

Literature Review

The CoI framework and its earlier methodology were designed for exploratory studies, with early research relying on laborious transcript analysis extracted from online discussion forums (Garrison, Cleveland-Innes & Fung, 2010). Due to the need to study larger samples of learners' perceptions and experience of the three presences**,** Arbaugh and colleagues (2008) developed and tested a CoI questionnaire through a multi-institutional effort. The Community of Inquiry (CoI) framework is well-established in guiding research in the specific context of asynchronous, text-based group discussions in higher education and can be used for blended learning context (Akyol & Garrison, 2008). It is conceptually grounded in theories of teaching and learning such as collaborative-constructivism and John Dewey's belief that inquiry is a social activity and the essence of an educational experience. The framework was proposed to provide order, heuristic understanding and methodology for studying the effectiveness of online learning (Garrison, Anderson & Archer, 2010). The CoI framework attempts to outline not only the interdependent presences (social, cognitive and teaching) but also to understand and create a deep and meaningful educational experience as the heart of the framework (Arbaugh et al., 2008). The basis of this framework is that a deep and meaningful educational experience is best supported in a community of learners engaged in inquiry, critical reflection and discourse. It identifies the core elements of a collaborative-constructivist learning environment required to create and sustain the online learning community for purposeful educational experience (Garrison et al., 2010). The CoI framework can be used to understand the effectiveness of blended learning and the dynamics of learners' blended learning experience (Arbaugh et al., 2008; Garrison et al., 2010).

Social presence is defined as the ability to project oneself and to establish purposeful and personal relationships. It involves effective communication, open communication, and group cohesion. Cognitive presence is defined as the exploration, construction, resolution, and confirmation of understanding through collaboration and reflection, operationalised through the practical inquiry model and grounded in the work of Dewey's reflective thinking. Thus, a thoughtful, focused and attentive teaching presence is required to establish and maintain a community of inquiry, for the purpose of realising meaningful educational learning outcomes (Garrison, 2007; Garrison et al., 2010). Akyol and Garrison (2008) used the original 34-item CoI questionnaire and had found it to be suitable for the blended learning context. However, there is a need to further examine the influence of teaching, cognitive and social presences on satisfaction in a blended course using the 34 items in the original CoI questionnaire on a larger sample size. Choy and Author (2016) modified the CoI questionnaire and adapted it for use in the Singapore context. Their study was conducted on 167 students in a blended learning course on nutrition. Findings confirmed the hypothesised relationships among the three elements of the CoI framework (i.e., social, teaching, and cognitive) and students' learning related outcomes (i.e., satisfaction, continuous academic-related online performance, and academic achievement). Generally, the hypothesized model was able to explain 46% of the variance in students' online course satisfaction and 62% of the variance in students' academic achievements. However, only the cognitive element had a direct relationship with continuous academic-related online performance and satisfaction.

Learner satisfaction in learning refers to how instructional strategies are experienced by learners cognitively, emotionally and socially to help them achieve their learning goals. Learner satisfaction is an aggregate feeling that affects the interactions between the instructor and students, students and peers as well as student and resources in a blended course. Learner satisfaction can potentially affect the learners' effective learning and competence. The design of the blended learning environment, learning activities, facilitation and provision of timely feedback are the precursors to learner satisfaction and their desire to continue their learning. The outcome of learner satisfaction is likely to determine sustainability and scalability of blended courses (Bekele, 2010; Arbaugh, 2000). The learners' perceived satisfaction of the Internet-based courses in higher education context was measured using online surveys. The survey items would (i) focus on their satisfaction in taking the course, (ii) measure their perception of course quality and (iii) measure their likelihood of taking future courses. The perceptual measure of the learner satisfaction indicates the success of the educational program and decision making of the courses.

Methods

This study employed a cross-sectional survey design to explore the nursing students' educational experience and satisfaction in a blended course at a single point in time. For this blended nursing course, the researchers preserved the questionnaire for administration. In this study, Arbaugh's (2000) questionnaire on learner satisfaction was modified, with inputs from the researcher and nursing course leader after pilot testing. The modifications were made to tailor to the nursing students' prior experience and to suit the specific context of this blended nursing course. There are three parts to the overall questionnaire used in this study, consisting of (i) demographic of participants (e.g. gender, age, entry qualification), (ii) 37 items from modified CoI questionnaire showed overall good reliability (α=.95) and (iii) 10 items from modified learner satisfaction questionnaire with good overall reliability (α =.96). For (ii) and (iii), the use of the CoI items were based on the previous locally validated five point Likert COI questionnaire (Choy & Author, 2016) for use among the polytechnic context. This study is part of a bigger study which also examines the validation of the questionnaire among the nursing students. However, the findings would not be reported in this paper. The focus of this paper is to report the nursing students' perception of their experience and satisfaction based on the blended learning course using the modified CoI.

Sample

224 students volunteered and participated in this survey study. These participants comprised of 187 (83.5%) female and 36 (16.1%) male students. The majority of them (90%) were in the middle age. The participation rate

was 82.96%. These students attended Nursing Science 3 which was a 72 hour course that covered 11 categories of human system disorders. The blended learning design of this nursing course combines face-to-face (74%) and online instructions (26%). In the online learning, educational games were introduced to nursing students to learn by doing, rather than observational learning through traditional means. For the face-to-face lectures and tutorials, Students brought their own mobile devices so that they could access digital learning activities. These digital devices used were personal computers, mobile devices, tablets while the web 2.0 tools (e.g. Kahoot, Nearpod, Google Drive, Google Document, Google Slides). The Learning Management Systems (e.g. Blackboard) was used to support their access to course information and multimedia resources (e.g. Virtual Hospital game, PowerPoint slides, videos, pictures, course schedule etc) designed by their instructors.

Results

Overall Means and Standard Deviations of Nursing Students' Educational Experience and Satisfaction

Descriptive statistics were used to analyse 224 students' responses to the modified CoI. Table 1 shows the means and standard deviations of 224 nursing students' 5-point Likert survey responses. It was reported that the means of perceived teaching presence (M = 3.87, SD = .64), perceived social presence (M = 3.65, SD = .66), perceived cognitive presence (M = 3.71, SD = .65) and satisfaction (M = 3.69, SD = .74) were above the average of 2.5. This shows that most nursing students perceived themselves to have meaningful educational experience, in teaching, social and cognitive presence, and satisfaction in this blended nursing course.

Table 1: Overall Means and Standard Deviations of Nursing Students' Perceived Teaching, Social, Cognitive Presences and Satisfaction in Modified CoI Questionnaire (N = 224)

Dimensions	**Means (SD)**
Perceived teaching presence	3.87 (.64)
Perceived social presence	3.65 (.66)
Perceived cognitive presence	3.71 (.65)
Perceived satisfaction	3.69 (.74)

Nursing Students' Perception of Teaching Presence

Table 2 shows the nursing students' perceptions and the frequencies of their responses on the five-point scale. The mean and standard deviation of each item in the modified CoI questionnaire was also calculated. Findings show that nursing students perceived better teaching presence (Mean=3.87, SD=.64) as compared to the cognitive and social dimensions. The smaller standard deviation of .64 for perceived teaching presence indicate that more nursing students' responses cluster around the mean of 3.87, as compared to other factors. Nursing students' responses on the five-point scale were calculated for each item as shown in Table 2.

Table 2: Means, Standard Deviations and Frequencies of Teaching Presence in Modified CoI Questionnaire (N = 224)

Dimension 1: Teaching Presence (Mean= 3.65, SD=.66)		Means (SD)	Frequency (%)				
			1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree
1.1	The lecturer clearly communicated important course topics.	3.92 (.78)	.4	3.1	22.8	51.3	22.3
1.2	The lecturer clearly communicated important course goals.	3.92 (.76)	.4	2.7	21.9	54.0	21.0
1.3	The lecturer provided clear instructions on how to participate in course learning activities.	3.87 (.78)	.9	2.2	25.1	52.5	19.3
1.4	The lecturer clearly communicated important due dates or time frames for learning activities.	3.95 (.80)	.9	1.3	25.0	47.3	25.4
1.5	The lecturer was helpful in identifying areas of agreement and disagreement on course topics that helped me to learn.	3.91 (.75)	.9	1.3	23.7	54.5	19.6
1.6	The lecturer helped to keep course participants engaged and participating in productive dialogue.	3.83 (.77)	.9	1.8	28.6	50.4	18.3
1.7	The lecturer helped keep the course participants on task in a way that helped me to learn.	3.89 (.78)	.4	1.8	28.1	47.8	21.9
1.8	The lecturer encouraged course participants to explore new concepts in this course.	3.85 (.77)	.9	1.8	27.2	51.3	18.8
1.9	The lecturer reinforced the development of a sense of community (i.e. a sense of belonging, safe learning environment, shared values) among course participants.	3.79 (.81)	1.3	3.6	27.2	50.9	17.0
1.10	The lecturer helped to focus discussion on relevant issues in a way that helped me to learn.	3.85 (.77)	.9	.9	29.9	48.7	19.6
1.11	The lecturer provided feedback that helped me understand my strengths and weaknesses relative to the course's goals and objectives.	3.79 (.81)	1.3	2.2	30.8	47.8	17.9

Nursing Students' Perception of Social Presence

Table 3 shows the nursing students' perceived social presence has the lowest mean (M = 3.65, *SD* = .66). Course leaders and lecturers could look into strengthening social presence in this blended course. The lowest mean score of 3.58 was from "I felt comfortable disagreeing with other course participants while still maintaining a sense of trust" in the social presence scale. 10.7% felt uncomfortable disagreeing while maintaining a sense of trust, 33.2%

remained neutral and 56.1% felt comfortable disagreeing while maintaining a sense of trust. In order not to break the sense of trust or sense of goodwill among course mates, some nursing students might tend to agree for the sake of being friendly, helpful or cooperative i.e. more comfortable and likely to share opinions that concur. This result is interesting as it contradicts nursing students' perception of having stronger knowledge and skills to use digital technologies responsibly for communication, socializing and learning through observing netiquette, protecting safety or privacy and dealing with cyberbullying issues. Lecturers may provide scaffolds in the form of sentence starters or model how to disagree respectfully in an objective manner e.g. not to be influenced by personal feelings or opinions when presenting their considerations and representing facts. By doing so, lecturers can help to create an atmosphere of trust and safety for learning in a community, thereby improving social presence.

Table 3: Means, Standard Deviations and Frequencies of Social Presence in Modified CoI Questionnaire (N = 224)

Dimension 2: Social Presence (Mean =3.65, SD=.66)		Mean (SD)	Frequency (%)				
			1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree
2.1	Getting to know other course participants gave me a sense of belonging in the course.	3.61 (.82)	2.2	4.9	32.3	50.7	9.9
2.2	I was able to form distinct impressions of some course participants.	3.64 (.80)	.9	4.9	36.3	44.8	13.0
2.3	Online or web-based communication is an excellent medium for social interaction.	3.65 (.79)	.4	5.8	34.5	47.1	12.1
2.4	I felt comfortable conversing through the online medium.	3.72 (.85)	.9	6.7	28.3	47.5	16.6
2.5	I felt comfortable participating in course discussions.	3.68 (.81)	.4	6.3	32.3	46.7	14.3
2.6	I felt comfortable interacting with other course participants.	3.66 (.84)	.9	7.2	30.9	47.1	13.9
2.7	I felt comfortable disagreeing with other course participants while still maintaining a sense of trust.	3.58 (.87)	.4	10.3	33.2	42.6	13.5
2.8	I felt that my point of view was acknowledged by other course participants.	3.64 (.78)	.4	5.4	35.4	47.1	11.7
2.9	Online discussions help me to develop a sense of collaboration.	3.64 (.77)	.5	5.4	34.8	48.0	11.3

Nursing Students' Perception of Cognitive Presence

Table 4 shows the nursing students' perceptions and the frequencies of their responses on the five-point scale. The mean and standard deviation of each item in the modified CoI questionnaire was also calculated. Findings show that nursing students perceived fairly high cognitive presence (Mean=3.71, SD=.65). In this blended course, the lower mean scores perceived by students in the course activities, case studies and writing reflection could suggest that these learning activities might not be meeting the students' learning needs.

Table 4: Means, Standard Deviations and Frequencies of Cognitive Presence in Modified CoI Questionnaire (N = 224)

Dimension 3: Cognitive Presence (Mean=3.71 , SD=.65)		Mean (SD)	Frequency (%)				
			1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree
3.1	Case-studies posed increased my interest in course issues.	3.67 (.84)	2.2	3.1	34.1	46.6	13.9
3.2	Course activities piqued my curiosity.	3.62 (.84)	2.2	4.0	35.4	45.7	12.6
3.3	I felt motivated to explore content related questions.	3.64 (.85)	2.2	4.9	32.7	47.1	13.0
3.4	I utilized a variety of information sources to explore case-studies posed in this course.	3.71 (.73)	.9	2.7	31.5	54.1	10.8
3.5	Brainstorming and finding relevant information helped me resolve content related questions.	3.70 (.77)	1.3	2.7	33.2	50.7	12.1
3.6	Online discussion were valuable in helping me appreciate different perspectives.	3.71 (.78)	1.3	2.2	33.6	49.3	13.5
3.7	Combining new information helped me answer questions raised in course activities.	3.74 (.73)	.5	2.7	32.4	51.4	13.1
3.8	Learning activities helped me construct explanations or solutions.	3.76 (.76)	.9	2.7	30.2	52.3	14.0
3.9	Reflection on course content and discussions helped me understand fundamental concepts in this class.	3.68 (.76)	1.4	2.7	33.8	51.4	10.8
3.10	I can describe ways to test and apply the knowledge created in this course.	3.73 (.77)	.9	2.2	34.1	48.4	14.3
3.11	I have developed solutions to case-studies that can be applied in practice.	3.73 (.75)	.4	3.6	31.8	50.7	13.5
3.12	I can apply the knowledge created in this course to my work in future.	3.84 (.73)	.5	.9	30.1	50.7	17.8

Nursing Students' Perception of Satisfaction in a blended course

Table 5 shows the nursing students' perceptions and the frequencies of their responses on the five-point scale. The mean and standard deviation of each item in the modified CoI questionnaire was also calculated. The mean scores of all items in the modified satisfaction questionnaire ranged from 3.58 to 3.74. The standard deviations ranged from .80 to .92. One of the items, "I will take as many courses that incorporates uses of technologies as I can." has shown the lowest mean score (M = 3.58, *SD* = .92), 9.4% of the nursing students disagreed, 33.9% remained neutral and 56.7% agreed. In another item, "I was satisfied with the way this course worked out." has the highest mean score (M = 3.74, *SD* = .87). 5.8% disagreed, 32.1% remained neutral and 62.1% agreed.

Table 5: Means, Standard Deviations and Frequencies of Satisfaction (N = 224)

Satisfaction (Mean= 3.69, SD= .74)		Means (SD)	Frequency (%)				
			1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly agree
1	I am very satisfied with this course.	3.71 (.85)	1.8	4.5	30.8	47.3	15.6
2	I feel that this course served my needs well.	3.72 (.83)	1.3	4.0	32.1	46.0	16.5
3	Conducting the course with the use of technologies improved the quality of the course compared to other nursing courses.	3.77 (.80)	.9	3.1	31.3	47.8	17.0
4	I will take as many courses that incorporates uses of technologies as I can.	3.58 (.92)	3.1	6.3	33.9	42.9	13.8
5	The quality of the course compared favourably to my other nursing courses.	3.70 (.87)	1.8	3.6	35.4	40.8	18.4
6	I feel that the quality of the course I took was largely unaffected by conducting it with the use of technologies.	3.71 (.83)	.9	4.9	32.7	44.8	16.6
7	I was satisfied with the way this course worked out.	3.74 (.87)	1.3	4.5	32.1	42.9	19.2
8	If I had another choice, I would still take this course with the use of technologies.	3.63 (.89)	3.1	3.1	36.6	42.0	15.2
9	Conducting the course with the use of technologies made it easier than other nursing courses I have taken.	3.61 (.86)	2.2	4.5	37.5	42.0	13.8

Discussion

Nortvig, Petersen and Balle (2018) conducted a review of studies comparing face-to-face teaching to online and/or blended learning and noted that student learning in online and/or blended courses appears not to arise from technology per se but from a combined influence of context, learner characteristics and implementation. Since nursing students' perceived social presence has the lowest mean ($M = 3.65$, $SD = .66$), course leaders and lecturers could look into strengthening social presence in this blended course. The lowest mean score of 3.58 was from "I felt comfortable disagreeing with other course participants while still maintaining a sense of trust" in the social presence scale. 10.7% felt uncomfortable disagreeing while maintaining a sense of trust, 33.2% remained neutral and 56.1% felt comfortable disagreeing while maintaining a sense of trust. In order not to break the sense of trust or sense of goodwill among course mates, some nursing students might tend to agree for the sake of being friendly, helpful or cooperative i.e. more comfortable and likely to share opinions that concur. Nortvig and colleagues (2018) reported that some students may feel empowered and knowledgeable, when posting on an online platform, while some students may refrain from posting due to their perceived lack of knowledge. The lack of moderation from lecturer or peer response to the postings may also contribute towards isolating the latter group of students further from the online academic community of learners. It is important for course leaders and lecturers to create sufficient learner support through scaffolding online discussions in details, setting rules on the quantity and quality of postings, monitoring and following up on non-participation (Nortvig, et al., 2018). Lecturers may also provide a structure for peer response (e.g. each student to respond to three different postings by others and to limit the maximum number of peer response to five) or provide scaffolds in the form of sentence starters or model how to disagree respectfully in an objective manner (e.g. not to be influenced by personal feelings or opinions when presenting their considerations and representing facts). Lecturers can also interact with students online, address some postings and highlight interpersonal dialogues during face-to-face and/or online lessons so that students perceive the importance of online participation.

Nursing students' perceived teaching presence has the highest mean (M = 3.87, *SD* = .64). Course leaders and lecturers should continue communicating important course goals, course topics, important due dates or time frames for learning activities and identifying areas of agreement and disagreement on course topics for learning. Since the items "the lecturer reinforced the development of a sense of community (i.e. a sense of belonging, safe learning environment, shared values) among course participants" (M = 3.79, *SD* = .81) and "the lecturer provided feedback that helped me understand my strengths and weaknesses relative to the course's goals and objectives" (M = 3.79, *SD* = .81) scored the lowest mean, improvements for better teaching presence can be done in these areas. Diep, Zhu, Struyven and Blieck (2017) acknowledged that lecturers assume more roles in blended learning as compared to traditional face-to-face or online learning. Besides having sufficient technological, pedagogical and content knowledge, lecturers must also invest time to be responsive to students on online platforms and inspire students to have a positive attitude towards blended learning to achieve the desired learning objectives. As such, regular communication online with students, consistent feedback, and modelling critical discourse online by asking key leading questions or prompts could be further strengthened. Nortvig and colleagues (2018) also acknowledged that developing a sense of community takes time and requires conscientious effort. Teaching presence is crucial in facilitating students' feeling of connectedness to others, through student-to-student interactions online, which can help to establish trust and safe learning environment. Lecturers could provide clearer guidelines for how to initiate and participate in online discussions. Students can also be instructed to use inviting tone and be better monitored for their online activities based on shared values (e.g. responsibility and respect).

Although nursing students had perceived relatively high cognitive presence (M = 3.71, *SD* = .65), the item "course activities piqued my curiosity" scored the lowest mean (M = 3.62, *SD* = .84). As this blended learning course was designed by replacing some of the face-to-face with online learning activities, course leaders and lecturers can identify the parts of the nursing that could be facilitated better online by considering students' characteristics, course goals and availability of online resources to arrive at a good balance between online and face-to-face components (Alammary, Sheard & Carbone, 2014). As there is no defined standard on the structure of blended learning, regular evaluative feedback and findings should be considered for iterative course redesign for course improvement (Alammary et al., 2014).
Nursing students had perceived relatively high satisfaction in this blended nursing course (M = 3.69, *SD* = .74). Although most nursing students are satisfied with the way this blended course worked out, they were cautious to agree that they would take as many courses that incorporate digital technologies as they could. The use of digital technologies must be useful and meaningful, to support their development of educational experience in a community of learners.

Conclusion

Digital technology evolves over time and the type of tools used during a blended course may be different across various courses. Hence, the items used in the questionnaires may need to be modified, validated and assessed for reliability due to different tools, practices or teaching approach used. Future research in the form of longitudinal study can also investigate the effect of instructional interventions to bring about better cognitive presence, social presence, teaching presence on blended course satisfaction.

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Defining Digital Literacy: A Case Study of Australian Universities

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The contemporary appearance of the term "digital literacy" on university websites suggests institutional interests on digital literacy that focus not only on the development of technology skills but also cognitive and attitudinal aspects in student development. This paper presents an exploration of institutional conceptions of digital literacy based on document analysis of university published information online. The investigation involved universities located in Australia as embedded case studies (n=42). Evidence suggests variations in defining this term and shows that universities have diverse goals as espoused in their corresponding definitions of digital literacy, from developing technical skills of using and understanding technology, to possessing a set of capabilities for living, learning and working in an increasingly digital world. For universities who enumerated a coherent account of digital literacy, the results indicate that their practices of promoting the development of digital literacy are entrenched in their espoused intent of graduate outcomes. The paper concludes with curricular and pedagogical implications in preparing and assisting students for the challenges of 21st century living, learning and working.

Keywords: Digital literacy; digital fluency; digital capability; higher education; case study.

Introduction and literature base

With the global world embracing the fourth industrial revolution, also known as the digital revolution, the world that we live in has been characterised by a culmination of technologies causing fundamental shifts in the way we live, work, play, earn and learn (Doucet et. al, 2019; Secker, 2017). The digital workforce has seen the need for the development of many competencies and these competencies encompass the proficiency and comfort of being able to achieve desired outcomes using technology (Colbert et. al, 2016). Such a workforce means that digital disruption in education is inevitable. The recent report on education by Organisation for Economic Cooperation and Development (OECD, 2019) calls for an 'urgent' action for education institutes to connect education to the trends shaping the world that we live in. Given this urgency, it is imperative for education institutions to have digital literacy skills as part of its overall goal and acknowledge the role it plays in student digital literacy skills development (Reedy & Parker, 2017). 'Digital' has been a term that higher education uses to commonly express the incorporation into learning resources, the use of new information and communications media (Goodfellow, 2011).

The term 'digital literacy' was popularised by Paul Gilster in his 1997 book where he coined this term as the "literacy for the digital age", and described it as the ability to understand and use information in multiple formats, from different sources, and presented through computational means (Gilster, 1997, p. 1) Despite the appearance of this book, the term digital literacy did not gain widespread attention for at least another decade. More recently, this term is often misunderstood and used differently, at times interchangeably as digital fluency (Colbert et. Al, 2016), digital competency (Secker, 2017) or digital capabilities (JISC, 2014). The latter is the term used to describe the six capabilities that embody JISC's digital capability framework and defined as the "capabilities which fit someone for living, learning and working in a digital society" (JISC, 2014). The term 'digital fluency' on the other hand is interchangeably used with 'digital literacy', to mean going beyond simple use of a few programs or basic technological applications as it extends to having a level of proficiency that allows the users to manipulate information, construct ideas, and use technology to achieve strategic goals.

Presently, most higher education institutions offer a space of learning on an assumed understanding that students are digital natives, or even digital literate (Pangrazio, 2019). Pangrazio (2019) stresses that while the students do have understandings of how to use technological devices effectively and efficiently for social purposes, in most cases, they have not engaged in learning in a digital environment using digital technologies. There is an assumption that the notion of digital natives may seem to possess digital fluency, such assumption has created a gap when students graduate and enter the digital job market (Coldwell-Neilson, 2010). While digital natives have often been assumed to have a high level of digital fluency owing to their extensive engagement with technology in their lives, it is experience with technology, rather than generational membership, that best defines digital fluency or literacy (Colbert et.al, 2016). The interest of institutes of higher learning on digital literacy and related constructs is evident in the contemporary appearance of these terms on university websites that focus not only on the development of technology skills but also cognitive and attitudinal aspects in student development. Indeed, in the current higher education landscape, it appears that digital literacy involves more than the ability to use a digital device; it extends to a variety of cognitive, sociological and motor skills that the users need to function effectively in digital environments (Eshet et.al, 2004; Littlejohn, Beetham & McGill, 2012; Reedy & Parker, 2017). However, the term digital literacy has largely defied a concrete definition, despite the apparent currency of this term (Bawden, 2008; Secker, 2017).

Against this backdrop, the aim of the current research is to explore the meanings of digital literacy as ascribed by each university located in Australia, and to establish how such meanings influence the contemporary enactment of student development. Through a benchmarking exercise, a survey of each Australian university's website was undertaken to specifically locate the meaning of the term digital literacy. Investigator triangulation was carried out on data collected (Patton, 2005) and was conferred with published literature on digital literacy to validate insights generated in the findings.

Research design

This study is informed by qualitative research perspectives that utilise case study research and document analysis approaches to capture the phenomenon of digital literacy. Given the nature of the research problem—i.e., *How and in what ways do Australian universities engage in the development of digital literacy?*—embedded case study is considered appropriate for this investigation. Figure 1 outlines the research design which extrapolates the methodological fusion (Press, 2017) that embodies the current research. The fusion between case study design and document analysis approaches is aimed at generating rich data, in order to develop rich descriptions for understanding the bounded case (cf. Yin, 2017).

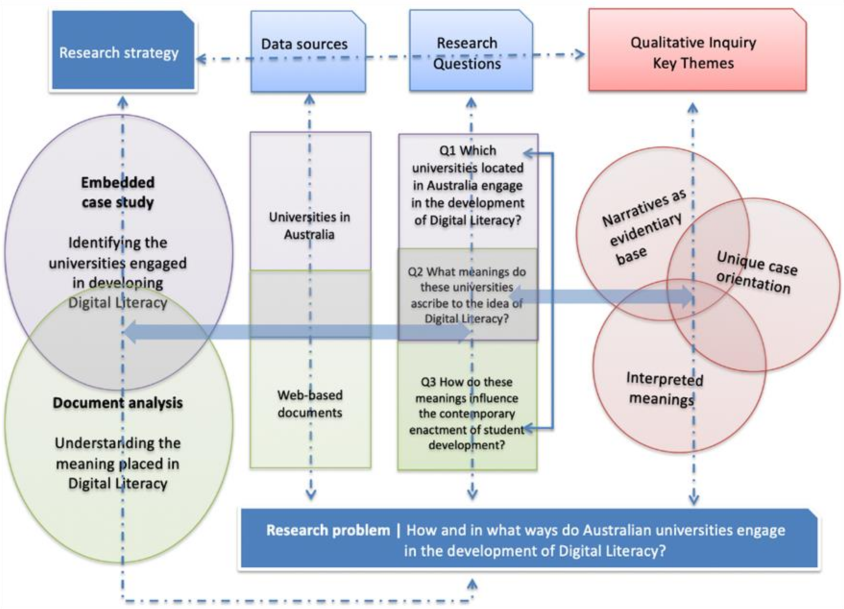

Figure 1: Methodological fusion* as a research strategy

The case in this research constitutes the Australian universities and within it are embedded cases—universities organised collectively in their State of origin. The embedded case study approach focused on the experiential knowledge of each university and close consideration of the influence of its social, political and other contexts (Stake, 2005; Yin, 2017).

*Please contact the first author for the methodological fusion template.

The aim of employing document analysis within a bounded system of the case—i.e., bounded by time and place—was to explore and examine in published documents views and orientations about digital literacy, directly expressed in such documents. The document analysis approach gave voice and meaning from universities in Australia around the idea of digital literacy. Data collection was carried out using published documents from respective universities' website. These are the official, ongoing records of the university's activities on digital literacy. Collected data were derived from print (e.g., PDF, Word) or web–based information. Data collected were stored and managed on Google Sheets to enable concurrent collaborative research work by the investigators. Bowen (2009) notes that document analysis is a social research method and, indeed, it enabled the current research team to triangulate and corroborate findings across data sets and facilitate evidence-based credibility in exploring the research questions noted in Figure 1 and elaborated on below.

Results and preliminary findings

The work of Huber and Shalabin (2018) surveyed the "digital literacy landscape for academic and professional staff in higher education" (p. 151) and identified the units responsible for the development of digital literacy. The current research, however, specifically explored how each university pursued digital literacy through their espoused meaning of digital literacy, their standpoints and conceptualisation related to student development.

Which universities engage in the development of digital literacy?

Universities in Australia were organised according to their State of origin. Where in some cases universities are located in multiple States, they were listed based on the location of their main campus. Table 1 outlines the number of universities investigated in this research and the types of documents found in public domain. A disclaimer that it is possible the information sought was only accessible in the universities' intranet and therefore not accessible for the purpose of this research. Moreover, the researchers made no attempt to directly contact specific universities, with the exception of obtaining a draft copy of the framework from one university in Queensland.

Table 1: Number of Universities per State

State of Origin	**Number of Universities**	**Direct Definitions of digital literacy**	**Organisational Document**	**Curriculum document**	**Other document**
Australian Capital Territory	2	0	0	1	1
New South Wales	11	5	5	5	10
Northern Territory	1	0	0	0	0
Queensland	8	4	6	7	2
Victoria	9	3	4	6	5
South Australia	5	2	3	1	3
Tasmania	1	0	0	0	1
Western Australia	5	2	4	0	5
Total	42	16	22	20	27

For a list of Australian universities go to the link below, which this research has adopted and used for triangulation: https://www.studyinaustralia.gov.au/english/australian-education/universities-and-higher-education/list-of-australian-universities

The groupings per State showed a snapshot of opportunities for the development of digital literacies and how they relate to other opportunities in neighbouring universities. Previous research (e.g., Huber & Shalabin, 2018) investigated the mention of digital literacy based on university affiliation, e.g., Group of 8 Universities, Regional Universities, Australian Technology Network, etc. One of the benefits of the State-based groupings is that themes can be easily detected, such as when the majority of universities in certain States actively engaged with the idea of digital literacy while very few in other States did so for all intents and purposes. See Attachments 1a and 1b.

The result showed that not all universities in Australia have published information on digital literacy and related constructs, such as digital learning, digital capabilities, digital competencies and digital fluency, among others. Documents encapsulating a whole-of-university strategic plan or framework were categorised as *organisational document*. The search also yielded curriculum information on digital literacy that formed part of course offerings (units of study) and was categorised as *curriculum document*. Information found on digital literacy not falling under the two previous categories was categorised as *other document*, such as student training materials, staff workshops, conference papers, etc. For the purpose of this paper, the organisational documents will be the predominant focus of the analysis in revealing specific definitions of digital literacy found in these documents.

What meanings do these universities ascribe to the idea of digital literacy?

Bounded by time and place, the case study universities' activities on digital literacies, or lack thereof, were captured from published documents in public domains and illustrated in Attachment 1a and Attachment 1b. Of the 42 universities surveyed, 16 universities presented a direct definition of digital literacy, communicating a vision for student development and, in doing so, some enumerating relationships with other literacies or capabilities, for example:

> Digital literacy is a broad spectrum of capabilities such as using technologies and systems to engage and connect with others; access, organise, and present information; manage risk and online identity. Being able to adapt to using new technologies easily and knowing which tool is best suited to a task are skills which will equip students for the rapidly changing digital work environment [Edith Cowan University].

> Digital literacies are those capabilities which fit an individual for living, learning and working in a digital society (cited JISC, 2014) [Adelaide University]

The investigation showed that the work of JISC in the UK on Digital Capabilities guided the development of many Australian universities' digital literacy initiatives, including Edith Cowan, and universities in Queensland such as James Cook University, Griffith University, University of Queensland and University of Southern Queensland, among others. The themes emerging from these universities' digital literacy commitment relate to enabling students to develop critical skills and knowledge as they experience tools, technologies and ways of knowing, thinking and valuing the increasingly digital environments. On this note, some of the educational goals espoused include developing cognitive skills, practice and dispositional aspects of student development and these reflect the definition of digital literacy for these universities, for example:

> The capabilities which fit someone for living, learning and working in a digital society (cited JISC, 2014) [James Cook University].

> Digital literacy is a set of skills, knowledge and attitudes that require constant attention and development through our lives and across all aspects of our lives… requires individuals to be adaptable and committed to ongoing personal and professional development [University of Southern Queensland].

> Digital literacy is the set of integrated abilities encompassing the reflective use of information, understanding how information is produced and valued, and the use of information in creating new knowledge and participating ethically in communities of learning [University of Queensland].

Across the border in New South Wales, the notion of digital literacy encompasses being literate as a digital citizen to navigate successfully the multi-dimensional digital environments. This requires a new concept of literacy and involves not only the ability to use the new technologies but also a whole set of social practices, for example:

> Digital literacy means having the skills you need to live, learn, and work in a society where communication and access to information is increasingly through digital technologies like internet platforms, social media, and mobile devices [Western Sydney University].

> Digital literacy means students have the knowledge and skills to safely access, question, evaluate and create using technology. Digital literacy is one part of being digital citizen; a person who is responsible for how they use technology to interact with the world [Macquarie University].

For a number of universities across Australia, the development of digital literacy is embedded in a set of Graduate Qualities or Graduate Attributes or Graduate Learning Outcomes or similar student development initiatives, such that the digital literacy development sits alongside other intended graduate capabilities with interrelated elements, for example:

> Digital literacy provides students with the skills they need to navigate our ever-changing world. Introducing Digital Literacies as a Graduate Learning Outcome ensures that the University is creating graduates who are flexible and adaptable users and creators of information [Charles Sturt University].

> The Digital Literacy Framework sets out digital literacies as a set of interrelated elements. These include: data literacy; media literacy; communication and collaboration; digital identity; scholarship; innovation and creativity; information literacy; and IT Proficiency [La Trobe University].

> The Real World Learning 2020 Vision states that graduates will employ digital literacies and use technology strategically to leverage information and to collaborate [Queensland University of Technology]

> Digital literacy is related to the graduate attribute, *Apply Technology.* It is the ability to use, navigate and understand technology, hardware and software… [University of the Sunshine Coast]

On that last note, it is worthy to mention that a good number of Australian universities have taken the position to state specifically that digital literacies are not confined to mastery of information and communication technology tools but also involve competencies and understanding to be critical in the elaboration and construction of knowledge. Thus, one of the espoused goals of digital literacy is to develop digitally literate individuals who possess analytic and critical skills alongside the ability to use and create technologies. Indeed, for some, digital literacy is defined as connected to lifelong learning, for example:

> Digital literacy is the ability to locate, evaluate, choose, use and create technologies effectively, critically, and safely for lifelong learning [James Cook University].

The definitions and meanings of digital literacy as presented here may have shown a confusion caused by diverse terminologies, meanings and mutually conflicting definitions. Similarly, such confusions and contradictory definitions are evident in the literature (Bawden, 2009). However, what is essential to recognise is the importance of these definitions to practice – how the development of digital literacy is enacted in student development. Moreover, the nurturing and maturity of literacy for the digital age is critical in that understanding, meaning and context should all be fundamental to the concept of such literacy (Selwyn & Facer, 2013).

How do these meanings influence the contemporary enactment of student development?

A university needs to provide enhanced and engaged learning, teaching and research experiences that promote agility of its staff and students, to be confident in their engagement with technological innovations because digital literacy "is a prerequisite in our open and global educational environment" (ACODE, 2014, p. 1). Viewed in this way, the meanings universities ascribe to the definition of digital literacy are likely to influence practices of promoting the development of digital literacy as entrenched in their espoused intent of graduate outcomes and the development of professional identity, for example.

> An explicit focus on scholarly and digital literacy is integral to the University's aim of producing world class scholars and graduates ready for the digital world [University of Melbourne].

The commitment of producing world class scholars and graduates for this university appears to be a key influence in enacting student development. In empowering individuals to navigate the digital world, stakeholders need to put emphasis on developing the literacies and capabilities and lesser emphasis on the rich media, tempting as it may. This is certainly evident in the data sets that emerged in the current research, for example:

> Fundamentally, it focuses more on literacies rather than media and involves finding, using and disseminating information in a digital world [Deakin University]

> To develop skills for learning, researching and working in a digital society [University of Western Australia]

On this note, the Australasian Council on Open, Distance and eLearning (ACODE, 2014) advices that universities need to operate effectively and critically in the constantly evolving environment and to advance digital literacy through leadership, readiness, clarity and credibility, organisational culture and belief in the purpose, among others. Engaging in these ideas reflectively and strategically is imperative in enacting student development, specifically for developing digitally aware, responsible and literate citizens. This calls for a digitally literate organisation. As JISC (2014) nicely put it "A digitally literate organisation is better equipped to address a range of challenges so building capacity for strategic thinking and leadership around digital literacy at all levels is critical for organisational change in this area".

Discussion, recommendations and conclusion

"The truth is that there is no one agreed definition of digital literacy" (Brown, 2018, p. 52). But in many respects, the underlying definition remains pointed to JISC's espoused definition, that is "Digital literacies are those capabilities which fit an individual for living, learning and working in a digital society" (2014, p. 1).

Equally important to note here is that digital literacy is clearly an essential aspect for successfully living, learning, working and even how people think in today's increasingly digitalized society. Digital forms of communication and information are transforming what it means to co-exist with the ever changing digital landscapes and the opportunities they present. Indeed, the current study has shown that at least 16 universities in Australia are listening and responding to new societal and technological developments, putting in place mechanisms to prepare graduates for the digital world. However, there is no denying the digital literacies movement is complex. While the term 'digital literacy' is widely used in curriculum and strategy, research indicates that universities still do not have a clear understanding of the types of digital literacy skills that would enable students to be job ready and how "students are enabled to build digital competencies" (Coldwell-Neilson, 2017, p. 85). Digital literacy also challenges "relationships between staff and students" as their expectations and understanding of digital skills are not always aligned (Coldwell- Neilson, 2010, p. 1).

Developing functional digital skills for life, work and wider societal participation, while challenging, provides a platform for the "transformative goal of promoting critical digital mindsets capable of reimagining and reshaping our inequitable, socially unjust and unsustainable societies" (Brown, 2018, p. 54). At this point, it is useful to reflect upon some generally agreed upon components of digital literacy (Bawden, 2008; Bawden & Robinson, 2009, pp. 54-56). These provide a framework of sort for understanding and enacting student development that bridges the digital divide.

1. Underpinnings
   – Literacy per se
   – Computer / ICT literacy
2. Background knowledge
   – The world of information
   – Nature of information resources
3. Central competencies
   – Reading and understanding digital and non-digital formats
   – Creating communicating digital information
   – Evaluation of information
   – Knowledge assembly
   – Information literacy
   – Media literacy
4. Attitudes and perspectives
   – Independent learning
   – Moral / social literacy

It is evident in the current research that many universities in Australia attempt to bridge the digital divide and tackling such divide is not just about focusing on technological tools, but universities need to address the many components of digital literacy, as shown above. It is linked to the development of new forms of critical digital literacies, acquired through student active involvement in the increasingly digital world in which we live, work, play, earn and learn (Bawden, 2008; Doucet et. al, 2019; Secker, 2017). On this basis, it is imperative that universities have a strategic vision and operational plans that encapsulate the development of literacies within core systems and processes to build capacity and capability.

We recommend consideration of critical questions for universities in helping articulate a vision for digital literacy:

- How does our institutional mission recognise the importance of digital capability?
- What learner or graduate attributes do we make it our mission to develop, promote and support in our learners?
- What part do digital technologies play in the learning experience at our institution?
- How are learners involved in decisions about ICT?
- How are we helping learners to thrive in a networked social context, where boundaries of many kinds are crossed?
- Do we actively address learners' expectations about the digital environment and forms of digital learning in which they will be engaged? (JISC, 2014)

These questions have curricular and pedagogical implications that ultimately impact on educational practices. Certainly, digital literacy in courses and units of study ought to consider how technologies get embedded into educational practices and not be narrowed down to a question of skills in handling the technology (Bawden & Robinson, 2009). The embedding impacts on the mechanism for influencing educational practices. There will be a better understanding, therefore, of the changes in the practices of developing digital literacy that the technologies may bring about (Bawden, 2008; Knobel, 2008). As it is, the terms digital literacy and 21st century skills have become synonymous is recent times. It is worth considering, then, the idea of "literacy for the 21st century"; what this looks like for different people, what kinds of digital literacies that need to be developed over time and how stakeholders might engage in digital literacy development.

To conclude, the research presented here forms part of a two-phase study, which aims to address specific questions that enabled us to contribute to the discourse of educational importance, that is to enhance knowledge and practice of digital literacy. We believe that digital literacy in higher education is a fertile ground for research and development, in particular in pursuing the ever-illusive meaning of this phenomenon. We intend to pursue the next phase of our investigation, to give voice to people and their understanding of digital literacy, how this plays out in practice, and the opportunities they present as well as obstacles. The goal is to gather empirical data to illustrate a definition of digital literacy, derived from experiences of study participants and as enacted within the walls of universities in Australia.

Finally, the limitations of this study are acknowledged. Attempts were made to locate documents on digital literacy but limited to those that are publicly available. As noted elsewhere in this paper, it is likely that relevant information may be present within universities' intranet and/or internal documents. This will be further investigated in Phase 2 of our research.

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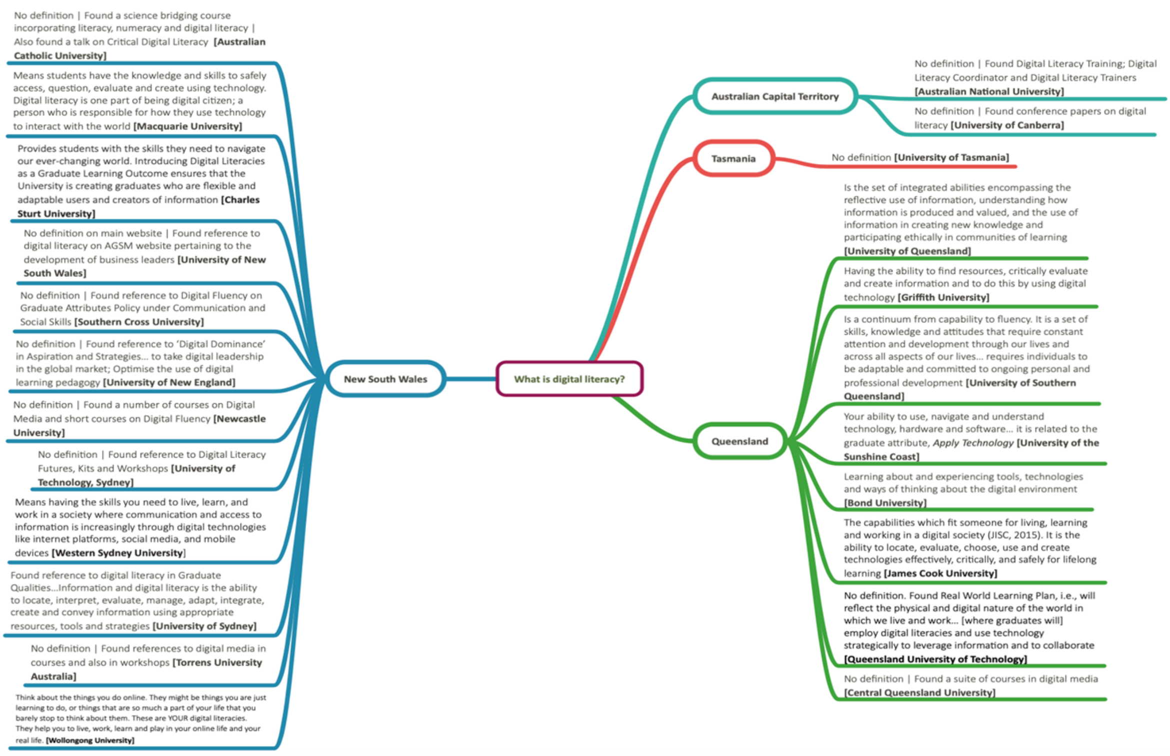
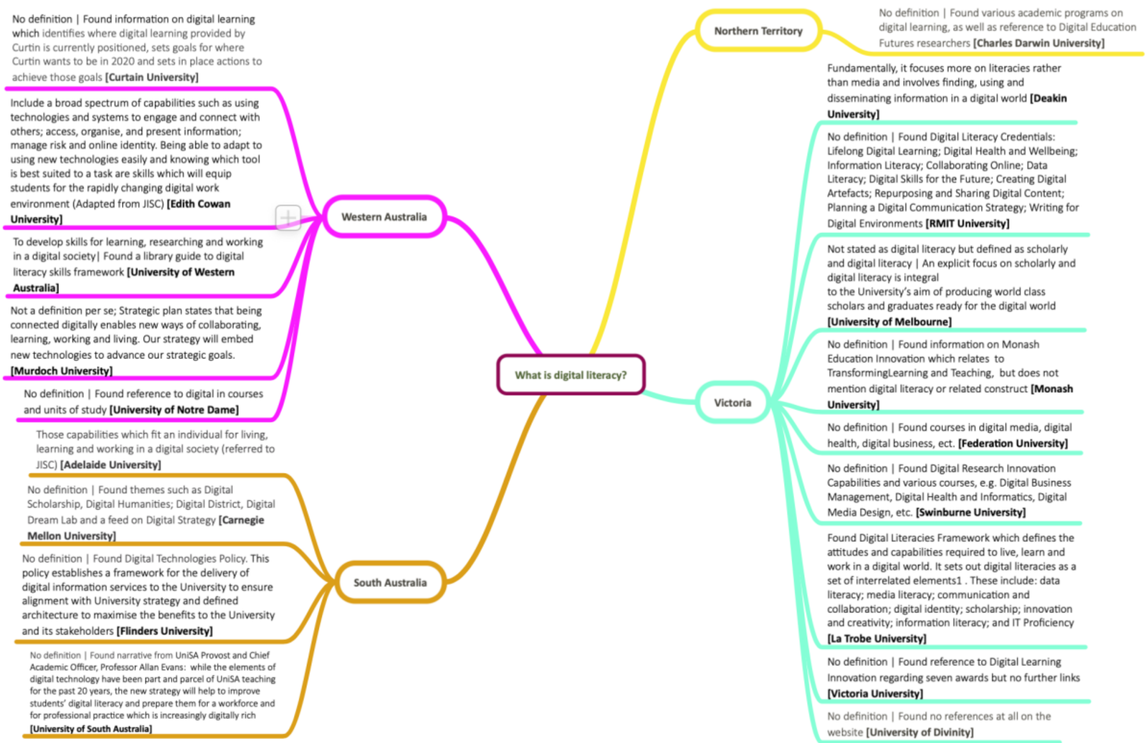
Attachment 1a Australian Universities' Definition of Digital Literacy



Attachment 1b Australian Universities' Definition of Digital Literacy



From text to audiovisual feedback: enhancing clarity, usefulness and satisfaction

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Research demonstrates that students generally find digitally recorded assessment feedback comments to be more satisfying than text-based feedback comments. However, positive perceptions of digitally recorded feedback may be impacted by the confidence and experience of the educator who is providing the comments. As such, this paper reports on an exploratory study in which we compare students' perceptions of the text-based and digitally recorded feedback created by five tutors in the same subject. Survey data were collected from 81 students, of which 58 received text-based and 23 received digitally recorded feedback comments. Students who received digitally recorded feedback comments provided consistently higher ratings for feedback clarity, usefulness, and satisfaction than students who received text-based feedback comments. It is proposed that the media enables these effects, but the structure of the feedback design is also important.

Keywords: digitally recorded feedback, text-based feedback, higher education, assessment feedback

Introduction

Assessment feedback is an important component of the learning process (Carless & Boud, 2018; Winstone & Carless, 2019). Effective feedback comments from educators on both formative and summative assessment can have a powerful influence on student achievement (Brown & Knight, 1994; Hattie & Timperley, 2007). However, Hattie and Clarke (2018) note that despite it being one of the most powerful single influences on student learning, it is also one of the most variable. Indeed, in an earlier work Hattie (2009) had conducted a meta-analysis that revealed a third of feedback studies that found to have a detrimental effect on learning attainment. The reasons for this variability continue to be a focus of feedback research, including the investigation of the modality of the feedback itself. In higher education, educators commonly create and deliver feedback comments through the use of text, such as handwriting or electronic annotations (Chang et al., 2012). However, the potential impact of text-based feedback comments is often undermined by ambiguity and lack of detail (Thompson & Lee, 2012). In contrast, face-to-face feedback, while often rich in detail, can be hampered by performance anxiety and is dependent on student memory (Henderson & Phillips, 2015).

A growing body of literature suggests that digitally recorded feedback comments, including audio, video, or screencasts, can be used by educators to provide performance information that students find to be clear, detailed, satisfying, and personalised (Ryan, Henderson & Phillips, 2019; Knauf, 2016; Luongo, 2015; Mahoney, Macfarlane & Ajjawi, 2019; Morris & Chikwa, 2016). However, findings also suggest that these perceptions may differ as a result of the educators' confidence, experience, and demeanour (Phillips, Henderson & Ryan, 2016; Phillips, Ryan & Henderson, 2017). To control for these potential educator differences across modalities, this study compares student perceptions of text-based and digitally recorded feedback comments created by the same group of five tutors.

Background

Feedback plays a critical role in orienting students to learning (McConnell, 2006). High quality feedback enhances student experience, improves motivation, facilitates development, and strengthens future performance (Costello & Crane, 2010; Duncan, 2007; Higgins, Hartley, & Skelton, 2001; Lizzio & Wilson, 2008). Although there is a vast body of research relating to feedback, there is surprisingly little consensus about the recommended design of feedback comments. Consequently, Henderson and Phillips (2014) synthesized a broad range of literature, and reported on a guiding set of eight principles relating to the design of educator-created feedback artefacts on summative assessment. These principles include being timely, clear (unambiguous), educative (and not just evaluative), sensitive to the individual, proportionate to criteria/goals, locating student performance, emphasizing task performance, and presenting the feedback as an ongoing dialogue rather than an end point (a more detailed review of the literature and explanation of the synthesis of design principles can be found in Henderson and Phillips, 2014).

Combined, the principles above require not only a quick process (i.e., for a timely completion), but also a means by which considerable individualised detail can be conveyed in a way that is sensitive to each student's context and needs. Unsurprisingly this balance is difficult achieve with written comments, especially if limited to the margins of essays or with rubrics. A growing body of literature is now revealing the benefits of video, audio, and screencast technologies for feedback in relation to assessment tasks (Ryan, Henderson & Phillips, 2019; Knauf, 2016; Morris & Chikwa, 2016; West & Turner, 2016). Students' preference for audiovisual feedback has been well established across a number of tertiary studies (Luongo, 2015; McCarthy, 2015). In particular, this mode has been reported to be more detailed, clear, individualised, and supportive (Ryan et al., 2019).

The advantages of audiovisual recordings can be explained using media richness theory (Daft & Lengel, 1986), which states that interactions involving complex issues are best conveyed through richer media. This point is highly relevant to assessment feedback, as educators often need to explain difficult concepts in ways that students can understand. However, emerging research suggests that digital recordings are not a silicon bullet, as students' perceptions and level of satisfaction may differ according to the experience of the educator, and the quality of the comments that they provide. For example, in a previous study (Phillips et al., 2016), we found that students who received digitally recorded feedback comments from one particular tutor rated the comments as less clear than students who received digital recordings from other tutors. This was attributed to that particular tutor's failure to follow the recommended comment structure, as well as issues with expression of language. Similarly, results from a subsequent study showed that students who received digitally recorded feedback from a tutor who was teaching in a subject for the first time appeared to be more dissatisfied with the quality of the comments than students who received recordings from more experienced tutors (Phillips et al., 2017). Therefore, despite the affordances of digitally recorded feedback, it appears that students' perceptions may differ as a result of the educators' confidence, experience, and demeanour (Phillips et al., 2016; Phillips et al, 2017).

This paper presents the results of an exploratory study which looked at students' perceptions of text-based and digitally recorded feedback comments created by the same five tutors. The purpose of this study was to identify useful future lines of enquiry for digitally recorded feedback research.

Method

This paper is based on a subset of data that were originally derived from a larger mixed methods study aimed with assessing the impact and design of digitally recorded feedback comments on assessment tasks across disciplines at a large Australian university. The subset of data examined in this study originates from a Masters level Education subject, which focused on models for learning, and cultural and socio-economic learning contexts. The subject was held in the first semester of the calendar year, and classes ran for nine weeks. The feedback comments under investigation in this paper were provided on the first assessment task of the unit; an essay in which students were asked to compare and contrast learning theories. Ethics approval was received from the university human research ethics committee prior to data collection.

It should be noted that, although all student respondents included in this paper were enrolled in the same subject, data collection for the two student groups (i.e. text recipients and digital recording recipients) occurred in separate years. Data from students who received text-based feedback comments were collected during a 2016 iteration of the study. In that iteration, four of 14 tutors teaching into the one subject created digitally recorded comments on assessment tasks. The remaining nine tutors used their usual method of text-based comments (see Phillips et al., 2016 for more details). In the 2017 iteration, 13 out of 15 tutors teaching into the same subject provided digitally recorded feedback to students. The data used in this paper are taken from students of five tutors who provided text comments in 2016 and digitally recorded comments in 2017.

Participants

Participants were 81 Masters level Education students, of which 89% were women and 53% were non-native speakers of English. Seventy-two per cent of the sample completed the subject in 2016 and received text-based feedback comments, and 28% completed the subject in 2017 and received digitally recorded comments. Among those who received digitally recorded comments, 57% received video recordings, 39% received audio recordings, and 4% received screencasts. With regard to the frequency of respondents who received feedback comments from each tutor, 35% received comments from Tutor 1, 20% from Tutor 2, 15% from Tutor 3, 18% from Tutor 4, and 12% from Tutor 5. The majority of students completing this subject had been out of the higher education system for some time and, as such, the feedback comments they received on this assessment task were likely to have been the first they had received in a higher education context in several years.

Materials

For the scope of this paper, data from seven survey items - referred to collectively as the Feedback Attitudes Survey (see Appendix) - are included. There are three items related to clarity of the comments, three items related to the usefulness of the comments for future work, and one item measuring satisfaction with the comments. The latter item was rated using a 5-point satisfaction scale (1 = Extremely dissatisfied, 5 = Extremely satisfied), while the remaining six items were rated using 5-point agreement scales (1 = Strongly disagree, 5 = Strongly agree). There was one negatively worded item in the survey, 'The feedback was confusing' and this was reverse-coded and reworded to read 'The feedback was not confusing' for the purposes of reporting.

Procedure

In the 2016 iteration of the study, the five tutors providing text-based feedback were free to follow their normal routine for providing comments on assessment tasks. In 2017, with the introduction of digitally recorded feedback, the researchers provided the tutors with an advised structure of feedback content that had been tested in tertiary settings (see Phillips et al., 2017). Key components of the structure included addressing the student by name, recognizing their context and histories, using examples from their work when discussing issues, and placing the greatest amount of emphasis on how the student could improve their performance in future pieces of work. The tutors were then trained in how to use video, audio, or screencast technologies to provide feedback comments to students. Following this, the tutors selected the mode of digital recording they felt most comfortable with to provide feedback comments to students. We acknowledge that allowing tutors to choose which type of recording they used to provide feedback comments means that there is variability in the richness of media received by students in the digitally recorded feedback group, however, we considered it important that the tutors were able to adapt the interventions to suit their needs and preferences.

Results

Table 1 presents descriptive results showing the percentage breakdown of ratings of the clarity and usefulness of feedback comments by text and digitally recorded feedback recipients, and Table 2 presents descriptive results for satisfaction ratings. The highest proportion of responses for text recipients was in the agree/satisfied responses categories, whereas the majority of digital recording recipients provided responses in the strongly agree/extremely satisfied response categories. These results suggest that students who received digitally recorded feedback comments were more likely to find them to be clear, useful, and satisfying than students who received text-based comments from the same tutors.

To examine whether there were any significant differences in the mean ratings of each item for text and digital recording recipients, a series of Mann Whitney U tests were performed (see Table 3). Mann Whitney U tests involve comparisons of ranked means rather than raw means, and are considered to be more robust than t-tests when the data are ordinal and sample sizes are unequal (Field, 2009). As the results reveal, there was a significant difference with a medium-to-large effect between the ranked means of text and digital recording recipients for all survey items.

Table 1. Percentage breakdown of clarity and usefulness ratings for text-based (n = 58) and digitally recorded feedback recipients (n = 23)

Theme	Survey item	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
		Text	Rec	Text	Rec	Text	Rec	Text	Rec	Text	Rec
Clarity	Easy to understand	0.0 %	0.0 %	3.4%	4.3 %	6.9%	0.0 %	55.2 %	17.4 %	34.5 %	78.3 %
	Clear message	0.0 %	0.0 %	6.9%	4.3 %	13.8 %	8.7 %	56.9 %	8.7%	22.4 %	78.3 %
	Not confusing	1.7 %	0.0 %	10.3 %	4.3 %	25.9 %	4.3 %	44.8 %	34.8 %	17.2 %	56.5 %
Usefulness	Provided constructive comments you could use to improve	1.7 %	0.0 %	15.5 %	4.3 %	15.5 %	8.7 %	51.7 %	17.4 %	15.5 %	69.6 %
	Was useful	1.7 %	0.0 %	5.2%	8.7 %	24.1 %	4.3 %	44.8 %	8.7%	24.1	78.3
	Improved confidence for completing future assessment tasks	3.4 %	0.0 %	13.8 %	4.3 %	19.0 %	8.7 %	37.9 %	21.7 %	25.9	65.2

Table 2. Percentage breakdown of satisfaction ratings for text-based (n = 58) and digitally recorded feedback recipients (n = 23)

Survey item	Extremely dissatisfied		Dissatisfied		Neutral		Satisfied		Extremely satisfied	
	Text	Rec	Text	Rec	Text	Rec	Text	Rec	Text	Rec
How satisfied were you?	0.0%	0.0%	15.5%	8.7%	19.0%	4.3%	53.4%	21.7%	12.1%	65.2%

Table 3. Results of Mann Whitney U tests comparing mean ranks for text feedback recipients (n = 58) and digitally recorded feedback recipients (n = 23) on the Feedback Attitudes Survey

Theme	Survey item	Mean rank for text recipients	Mean rank for digital recording recipients	*z*	*p*	*r*
Clarity	Easy to understand	36.07	53.43	-3.331	.001	.37
	Clear message	35.22	55.57	-3.781	<.001	.42
	Not confusing	35.47	54.93	-3.548	<.001	.39
Usefulness	Provided constructive comments you could use to improve	34.80	56.63	-3.986	<.001	.44
	Was useful	35.33	55.30	-3.651	<.001	.41
	Improved confidence for completing future assessment tasks	36.04	53.50	-3.162	.002	.35
Satisfaction	How satisfied were you?	34.94	56.28	-3.910	<.001	.43

Discussion

As the ranked means for digital recording recipients were consistently higher than text recipients, the results of the inferential statistics strongly indicate that digital recordings are more clear, useful, and satisfying than text-based comments. In considering the positive impact of the digital feedback in this study, we argue that there are two, inextricably linked, factors at play: the first is the affordances of the audio and visual media, and the second is the structure of the feedback content. In particular, we propose that affordances of the media influenced the increase in perceived clarity, while the structured feedback content may have largely influenced the positive ratings of usefulness. Together, these two elements are likely to have contributed to the higher satisfaction ratings. The following discussion addresses each of these important factors in turn.

Audiovisual media may improve the clarity of feedback

Students who received digitally recorded feedback provided higher ratings than students who received text-based feedback on survey items measuring clarity. These results are likely to be due to the fact that audiovisual media are richer in communication cues, such as tone and pace. According to media richness theory (Daft & Lengel, 1986), the addition of these cues is likely to reduce ambiguity and increase clarity of the information being conveyed. For this reason, audiovisual media are thought to be more appropriate than text when the situation involves the transmission of complex, high stakes, or emotional information, as is the case with assessment feedback (see also Borup, Graham and Velasquez, 2011). In addition, audiovisual media afford more effective communication of tutor empathy and personalisation, which is likely to have influenced student receptiveness and understanding of the constructive nature of the commentary. This argument is supported by our previous work (Henderson & Phillips, 2015), which shows digitally recorded feedback can enhance student perception of the supportive nature of the feedback. Moreover, literature reveals that when students experience adverse emotional reactions to feedback comments, their receptiveness, sense making, and motivation can be negatively impacted (Molloy, Borrell-Carrio, & Epstein 2013; Pitt & Norton 2016; Winstone et al. 2017).

Further research obviously needs to be conducted to explore these arguments. In the meantime, we propose several design considerations in the use of audiovisual media for providing feedback comments. First, these rich forms of media better allow for the effective communication of complex information, however this also places a degree of effort on the educator who needs to discuss the deeper ideas or complex issues in the assignment, rather than simply noting superficial corrective feedback. This is a deceptively obvious argument. In the authors' experience, it is far too easy to spend the entire recording saying more of the same things, such as comments about grammatical changes, rather than deeply engaging with key ideas or conceptualisations within students' work. A second design consideration is that audiovisual media enhances the educator's ability to explain difficult ideas more clearly than with text, but it can also increase students' perceptions of personalisation, and therefore their degree of receptiveness to the feedback. To take full advantage of this opportunity, educators need to consider how to express themselves most clearly, such as by articulating distinctly and explaining key points in more than one way. Furthermore, educators may also make efforts to enhance the level of personalisation, by looking at the camera instead of the screen or assessment task, using the student's name, referring to interactions or process throughout the semester, and authentically revealing empathy and interest.

Feedback structure may improve the usefulness of feedback

There is a growing body of literature that reinforces the need to focus on how the feedback process could usefully influence future work or strategies (for example, see Boud & Molloy, 2013; Carless & Boud, 2018). Therefore, tutors in this study were given explicit instructions to structure digitally recorded feedback comments in ways that would enhance their usefulness. For example, it was recommended that a significant proportion of the comments were devoted to the intellectual substance (as opposed to textual issues) of the assignment, with an emphasis on feed forward. More specifically, tutors were told to:

Engage with the conclusions, arguments, logic, and justification in the assignment. Select two or three issues to discuss in detail that will be of most use to the students as they move forward in this field and in their future studies. Comment on strengths, weaknesses, flaws, gaps, creativity and insights. Importantly, the comments must be phrased to emphasise how students can improve their future work and thinking. This might include examples of alternative arguments, additional literature and different ways to think or approach the topic. (Extended descriptions of the feedback structure can be found at the project website http://der.monash.edu.au/lnm/technology-mediated-assessment-feedback/)

This careful focus on providing feedback comments that were useful and useable is likely to have impacted on students' perceptions of the digital recordings, especially in comparison to the text-based feedback comments which tutors created according to their usual practice.

There are a few noteworthy design considerations here. First, the digitally recorded feedback comments were largely focused on what the student could most usefully change or strengthen to improve their work or thinking. This is a marked departure from the typical content of feedback comments, which often focus on justifying the grade. Indeed, in this study, the tutors were told not to refer to grades, which had already been communicated through the online gradebook. A second design consideration was that the tutors did not try to address the entire assessment task during the process of creating the digitally recorded feedback comments. Instead, they were selective; focusing on just a small number of key issues that they felt would be most useful for that student. This ensured there was sufficient time in the recording to deal with issues in a considered way that was not rushed. The decision to be selective in providing comments was also informed by researchers such as Crisp (2007), who point out that extensive feedback comments may be inefficient because students are only able to process a proportion of the information within. A third design element was that the tutors were told to begin their feedback recording with a personal salutation, and to explicitly explain the purpose and structure of the feedback comments - namely, that they would focus on only a few key ideas for improvement. Together, these design features are likely to have influenced students' understanding of the purpose of the feedback.

Conclusion

This exploratory study adds to the growing literature that confirms the value of technology enhanced feedback on assessment, particularly in terms of it being perceived as clearer, more useful, and more satisfying. However, this investigation also proposes that the positive perceptions of audiovisual comments were likely to have also been influenced by the increased focus on actionable and personable comments. This is in alignment with Mahoney, Macfarlane and Ajjawi (2019) who note in their literature review that while audiovisual modes appear promising, they need to be coupled with careful feedback design. While the results from this study showed a positive impact, it is in keeping with the exploratory nature of this study to treat such results critically. Further research now needs to be conducted to understand the complex relationship between the affordances of the media, the instructional content and its structure, as well as the ecology of the individual participants including student preference and educator experience.

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Appendix

The Feedback Attitudes Survey

Thank you for taking part in this survey, which has been designed to investigate the impact of feedback on assessment tasks.

Please indicate how much you agree or disagree with the following statements…

1. The [recorded/text-based] feedback that you received on your most recent assessment task for [insert name of subject]…

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
Used language that was easy to understand	○	○	○	○	○
Had a clear message	○	○	○	○	○
Was confusing	○	○	○	○	○
Provided constructive comments that you could use to improve your work	○	○	○	○	○
Improved your confidence for completing future assessment tasks	○	○	○	○	○
Was useful	○	○	○	○	○

2. How satisfied were you with the [recorded/text-based] feedback you received for your most recent assessment task for [insert name of subject]?

○ Extremely dissatisfied

○ Dissatisfied

○ Neither dissatisfied nor satisfied

○ Satisfied

○ Extremely satisfied

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Challenges in sustaining technology enhanced learning: Recruitment, employment and retention of learning designers in Australian universities

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Universities require learning designers with creative digital experience and significant knowledge of educational theory and practice to meet institutional teaching and learning strategic priorities. Little is known about how best to attract and retain learning designers or alternatively, to assist learning designers navigate their career pathways in higher education. In response to these needs, this study aimed to provide a snapshot of current learning design practices across Australian universities; to document relevant skills, knowledge, education and professional background, role types and employment conditions, challenges for directors, and to identify areas for future attention. The researchers used two separate online surveys to target 1) directors of central teaching and learning units and 2) learning designers employed in universities. The results are useful as a means to sustain and improve practice through evidence-based decision-making in the conceptualisation of learning designer positions, the management and retention of learning design staff, and to assist learning designers in their career choices.

Keywords: Learning designer, directors, recruitment, employment, retention, career progression

Introduction

Directors of central teaching and learning centres in Australian universities are responsible for the translation of sector and institutional strategic priorities into academic practices (Ling & Council of Australian Directors of Academic Development (CADAD, 2009). Centre directors look to learning designers to meet diverse roles and employment conditions within the changing higher education sector. Other titles, such as educational designers, instructional designers or similar also describe learning design roles, although each has its own definitional nuances, due to the type and frequency of different roles and institutional contexts (Mitchell, Simpson & Adachi, 2017). Learning designers are conventionally understood as professional staff who help individual academics introduce and use educational technologies in their teaching for improved student experience (Browne & Beetham, 2010) or those who create digital teaching and learning resources for a wider audience (Fraser & Ling, 2014). Learning designer responsibilities, however, have broadened, as explained by Obexer and Giardina (2016) to 'the role of supporter, change agent, catalyst and provider of expertise in [higher education] and is seen as critical in supporting sustained change' (p. 138).

It is imperative that directors recognise learning designers' marketability and strong connections with professional networks outside an institution and provide work contexts that will be attractive to recruit and retain effective learning designers (Whitchurch, 2012). For example, lack of professional recognition and career progression can lead learning designers to move into other roles (including academic), or accept a better contract elsewhere; with both alternatives detrimental to the original employing institution (Shurville, Browne & Whitaker, 2009).

Yet, little is known about how best to attract new learning design staff members, both from an institutional and employee perspective (Shurville et al., 2009). Directors can be responsible to envision the requirements of new learning designer positions and the development of the appropriate position descriptions and selection processes. Directors also oversee the teams in which learning designers work and need to be able to retain capable learning design staff. Without understanding current baseline practices, this situation inherently brings challenges for directors in conceptualising and designing new roles, attracting suitable learning design staff, providing ongoing effective management and securing retention of excellent staff members. Similarly, learning designers lack information about entering the field, gaining career security and opportunity for promotion.

This research aims to shed light on the role of the learning designer and to provide a current snapshot of learning design practices in Australian universities, to enable directors to write well-defined position descriptions to recruit effective staff, and have better understanding of how to manage and retain learning design employees. Further, this work informs learning designers about the current employment context and provides empirical evidence for their career decision-making.

Theoretical lens – third space professionals

Beckmann (2018) notes that learning designers (or equivalent) often work in innovative areas of academic development with significant impact on students' learning environments. Learning designer roles may overlap with those of an academic, academic developer, e-learning and/or information technologist, for example. As such, learning designers are an integral part of sustaining and scaling up technical and pedagogical priorities in teaching and learning centres, which makes their successful recruitment, employment and retention essential.

Researchers theorise the idea of the 'third space' of collaboration to explain the porous nature of role delineation in academic development (Whitchurch, 2008; Veles & Carter, 2016). For example, Gray (2015) explains that while staff may be appointed to academic or professional roles, they find themselves crossing role boundaries because of the nature of their day-to-day work. By the very nature of the learning designer role they become boundary crossers to ensure the success of projects, as described by Motteram, Forrester, Goldrick and McLachlan (2007) in their study about managing the complexities of producing e-Learning courseware.

This blurring of roles creates highly collaborative 'third space professionals', such as learning designers, who have strong agency, assume professional development responsibility for themselves and others and envisage career progression as an ongoing personal journey (Veles, Carter & Boon, 2018; Whitchurch, 2012). These professionals use relational and collaborative foundations to enable strategic lateral skill-learning opportunities rather than only upward career progression (Veles & Carter 2016), which is contrary to the hierarchical career pathways and siloed operational structures in universities (Whitchurch, Skinner & Lauwerys, 2009). These authors suggest key recruitment, employment and retention issues include:

- Managing the disconnection between 'portfolio' careers and higher education's hierarchical career pathways and siloed organisational structures
- Designing job descriptions so that they are enabling rather than prescriptive
- Providing flexibility to allow individuals to enter higher education later on from other sectors; and
- Enabling appropriate professional development opportunities (p. 59).

The research questions guiding this investigation of learning designers as third space professionals are:
1. What are the key considerations for directors when recruiting, employing and retaining learning designers?
2. What is the career progression cycle like for learning designers?
3. In what ways can directors support the career progression of a learning designer?

Research context and survey design

The research team included an academic, a senior academic developer, a lead learning designer and an experienced research assistant from two Australian universities; all of whom have a strong interest in this research area. A small grant was secured from the Council of Australian Directors of Academic Development (CADAD now CAULLT) which enabled the researchers to design and deliver two online surveys. The research assistant helped with the qualitative data analysis.

Previously, two of the researchers undertook a pilot scan of advertised learning (or equivalent educational, instructional) designer positions (n=38) advertised across Australian universities from July – December 2016. Findings pointed to a diverse, ad hoc set of employment criteria and expected roles. Centre directors wanted professional staff with creative digital experience as well as significant knowledge of educational theory and practice to fill the work gaps, often on a project basis. This scan of position descriptions and the researchers' experience in higher education indicated there is a growing heterogeneous group of professional staff, commonly called learning designers in Australia, who are asked to undertake an extensive (often overwhelming) suite of roles. These learning designers are usually employed at HEW 7 or 8 levels, on short-term contracts, making them a cheaper and more flexible pool of talent than employing academic staff. These initial findings informed the larger research project that surveyed centre directors and learning designers across Australian universities.

Themes found in this pilot scan (e.g. length of employment, salary level, selection criteria and supervisor position) informed the design of two separate online surveys. These surveys targeted the following stakeholder groups: 1) directors of central teaching and learning centres (n=40), and 2) learning designers employed in universities (number unknown). The knowledge and experience of the research team working in central teaching and learning units with learning designers was also considered in the survey design. The survey was reviewed by the research reference group and given to a small test group of learning designers to complete and provide feedback to strengthen its rigour and relevance. Human ethics permission for the research was initially granted by the University of Queensland and approved by the University of the Sunshine Coast through the prior ethical review pathway in March 2017.

Data collection and analysis

In 2017 we invited directors and learning designers (or equivalent) in Australian universities to respond to online surveys about current learning design practices. We contacted the directors via their publicly available professional email address to explain the purpose of the study and potential involvement for themselves in completing the directors' survey online (link included in the email). The Participant Information Sheet and Consent Form was attached to the recruitment email (and again at the beginning of the surveys online). The potential participants needed to click on the link to the online survey if they wished to activate participation, and thus would remain anonymous.

We also asked relevant professional networks such as CADAD, Australasian Council on Open, Distance and E-Learning (ACODE), HERDSA, ASCILITE, Group of Eight (Go8) and the Regional Universities Network (RUN), to distribute the research information (including the necessary human ethics documentation) and survey links to their members (both directors and learning designers) so as to increase the potential number of participants that may be missed by other methods. Some learning designers contacted the researchers directly and asked for details about participation. They were directed to the project webpage that contained links to both surveys and further participation decision making information.

We considered the use of an online survey method, through a platform such as SurveyMonkey that includes quantitative and qualitative elements, as a resource efficient and time effective way to explore the depth and extent of current practice. The quantitative data were analysed using a descriptive statistics approach, based on those found in SurveyMonkey and checked by the research team. The qualitative responses were analysed and categorised according to themes developed by the research assistant using NVivo 11 Pro software and in iterative discussions with other members of the research team.

Results

Twenty-one directors responded to the survey, which we considered a high response rate, at 50 per cent of the available sample of Australian institutions. One hundred and three learning designers responded to their survey. Whilst this was a good sample size from learning designers across institutions, we are not able to confirm the number of learning designers employed nationally as this information is not readily available. The learning designers were asked additional demographic information at the beginning of the survey. Of the learning designers who completed the survey 76 were female and 27 were male. They were aged between 25 and 74 years of age, with the largest group in the 35 to 44 age brackets (39 per cent) followed by 45 to 54 age brackets (31 per cent). Only one respondent was over 65 years of age and none indicated they were under 25 years.

To best explain the results, the next section is organised using the following three categories: Recruitment (demographic data, educational and professional background, challenges in recruitment, length of current employment); Institutional context and employment conditions; and Professional development and potential career projectories.

Recruitment

The directors were asked about the greatest challenges in recruiting learning designers. Responses were collated around finding applicants with the breadth of expertise, experience, knowledge, capabilities and personal attributes needed for current learning designer positions (12 responses); an understanding of both technical and pedagogical aspects (5); and who were attracted to the University’s location or reputation (3). Two respondents recognised a lack of career pathways for learning designers while another one acknowledged the challenge of having the appropriate remuneration for an upcoming position.

The learning designers were asked several questions related to recruitment. The first question asked about the highest level of education they had achieved. Seventy per cent of the respondents stated they had attained a post graduate qualification, 17 per cent a bachelor degree, 4 per cent an associate diploma or certificate and 2 per cent some university study but no degree. Six per cent answered the ‘Other’ category giving more detail – post graduate certificate (1), post graduate diploma (1), masters (1), doctor of philosophy (2) and one respondent was currently a doctor of philosophy candidate.

When asked about the discipline of study, learning designers provided a diverse range of responses (Table 1) with 61 per cent of respondents having studied multiple disciplines. Education was the most frequent response including graduate certificates, masters of arts and adult education, master of arts/information and communications technology (ICT), higher education (graduate certificates), undergraduate primary and secondary teaching, graduate diplomas and/or doctorate in education. There was a significant per cent drop from Education at 68 per cent to a variety of disciplines between 13-6 per cent, followed by four disciplines at 4 per cent, three at 3 per cent and eight at 2 per cent.

Table 1: Educational background of learning designers

Discipline	Respondents %	Discipline	Respondent %
Education (primary, secondary, adult or tertiary)	68	Languages	3
Arts	13	Philosophy	3
Media	11	Visual Arts	3
Science	11	Creative Industries	2
IT	10	Engineering	2
Business or Economics	8	Gender Studies	2
Design	7	Law	2
Information Systems	6	Literature	2
Communications and Marketing	4	Mathematics	2
English	4	Project Management	2
History	4	Psychology	2
Linguistics	4	Other	-

Respondents were then asked about their professional background before becoming a learning designer (Table 2). There was a diverse range of previous experience noted, with 40 per cent having a teaching background and 25 per cent worked in technology or academic-related areas. Over 20 per cent of respondents had more than one professional background before becoming a learning designer. The 'Other' category responses were incredibly diverse with no more than two respondents identifying the same profession; therefore, it was difficult to cluster any further.

Table 2: Professional backgrounds of learning designers

Role	Respondent %	Examples
Teacher	40	Primary school teacher; Teacher K-12 technology, design, software
Academic	25	Lecturer in Linguistics courses; Academic, Philosophy, 10 years
Other	22	University office administrator; Architect; Librarian
Graphic/Media Design	18	Web producer and designer; Multimedia designer
Human Resources	9	HR advisor; University organisational development consultant, 23 years
Tech	7	IT analyst; IT professional
Student Services	3	Teaching academic skills, and designing academic skills resources for university students; Academic skills adviser at university

Although the largest proportion of respondents were teachers, they too were diverse in career characteristics. It is evident that there is no one pathway or progression into the role of a learning designer.

Institutional context and employment conditions

Both surveys asked respondents the network of universities in which they work. This question used four classifications of Australian university networks i.e. Group of Eight (Go8) research intensive universities (https://go8.edu.au/); the Regional Universities Network (RUN) of six universities (http://www.run.edu.au/); the

Innovative Research Universities (IRU) of seven universities (https://www.iru.edu.au/); the Australian Technology Network (ATN) (http://www.atn.edu.au/); and an 'Other' option. Responses were received from all university networks with the largest proportion from the Go8 for the learning designers and the RUN network for the Directors as shown in Figure 1. The majority (52 per cent) of learning designers report working in a central learning and teaching centre, 26 per cent said they work in a faculty, and the others are in schools, cross-faculty and in information technology.

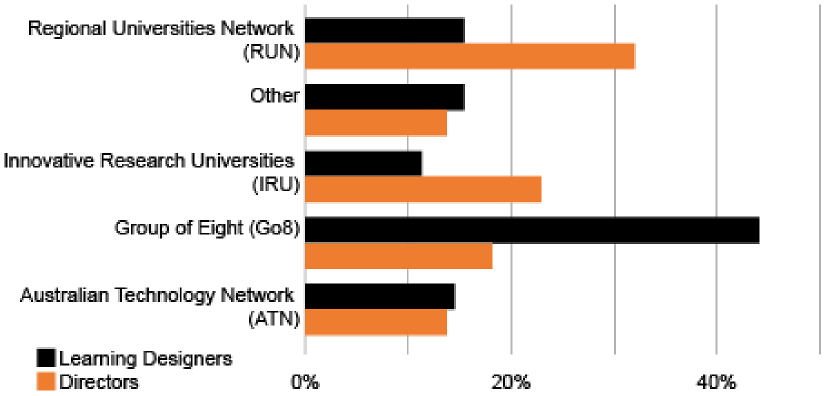

Figure 1: Respondents identified university network

The directors reported employing more full-time learning designers than part-time. Ninety per cent reported that they have learning designers in full-time roles and only 35 per cent of directors reported part-time roles. The data received from the learning designers indicated that 50 per cent of respondents were employed full-time and 50 per cent were on a contract (47 per cent) or casual (3 per cent) as shown in Table 3.

Table 3: Mode of employment for learning designers

Mode	Full-time	Part-time	Total %
Ongoing	47	3	50
Contract	38	9	47
Casual	2	1	3
Total	**87**	**13**	**100**

The learning designers were asked about the professional level classification of their appointment (Figure 2). The majority are employed at either HEW Level 7 (40 per cent) or Level 8 (37 per cent) of the Higher Education Industry professional staff award, as interpreted by their institution. Only 4 per cent were employed at a lower Level 5 (1 per cent) or Level 6 (3 per cent) and no one reported being below Level 5. The qualitative 'Other' category (19 per cent) captured ten Level 9 responses, six academic appointments and one Level 6-7 banded position.

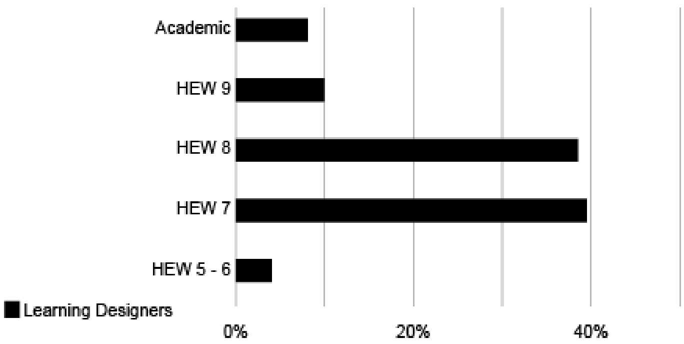

Figure 2: Learning designers identified level of employment

There were two further questions for learning designer respondents about employment. Firstly, the length of time they had worked as a learning designer and secondly, how long they had worked in their current role (Figure 3). Forty-three per cent of the respondents have worked as a learning designer for more than six years indicating some consistency and stability among the learning designer environment. Sixty-two per cent of the total learning designer respondents have been in the same position for less than four years.

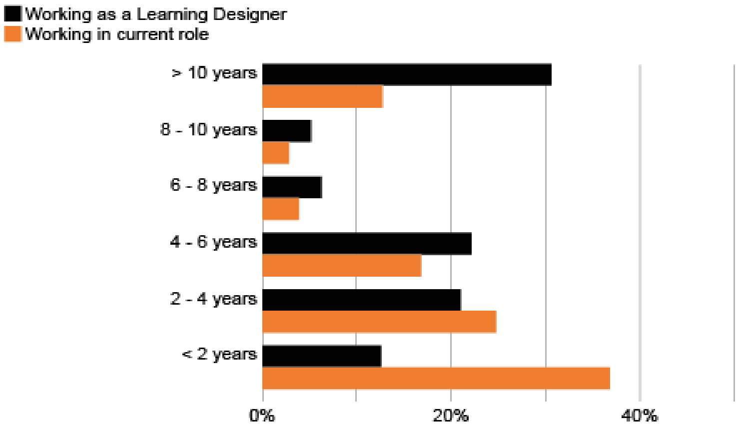

Figure 3: Learning designer's reported time in current role and as a learning designer.

Continuing professional development and potential career projectories

This section reports the responses to the survey questions related to continuing professional development and potential career projectories for learning designers. The surveys asked the directors and learning design respondents about the opportunity for and engagement in continuing professional development (Figure 4). In particular, the directors were asked 'What professional development is available for learning designers at your institutions?' and could respond with multiple answers. Sixteen respondents answered this question. The highest response was 'attending conferences' at 94 per cent, closely followed by 'engage with professional organisation' at 88 per cent, 'self-directed learning' was next at 81 per cent, and 'institutional communities of practice' at 75 per cent, then 'MOOCs' at 63 per cent and lastly, 'formal courses and training' at 31 per cent. The 'Other' category listed 'peer to peer learning', completing a portfolio for the Higher Education Academy fellowship scheme, 'team meetings' and 'in-house development'.

The learning designers were asked how they engage in continuing professional development and again could respond with multiple answers from the same list of options as the directors' survey. The highest response was 'self-directed learning' at 96 per cent, followed by 'attend conferences' at 80 per cent, being part of 'institutional communities of practice' at 70 per cent, followed closely by 'engage with professional organisation' at 67 per cent. 'Formal courses and training' at 52 per cent were followed closely by 'MOOCs' at 49 per cent. The qualitative 'Other' category included self-funded conference attendance, tacit knowledge from senior learning designers, 'trial and error and a lot of help from other staff and then helping staff as well', 'industry communities of practice', 'postgraduate study', 'learning on the job', 'publishing resources', 'mentoring others', 'collaborative research', 'in house', and 'connections on social media'.

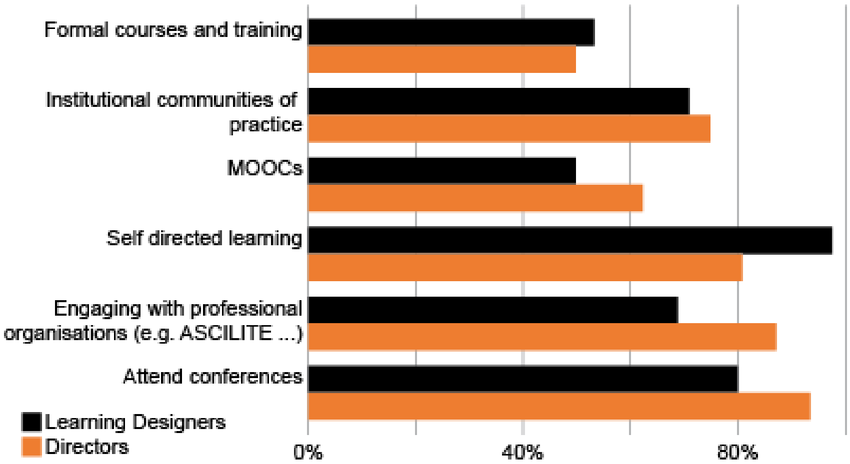

Figure 4: Learning designer professional learning activities identified by directors and learning designers

The directors were asked about their greatest challenge in retaining effective learning designers. Fourteen respondents answered with a variety of responses, mainly related to employment conditions with short-term contracts or project-based work, such as remuneration, consistent workflows, ensuring recurrent funding, and lack of promotional pathways. They were concerned that 'good learning designers are often looking for more certainty', 'mismanagement by senior staff' or 'a disconnection between their expectations and the organisations'. Further, other concerns were learning designer 'boredom' and 'motivation in the face of resistance by academics' and losing good quality learning designers due to high demand elsewhere.

Next, directors were asked what types of roles they saw learning designers progressing to in their careers. The responses from the directors identify a variety of possible career pathways. Forty per cent said those roles may be an academic position as demonstrated by two directors who said:

> I would like to think that they could pursue an academic path (Director A)

and

> Multi choices e.g. moving into academic developers, CPD developers, academics, teachers (Director B).

Forty per cent of director respondents also suggested institutional leadership roles, including:

> Management of Learning Technologies, User Experience Design, Manager of Educational Design Departments (Director C)

and

> Increasingly, to leadership roles around designing and managing student experience: as the roles of academics become 'unbundled', it will become increasingly possible for learning designers to coordinate degree programs, innovative teaching initiatives, and university-wide student experience programs… (Director D).

The results from the learning designers show that they hoped to move into senior learning designer roles (25 per cent) or stay in a similar learning design role (23 per cent) in 5 years' time. For example:

> I like what I do so I hope to be doing much the same in 5 years' time (LD A)

and

> Similar but more in-depth work with academics and less across the board, surface level work (LD B)

Other learning designers shared they would like more leadership responsibility and/or involvement in more strategic and complex learning design work. For example:

> I have for some time had my sights set on a director role. However, as tertiary ed continues to change, I see opportunities for emerging roles we have yet to name. So more often I see my next role as being one that combines learning design and leadership in addressing the challenges faced by the sector (LD C)

and

> Learning design on complex, large scale projects with strategic value to the institution (LD D)

Two learning designers saw research having a greater priority in their future roles:

> Greater research and leadership in academic development (LD E)

and

> I would like to be a published Learning Designer or perhaps become an academic specialising in SoTL or Online Teaching/Design (LD F)

Only 9 per cent of learning designers indicated that they would like to be in a management role and less as a teaching academic.

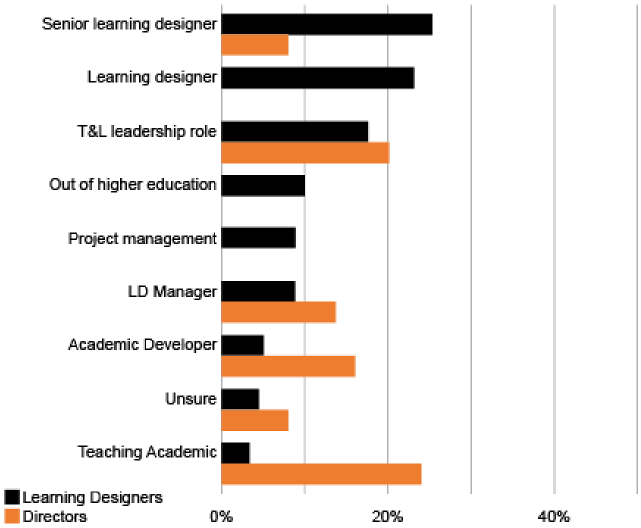

Figure 5: Career progression preferences for learning designers

Discussion and implications for practice

The results of this research highlight key issues, such as improving the attractiveness and consistency of learning designer recruitment, career planning and providing professional development opportunities that impact workplace planning for both directors and learning designers. It must be remembered however, that the results only represent a subset of the learning design population and should be viewed within this limitation.

Recruitment

Given the high marketability of learning designers and their strong sector-wide connections, it is important to develop attractive recruitment and employment opportunities for them (Whitchurch, 2012). Learning designers are highly qualified professionals, with 70 per cent having a post graduate qualification, but due to their coming from diverse backgrounds and multiple disciplines, opportunities in such a profession are undefined (Shurville et al., 2009). A further challenge is that the title of 'learning designer' is unclear in terms of role definition and institutional practices (Mitchell, Simpson & Adachi, 2017). Similarly, there is no formal career pathway to enter learning design roles. Very few junior roles are available to foster career development as indicated by the fact there was no learning designer respondent under the age of 25 years. Lack of formal entry pathways into learning design roles, makes it difficult for directors to target potential recruits with the appropriate professional backgrounds and to find applicants with the breadth of expertise needed for current learning designer positions. There is an opportunity here, however, for directors to work through their professional networks to collaborate in an effort to develop consistent and enabling position descriptions across the sector (Whitchurch, Skinner & Lauwerys, 2009). This approach would allow learning designers to move within the sector and have their skills and knowledge acknowledged at all institutions through a shared understanding of the role/s.

Institutional context and employment conditions

Learning designer recruitment, employment and retention brings into play new ways of thinking for directors and other institutional decision-makers (Obexer & Giardina, 2016). The results report that learning designers tend to adopt the role of a learning designer for a long period of time, with 30 per cent greater than ten years. However, they may stay in each role for a short period of time due to the project and short-term nature of the work. We know that 50 per cent of learning designers are employed full-time in continuing employment and the other 50 per cent are on contracts or work part-time. Employing learning designers as third space professionals challenges the conventional career progression pathways and institutional structures of universities because of their role, boundary crossing and attitudes to ongoing career development (Whitchurch, Skinner & Lauwerys, 2009; Gray, 2015; Veles, Carter & Boon, 2018; Whitchurch, 2012). Given that technology is ever-evolving, the work of the learning designers will be ongoing, making it necessary for directors to consider new ways of working to accommodate.

Learning designers prefer to be retained and recognised for the work that they do. Currently career pathways are limited for learning designers due to the professional classification levels of HEW 7-8. The experience and expertise of the learning designer cannot be highlighted within these two levels, for example, a starting HEW Level 7 is not as experienced as someone who has been in the role for a long period of time. Academic staff are rewarded for their research and their teaching but there is no similar recognition for learning designers. Learning designers support and build capacity within their teams and with one another, and have expertise and knowledge of a variety of areas but are rarely remunerated accordingly.

Continuing professional development and potential career projectories

Directors seem out of step with learning designer professional development activities and needs. Learning designers reported their highest professional development engagement was with ‘self-directed learning’ while directors reported ‘conference attendance’ for learning designers as the highest option. Directors may note visible professional development activities for learning designers, such as attending a conference, but for other learning designers who might not have the opportunity to attend such observable events, it is difficult to report their activities. Directors could suggest more broad-reaching opportunities that ‘enable appropriate professional development opportunities’ (Whitchurch, Skinner & Lauwerys, 2009, p. 59), such as ensuring space in work schedules for supporting learning designer networks, especially when other opportunities are unavailable.

The majority of learning designers want to continue in learning design roles with more senior responsibilities or complex large-scale projects, rather than progress to the management of staff. Even fewer learning designer respondents wanted to move into academia which was at odds with the views of the directors. An academic role would take the learning designers’ attention away from what they enjoy in their roles to a more research and teaching focus. Again, there could be the opportunity to develop new roles, and thus more flexible role statements to facilitate more senior roles for learning designers. Discussing career aspirations and progression with staff will assist directors to plan for and support learning designers into more senior roles.

This indicative study provides a basis for future research to understand the roles of learning designers in higher education in sustaining technology enhanced learning and innovative teaching practice. While our survey does not intend to provide replicability or prediction, it does provide empirical foundations for discussions and workplace planning between differing stakeholder groups, with the view to improve recruitment, employment and retention of staff, and to ultimately enhance learning opportunities for students.

Conclusions

This research contributes understanding of the current learning design practices, particularly in recruitment, employment and retention, across Australian universities from the perspectives of directors and learning designers. It highlights the disparate avenues into the learning design profession, gaps in professional development, and the future career pathways desired by learning designers. The results of this research are useful as a means to improve practice through evidence-based decision-making in the conceptualisation of learning designer positions and the management and retention of learning design staff. It also demonstrates several gaps in understanding between directors and learning designers and provides opportunity for professional conversations and collaboration across the sector. Future research and practice areas include how to build capacity in the workforce for emerging learning designers, the development of effective learning design position descriptions in light of directors’ needs, and ways to improve learning designer professional development and career progression.

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Learning design is not a prescription: Framing and disposition in collaborative infrastructure

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Same task, same instructions, same tools, different outcomes. What students bring to a group assessment task, their disposition, and how they make sense of what is being asked of them, their framing, will influence how they explicitly and tacitly construct and use a collaborative infrastructure. Learning design can nudge towards a particular path, but a project and its supporting infrastructure is ultimately the epistemic work of the student group. In findings from case studies of seven group projects at an Australian university I compare framing and disposition of the groups with the infrastructure that they created around assessment tasks. I place the cases under three loose categories of shared knowledge creation and proffer suggestions for learning design, including individually-produced artefacts as part of group knowledge creation.

Keywords: sociomaterial, collaboration, objects, infrastructure, framing, disposition, design

Introduction

There is a recognised need for graduates to be good collaborative problem solvers, but there has been a lack of research into related student practices (Graesser, Fiore, Greiff, Andrews-Todd, Foltz & Hesse, 2018). Infrastructure is not something to be instrumentally prescribed and designed for students, but constructed by learners. As students work on open-ended or complex problems, their knowledge work is embedded in the environment and objects they find and create: within a distributed cognitive (Hollan, Hutchins & Kirsh, 2000) infrastructure. Learning design should be about "supporting learners in organizing complexity and sense-making" as they engage with the many available resources and tools (Damşa, Nerland & Andreadakis, 2019, p. 3). To do this, we need to know more about students' infrastructure for shared knowledge creation, and what might support them in this process.

The aim of the main study from which the findings in this paper originate was to investigate how university students create knowledge together–what infrastructure they assembled and built, and how that infrastructure influenced their epistemic work. The seven case groups constructed unique infrastructures through activity in support of their projects and related epistemic work. Research questions for this paper are, for university student groups, 'What influences how infrastructure is assembled and used?' and 'What infrastructure do students assemble to support knowledge-based tasks?' I share a summary of part of the study findings, concentrating on group disposition towards and framing of assessment tasks and the shape of their collaborative infrastructure. 'Infrastructure,' in this context, is expansively defined to include tool use, processes, and found and created objects: what students do and use to complete their task. All cases are covered in brief, with more detail on two cases of individuals contributing substantial artefacts to group knowledge creation. Implications for learning design are outlined in the discussion.

Literature

In any task, but especially an open-ended or complex project, student groups need to assemble an infrastructure. Infrastructure is emergent from activity and assembled in use: students work out how to do things in practice, and accommodate to, or adapt, the tools at hand (Damşa et al., 2019). Each student brings their particular experiences, skills and expectations to a task—a particular disposition—and the group needs to make sense of their assessment task and how to approach it. In an open-ended project especially, the group is required to create knowledge together. Here I briefly outline relevant concepts in explaining how students came to create an infrastructure around shared knowledge creation: sociomaterial activity; framing; disposition; and infrastructure and its constituent parts.

I took a sociomaterial view of activity in this study, in attending to how students created knowledge together, what they did and said, what tools they used and the objects they assembled and created (Johri, 2011). The knowledge creation metaphor "is a kind of individual and collective learning that goes beyond information given and advances knowledge and understanding: there is collaborative, systematic development of common objects of activity" (Paavola & Hakkarainen, 2005, p. 536). 'Common objects of activity' means both artefacts and concepts: anything that can be developed and shared by a group. Students are thinking with and through objects: what they create, their material and conceptual infrastructure, is key to building situated knowledge. Situated, because knowledge is created uniquely in application to a particular problem. The type of knowledge and how it is created depends on how group members exercise agency—recognise and act on opportunity. They need to frame the task appropriately.

Framing here is how a group makes sense of an assessment task and understands what their response to it should be, in effect their answer to "What is going on here?" (Goffman, 1974, p. 8). Students frame a task at both a high level, around the project as a whole and how it aligns with longer-term goals, and the local level of immediate action, such as the topic of a particular conversation or what to post online (Goffman, 1974; Scherr & Hammer, 2009). Framing describes how students approach a task epistemically, that is, how they understand what type of knowledge, related conceptual work and practical steps are required. It is not necessarily explicit or stated but evidenced in the activities of students.

Why do different groups frame the same task differently? An expanded view of dispositions offers a conceptual approach to how students understand and react to an assessment task, often in quite different ways. Perkins, Jay & Tishman (1993) define disposition as a composite, combining the three elements of sensitivity to occasion, inclination, and abilities. This is expressed mnemonically as the 'detect-elect-connect' model (Perkins & Salomon, 2012). A sensitivity to occasion is to detect that a situation requires a particular response, and this may arise from, for example, experiencing similar situations, or from environmental or designed cues. Inclination is volition, electing to act in a certain way: one may have formed a habit, value particular opportunities and respond to specific motivations. The third element of disposition is ability to act as intended, that is, appropriately connect and apply knowledge and skills to the recognised situation. As a group, students bring dispositions to a task and together frame their work on it.

The theory of distributed cognition "extends the reach of what is considered cognitive beyond the individual to encompass interactions between people and with resources and materials in the environment" (Hollan, Hutchins & Kirsh, 2000, p. 175), making a focus on infrastructure important to understanding student collaboration. 'Infrastructure' is treated here as what students assemble for their knowledge work. Not only tools and technologies, but also processes, ways of working and knowledge work centred on constructed objects. In analysing infrastructure, I concentrate on the "selected" and "constructed" environment (Bandura, 1999) that students build for their group projects. These are (a) selected technologies, tools and information sources to support work, and (b) direct shared construction of concepts and knowledge objects (Nicolini, Mengis & Swan, 2011). The Distributed Cognition for Teamwork (DiCoT) framework, as implemented by Furniss and Blandford (2006), uses a range of measures in the physical layout, information flow and use of artefacts (which represent cognition and coordinate activity), as well as a social/cultural model, to describe the functionality of teams who share knowledge and information. In this paper, I use elements that indicate "situation awareness" (of what has been done, what is happening now, and what is planned) and the immediate "horizon of observation" (what is shared and can be seen and heard) (Furniss & Blandford, 2006, p. 1177). The elements I use characterising groups' infrastructure are: the ongoing shared record; shared conceptual development; visibility of progress and use of artefacts and knowledge objects.

Methodology

I used an ethnographic case-based methodology to investigate the sociomaterial aspects of shared knowledge creation. I used case studies because they allow "the development of a nuanced view of reality," with the understanding that behaviour is not "rule-governed," but complex and contextual (Flyvbjerg, 2004). The seven cases were groups of 3-5 university students collaborating on open-ended assessment tasks in a large metropolitan Australian university. Cases came from two courses in engineering and education (see below). Concentrating on object-centred shared knowledge creation, I video-recorded, transcribed and descriptively coded in-person group meetings, noting actions, artefacts and tools used over the course of the group projects. I also followed groups online, accessing shared spaces and documents, and interviewed 12 of the 27 participants. I produced summary diagrams of actors and objects across each project, and wrote case descriptions, focusing on: actions over time and the resulting changes to shared objects; emergent practice and local adaptation of supporting infrastructure, including technologies and tools, for group collaboration; and the role and influence of objects in group knowledge creation. Focus was on process rather than grades. Ethics approval was attained.

This paper presents a brief summary of part of my findings, comparing groups' framing and disposition against how they assembled and used infrastructure in their collaborative projects. All names are pseudonyms and groups are named for their course and numbered according to categories for shared knowledge creation. Staff self-nominated tasks and students volunteered groups. Because groups self-selected for the research, they may have been more confident and cooperative than others. The cases were a snapshot of groups in specific circumstances, neither best-practice models nor cautionary tales, producing a useful range of situated examples of group knowledge creation.

The cases

The four education cases (Edu1, EduA2, EduB2, Edu3) were from an assessment task in a first-year-level history and sociology of education course in second semester, worth 30% and completed over four weeks. It gave equal marks weighting to the collaborative process, product and individual reflections. The task required groups to produce a digital artefact in a format of their choice, to answer a 'driving question' they formulated (for example, 'What if all education in Australia was virtual,' Edu1). The artefact would be up to five minutes in length (or non-linear equivalent) and used in a class presentation. Learning design scaffolded group work and stimulated individual and group reflection through reports during the project. Students were required to nominate and use some form of online communication. The novel digital format led all groups to show an interest in being creative and original.

The three engineering cases (Eng1, Eng2, Eng3) collaborated on an assessment task that added up to 85% of their final mark in a second-year course, first semester, focusing on professional practice. Groups researched and created a report on one of several scenario-based problems and presented results in class. Marks were based on output, mediated to some extent by evaluation of individual contribution. Students were given minimal guidance on their projects, with the stated intention of fostering independent learning. Students were expected to apply professional or transferable skills, such as ethics, critical thinking, research, teamwork and communication. Groups Eng2 and Eng1 chose projects aimed at making Australia carbon-neutral in its energy production. Eng2 elected to research nuclear energy generation, specifically nuclear fusion, and Eng1 divided a range of energy sources between members. Eng3 chose an aid project, 'Modernising a remote village in a developing country,' taking on housing as their project focus.

Case findings

In this section, I describe each case in terms of how they framed and worked on their projects, including the infrastructure they assembled and used. Table 1 summarises the findings. Through analysis of their approach to shared knowledge creation, I classified case groups into three loose categories, and present the cases under these headings. I briefly outline all cases, with more detail for category 3:

1. Divided knowledge work–group members were each allocated discrete tasks to be assembled in the final product, with limited shared knowledge creation.
2. Whole group shared knowledge creation–group members worked together conceptually for most of the project, producing a common repository of activity through artefacts.
3. Shared knowledge creation plus individual artefacts–these groups combined shared conceptual development with substantial artefacts created by an individual.

1. Divided knowledge work

The two groups in this section gave each group member responsibility for particular sections of the project and did not organise extra meetings outside scheduled classes. They were much lighter on conceptual discussion than the other groups, except EduB2. Both groups shared some limited conceptual discussion late in projects.

Edu1
This group of three had not worked together before, and showed differing dispositions towards assessment work: Ellis tended to start work early, Jamie chronically postponed work until submission time, and Finley fell somewhere between these. They were inclined to avoid extra meetings and, in their chosen format of an online timeline, they divided sections between members—covering the past, present and future—on the topic of virtual education. Discrete posts along a timeline supported the division of tasks, not requiring shared development of a

narrative; posts were summaries of information sources. The timeline acted as a record of progress: Finley, covering the 'present' section, saw the large number of posts in Ellis' 'past' section and was moved to add more posts. Jamie did not talk with the other group members about difficulties in finding content for the 'future' section. In the final tutorial, the group members did animatedly discuss concepts, referring to experiences with technology from high school, such as the school laptops scheme (covered in a timeline post) and showing educational video channels they used, such as Khan Academy and Crash Course. Finley described them as "videos that I like to follow, but they are not lectures because they are not made by the university."

> Ellis: In your [Finley's] part [of the timeline], you can write how the internet has opened up learning for everyone. You don't need money anymore to go somewhere to learn.
> Jamie: (leans forward to join the conversation) Cause that's online education now, isn't it? I just realised… So there won't be like textbooks anymore, you'll just be like (pauses)
> Ellis: Yeah, yeah. Even like our library, we don't even go to the library.

The students thus generated ideas on future education, but the sense of "open[ing] up learning for everyone," ideas around formal versus informal sources of learning and improved access were not conveyed in the timeline.

Eng1

Eng1 quickly assigned each student one energy source to research and write up. They agreed on a verbal set of parameters to guide the research and for most of the project did not discuss what they found, beyond brief comments. The group discussed online communications options, but did not establish any, partly due to one member's non-participation in social media, and were also unsuccessful in scheduling extra meetings, so communication was limited to their weekly classes. Students tended to work independently in class, often on other, more immediate, assessment tasks. There were a couple of attempts to discuss the project, but the group seemed at a loss as to how to manage this and were prone to tangential conversation. The group had not worked together before and students generally showed some reticence to lead or direct; one group member did take the lead early in the project, but left mid-semester without a word. In the final class, students shared some information about their allocated energy sources. The report was assembled remotely in Google Docs from individual pieces on the last weekend, delegated group members writing introduction, conclusion and connective text.

2. Whole group shared knowledge creation

The three groups under this heading framed their project as an ongoing collaboration between all group members. EduA2 combined individual research with this approach.

EduA2

The EduA2 sense of the situation was place it in a wider setting, relating it to ideas covered in their studies and to increasing professional understanding. They had worked together before, and oriented towards exploring concepts in their topic, the use of popular culture in education. They related discussion to future activities as teachers, drawing on recent experiences as high school students. Louise reviewed English titles she had studied in school, placing them in the context of popularity and relatability as well as a linguistics course examining sexism in texts. Their dispositions were in agreement and two noted the smoothness of collaboration in interviews. They were inclined to share ideas early and were highly engaged and collaborative, willing to put in effort to achieve high marks, including extra-tutorial meetings. They showed abilities in collective epistemic practices: research; exploration of topic; and recording detailed mind maps and notes, deictic reminders of each conversation. They maintained high levels of conceptual discussion in person and online, sharing multiple resources, including news and academic articles, in their private Facebook Group. The group was stretched beyond their usual structured tasks. Two of the group members noted their initial uncertainty: "it was just very open ended, and that was why it took us a while to get going on it" (Louise, interview); "there wasn't really any triggers for, 'You should go this way'" (Sean, interview). Talking with a tutor helped, and they made better progress "once we'd been researching. It was less of a sort of white-wash idea and we got more specific" (Sean, interview). Sean, by connecting research activity with the early stages of problem-solving, was building personal resources in shared knowledge creation. They created detailed common understanding of the issues and so encountered few problems in translating those into their assessment submissions.

EduB2

EduB2 framed the task as collaborative, electing to develop and create a video together about violence in games, but found it difficult to engage together on the problem. A group member suggested that they each research the topic and bring these to an extra-tutorial meeting, but they did not do so and instead relied solely on personal experience for the video. For example, a group member talked energetically about observing racism in games. By contrast, three of the four students independently researched and wrote a conceptual discussion of their chosen topic in individual reflections, directing effort to personal rather than group achievement. They did not complete research until after the group artefact was finalised, suggesting a different framing of shared and individual epistemic processes. Their use of online communications was limited, and primarily for group coordination of tasks rather than conceptual discussion. They showed scant experience of video production processes, which stymied progress. The topic of racism was quickly dismissed in favour of the perceived 'easier' subject of violence in games. The frame of an assessment task to be completed was more dominant than one of investigation of ideas, and their approach can be classified as surface learning (Entwhistle & Ramsden, 1983).

Eng2
This group of three were members of a larger study group that had been meeting since the previous year; they were highly collaborative and used the same shared Google Doc for dot-pointed notes through to the final submitted report, combined with Skype for remote work. They tended to work with 2-3 members sharing a screen or working simultaneously on the document, finding sources and making sense through discussion of the information they found. They used extra study sessions. Quinn was inclined to learn more about nuclear energy and this informed their framing of the task, which approached technical factual reporting of nuclear fusion, rather than addressing the task problem. They built some limited awareness of the surrounding political and environmental issues. Eng2 were able to review and edit each other's text, "We really didn't care if people edited it… I could see what they were writing and see if I thought it was okay" (Quinn, interview). The group had both an ongoing record of previous work and a clear view of how the shared document was progressing in real time. Work was flexible: Sam worked on a phone while travelling; Skyping with the others aided Jessie's concentration. The group has subsequently re-used this combination of tools and processes in other tasks.

3. Shared knowledge creation + individual artefacts

These groups were distinguished by a strong foundation of conceptual development and detailed artefacts that individuals in the groups contributed towards the group project. The artefacts were based on discussions and extended or added to ideas initiated by the group, building upon and progressing shared work. This pattern offers a way of managing some division of tasks with shared knowledge creation.

Edu3
Three of the four members of the Edu3 group had worked together on smaller activities. In their initial tutorial, they ranged widely over ideas as they agreed on a driving question to guide their video; conceptual discussion continued in subsequent tutorials and through a private Facebook Group. River posted immediately after the first tutorial, dividing tasks and noting the short time left to complete. All group members used Facebook for both knowledge work and coordination: sharing information sources and summaries, organising group meeting times, giving feedback, and posting items for inclusion in the video. Both River and Charlie noted affordances in posting online, of taking time to craft the point they wanted to make, without having to deal with the "four strong voices" of the group during tutorials: "you're kind of distant from the situation so you can give clear comments without trying to regulate what everyone's trying to say" (River, interview). The group referenced the shared online material in tutorials, and online posts recorded ideas.

River and Blake, who had experience in digital media production, appreciated but were concerned by the extended conceptual discussion: they were aware of the time and effort required to produce a video and so pushed for practical decisions. This led Blake to produce a draft video very early to show Blake's understanding of discussed ideas, "I was just concerned with getting the artefact done. And I do think they did listen to that, but they were also very caught up in the ideas of it" (Blake, interview). If it had been an individual project, Blake may have been satisfied with submitting that initial video as final, however, "You've got to handle everyone's ideas and form them into one, and get a thing out of all of that" (Blake, interview). The group continued to expand on ideas, online and in tutorials. After the next tutorial, River asked group members to each produce a storyboard for the video, but was the only person to do so (Figure 1). It included elements from group discussion and individually-contributed items, including images and videos—together with a script and timing for each segment of the video, ready for assembly by Blake, the editor. In effect, the storyboard and accompanying script organised and made sense of the emergent epistemic object of the group. By conscientiously incorporating common ideas and individual contributions from each member of the group, River produced an artefact that was easily understood and accepted, as well as satisfied River's (and Blake's) need for a more practical and definite plan. After a few tweaks during the tutorial and subsequent recording of the voiceover, Blake edited the video according to the storyboard and script.

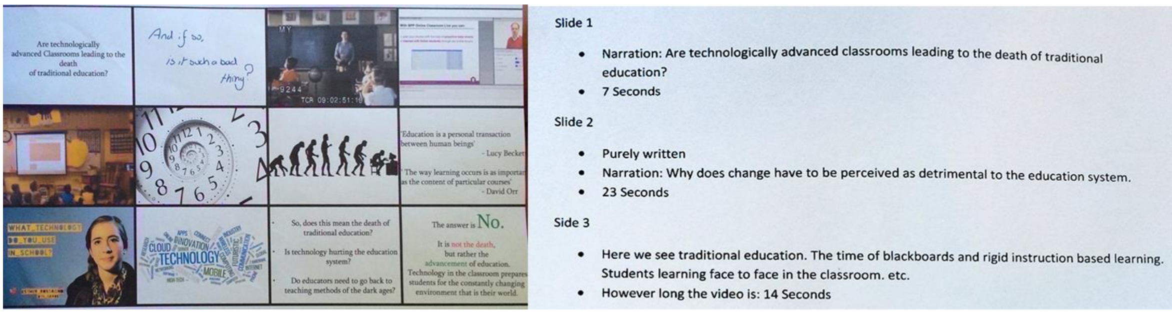

Figure 1: Edu3 storyboard and script by River

Eng3

The Eng3 group of four had the task of designing houses for a remote village. Cameron and Adam formed a central partnership in conceptual and practical development of a solution, partly in response to Cameron's insistence on working together, and possibly influenced by a feeling of urgency due the group's delayed start. The other two members completed tasks assigned to them by the central two. The group did not keep notes after their first meeting, and, using online communication for coordination of work rather than recording conceptual progress, it was difficult for the other two group members not directly involved in discussion to be informed on all aspects of the project. Adam assembled the report just before submission from individual sections emailed to him, so the group had limited opportunity to share and review contributions or the report as a whole.

Throughout, Adam and Cameron used the perspective, "we are an engineering company" (Adam). In contrast to the other two engineering groups, this group produced original design artefacts, a house design and village layout, to answer their identified problem. Collaborative work was almost wholly in person, using paper and pen as well as in-situ computers, with online tools used for incidental communication and file sharing. In addition to using class time, the group also met for an almost-7-hour collaborative session, in which Cameron and Adam sat side by side working on the project. The solution for housing they produced was problematic (e.g. no powerpoints, no kitchen, estimation of materials and costs excluded tools and machinery), however, they showed high engagement with the problem and an inclination to work creatively on it. Information sources used were minimal, mostly online sites covering aid projects, energy-efficient lighting, building materials and construction, and one book on climate-responsive building. Otherwise, Adam and Cameron often relied on personal experience, for example, referencing their Sydney neighbourhoods, when constructing a narrative of the needs of the fictional villagers they were providing with new housing. They used a village layout diagram (Figure 2) and house plan created by Adam as anchors for discussing their solution.

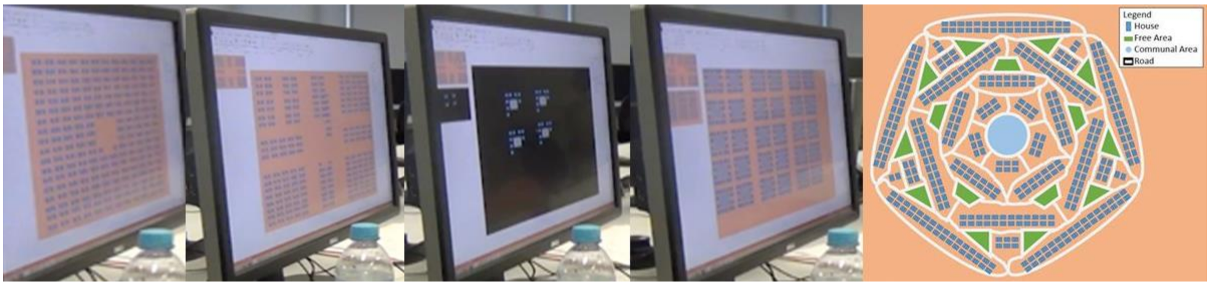

Figure 2: Adam's iterative in-class PowerPoint layouts, with the final layout on the right (Eng3)

Adam started sketching the village layout using PowerPoint in their long collaborative session. At first, he arranged houses in a grid, leading him to say, "Oh this looks like a cage *[expletive]*." Leaning back in his chair invited Cameron's attention. Adam searched Google Images for ideas and Cameron pointed to an image that showed "roads lead[ing] to the middle" that supported his idea on design to support community, which he had talked about the previous week. They discussed ways of rearranging the houses and where to add amenities. Adam worked further on the plan, with Cameron looking on occasionally, but still thought it looked "like a prison." They talked further about how to arrange the new village, and Adam produced a final design at home, incorporating ideas that the two had discussed, as well as Adam's research on orienting housing to the sun.

Summary

Table 1 summarises the cases against elements of infrastructure and approaches to knowledge creation. The groups that showed high levels of shared knowledge creation between the whole group (EduA2, Eng2 & Edu3) combined online and offline conceptual development. Simply having online communications did not guarantee that they were used for conceptual discussion (EduB2, Edu1). With a disposition for dividing tasks (Edu1, Eng1, partly Eng3), groups missed steps in shared problem exploration and knowledge creation. While most projects required some division in roles, the groups that allocated time for group or paired conceptual development and maintained a shared record of the project or used a common document for ongoing work, were in a good position for knowledge creation. By framing the project as requiring a group-devised solution, with progress and contributions visible over time, students had better opportunities to contribute materially, either individually or as a group. Of course, not all groups perfectly fit the categories applied: for example, while Eng3 showed strong conceptual development between two members, they did not use online conceptual development or a shared record, and the other two members were allocated tasks rather than taking part in an overall solution.

Table 1: Comparison of cases on dimensions of shared knowledge creation and infrastructure

Group	Shared conceptual development		Individually-created artefacts	Shared artefactual repository	Visible progress	Pattern of knowledge creation [] indicates category
	Offline	Online				
Edu1	limited	limited	no – but added posts to the timeline	yes, the timeline artefact itself	timeline posts, but one member obscured their lack of progress	[1] Division of tasks, no extra meetings
Eng1	very limited	no	to an extent – worked on separate topics	no	no	[1] Division of tasks, no extra meetings
EduA2	yes – high levels	yes – high levels	no	yes, extensive notes and posts	yes	[2] Deeply collaborative, connect to professional future
EduB2	very limited	no	no – script created as they recorded	no	progress was slow – this was apparent	[2] Surface approach, intended collaboration
Eng2	yes	yes	no	yes: used shared document for writing	yes	[2] Deeply collaborative, ongoing shared work
Edu3	yes	yes	yes	yes, posts and interim objects	yes	[3] Group conceptual development, specific production roles
Eng3	yes – dyad	no	yes	no, but main dyad shared objects and discussion	mostly yes for main dyad, no for other two students	[3/1] Two students shared epistemic work and allocated tasks to the others.

Discussion

To collaboratively solve problems, students need to talk to each other about the problem and identify and explore related concepts; a foundation of problem-based learning (Hung, 2013). In addition, they should create artefacts, such as notes, diagrams, mind maps, images, text—as a group or individually. These artefacts record ideas accessible to the whole group and are a reminder of concepts to be built upon and elements to structure into a solution. This study found contributing factors that stood in the way of students recognising and/or electing to use these strategies and abilities to execute them. How students frame a task, and the dispositions they bring to it, influence the way they create a collaborative infrastructure for knowledge creation, and can help explain why student groups approach tasks and collaboration differently. While learning design cannot prescribe successful knowledge creation, it can employ principles to support it.

Dispositions and framing

According to Perkins et al.'s (1993) definition of disposition, being able to recognise a situation, being motivated to act, and then having abilities to act in the way indicated, all contribute to the likely approach a student will take to an assessment task, their framing of it. The cases showed that the recognition of the type of situation was key in guiding framing, and that while most groups had little problem with motivation or inclination to engage, their inexperience in shared knowledge creation was a barrier—the aspect of 'abilities' in disposition. The quick division of work in the cases under category 1 above indicates that students did not recognise the task as one that required shared knowledge creation. In dividing responsibility, the groups forfeited much of the shared conceptual discussion that occurred in other groups. However, once individuals had researched topics, both Edu1 and Eng1 groups managed some limited conceptual discussion. By contrast, Eng3 divided tasks, but also recognised the need for a collaborative solution to their problem, which manifested in the main dyad's shared inquiry. EduA2 were unique in the education cases, in expansively framing inquiry in terms of their studies and future careers.

EduB2 group recognised the need for shared knowledge creation, but could not activate shared inquiry, although they were able to do this individually. EduA2 was uncertain how to proceed, but group members found and shared information sources, and persisted with conceptual discussion. The groups consistently weighed up effort against likely effect and impact on assessment criteria; two of the three engineering groups abandoned the use of LaTeX markup, for example. Without experience in group research, EduB2 chose the 'safe' topic, while EduA2's persistence reaped strong conceptual development. Eng2 avoided the main problem of how to provide renewable energy for the country, concentrating on explaining one energy source. Eng1 did not connect the problem to a need for developing a shared solution and could not establish basic project management, although recognising a need for it. The Eng3 dyad worked together on a shared solution, but in isolation from the professional processes and methods to which the task was ostensibly there to introduce them.

Edu3, like EduA2, had worked together on small in-class activities and had some understanding of working together. Edu3 also showed how even limited experience in the target skill, digital media production, can influence how group members view their activity: River and Blake were keen to move conceptual development into a practical frame. Many of the students interviewed had not previously experienced group projects at university and/or an open-ended task. If students are faced with a novel situation, they may fall back on familiar patterns of work and require cues for productive epistemic framing; as did Edu1 and Eng1, and other groups to an extent. The novelty of the education task seemed to help EduA2 and Edu3 form new patterns for shared epistemic work, and the topic of housing was familiar enough for Eng3 to connect to their personal understanding of housing and suburbs. Each of the groups brought particular aspects of productive dispositions to their assessment tasks, and enacted varying levels of shared knowledge creation. The step of connecting abilities, including negative self-perception of those abilities, to task framing can serve to limit first how students frame a problem, in trying to manage scope, and then to limit their efficacy in working on that problem.

Infrastructure

From the start of each project, groups assembled a particular way of working on knowledge: some discussed this explicitly; all also built this tacitly. The emergent quality of infrastructure was evidenced by the cases, as they used similar or identical technologies for differing purposes. The shape and uses of infrastructure generally aligned with how groups framed their projects.

Features of infrastructure helped or hindered group approaches to knowledge creation. Edu1 chose a digital tool that afforded discrete posts and did not require an overall narrative, which supported their original inclination to divide work. Eng1 agreed they needed online communications, but did not establish any, exacerbating the lack of visibility of progress and level of observation between group members. Eng3 also lacked a common repository for their work. All the education cases were required to establish online communications and did so; EduA2 and Edu3 used their online space for conceptual discussion throughout their projects, although EduB2 did not and Edu1 only in a limited way. Even in a very un-scaffolded task, Eng2, with further prospective opportunities to work as a team, added to their collaborative skills by trying out a new set of tools and processes for their project. While mandating particular elements in infrastructure, such as a common file repository and online communications, will not by themselves ensure students create shared knowledge, they can at least help students with functional coordination and establish foundational understanding of how to manage group work, in preparation for deeper collaboration in later projects.

Artefacts

The type and volume of shared knowledge that groups created using their assembled and built infrastructure was important, because this provided opportunity for deeper learning, as students expressed ideas and negotiated meaning and solutions together in knowledge artefacts. For EduA2, created artefacts included online commentary on information sources, mind-maps and notes. Without extensive shared knowledge creation, Edu1, Eng1 and EduB2 group projects generated fewer artefacts during their projects. Although these groups still shared some conceptual discussion, it was not at the level observed in the other groups. Of course, not all ideas appeared in submitted assignments or even interim artefacts—there is conceptual development between students as they talk that is not captured.

I identified individually-created artefacts that incorporated, extended and contributed to the shared knowledge work of a group, especially in Edu3 and Eng3. These artefacts synthesised collaboratively-developed ideas into objects produced by one person. Blake (Edu3) produced the early video to visualise the format of their final product and progress the project. River (Edu3), through storyboard and script, brought together ideas, text, images and videos contributed by individuals or developed in group discussion, forming a blueprint for the final video. Adam's diagrams similarly incorporated ideas discussed with Cameron, and crucially provided a focus for their in-person problem-solving, as the location and shapes of elements in the diagrams prompted questions, reactions, explanations and iterative improvement. Individuals who created the artefacts did so of their own volition when they recognised a need for them: there was no task instruction to create artefacts. By contrast, all groups were instructed to provide a task timeline as a record of their collaboration, however none of the groups used theirs to actively monitor and plan their work.

Design principles for shared knowledge creation

Various principles for supporting students to create shared knowledge are covered in literature (for example, Hung, 2013; Hmelo-Silver, Chinn, Chan & O'Donnell, 2013); the ones outlined below focus on disposition, framing and sociomaterial infrastructure for productive shared knowledge creation.

Multiple opportunities to solve open-ended tasks. Groups should be assisted in developing appropriate dispositions through repeated exposure to tasks that require collaborative infrastructure for problem-solution. Even the most efficient and collaborative groups can be stretched out of their comfort zones, while other students will need scaffolding, such as scheduled class time and methods for problem exploration.

Cues for motivation and framing. Because students take a surface approach in one task does not mean they will take the same approach always (Buckley, Pitt, Norton & Owens, 2010). Consider how the task, its assessment criteria and supporting exercises cue students' framing and motivation.

Appropriate level of challenge. The engineering groups especially lacked foundational skills in engineering practice, but not motivation in learning to use them. The groups were keen to develop professional approaches, but did not show the abilities to identify and develop these independently. The projects created interest, but were too challenging. Structured exercises and resources for supporting relevant professional skills and processes would have been useful.

Guidance and practice in constituent skills for problem-solving. Although they created knowledge, groups' work was not necessarily backed up by strong research and knowledge integration skills. Unless students are confident in their abilities, they may not frame tasks as knowledge creation. Problem exploration was a new skill for groups: some skipped most of this stage. All of the engineering groups, faced with filling knowledge gaps in unfamiliar topics, were in need of support in developing productive epistemic practices. EduB2 took a relatively shallow approach, which fostering ability in collaborative research and video production could have improved.

Low-stakes preparatory group activities. EduA2, Edu3 and Eng2, who had worked together before, were able to work more conceptually and closely, and expressed confidence in each other. They had, or were on the way to establishing, a functional team. The two driving members in Eng3 developed a strong partnership. Students will benefit from activities to familiarise members with each other and develop common frames of action.

Online communications and shared working space. A shared record and visibility of progress helped the groups that framed their project as knowledge creation use their common tools for conceptual development. An online record contributed to the richness of collaboration. Instantiating ideas in objects, notes or individually-contributed objects, assisted all groups in conceptual development; the groups with fewer shared artefacts or visibility of concepts and progress were less productive epistemically.

Encourage artefact creation. Artefacts were used to solve problems–for Edu3 to enable production of a video and organisation of knowledge and for Eng3 to estimate materials and cost, as well as visualise and design the solution to building a village of new houses. They instantiated knowledge and had a goal. While an artefact for its own sake, such as an unused group planning timeline, is of little value, students should be supported and encouraged in instantiating and sharing ideas. If framing, task conditions and conceptual development align, it should become natural for students to share ideas in artefacts.

Conclusion

Students bring aspects of productive dispositions to assessment tasks. Some will be keen to learn, but need help in accessing related abilities. Students may not detect a need for shared knowledge creation, while others who want to collaborate need assistance in transferring individual skills into collaborative research. Helping students learn to collaboratively solve problems is a long game, as each student will react to and learn differently from each experience. In learning design, evaluation of student work, and in research into shared knowledge creation, consider the dispositions students bring to a task, evidenced in their framing of it and their resulting infrastructure, including the artefacts they create.

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Piloted Online Training Module to Teach On-Site Safety in Engineering

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Change in Australian engineering industry has caused difficulty for engineering students to secure placements and engage with engineering practice. Consequently, universities are developing learning modules using digital simulations to expose engineering students to authentic engineering practice as part of their curricula. Many simulations use technology such as virtual reality that is not accessible to students off campus without significant resource investment. One of the important elements of engagement with practice is learning about safety in engineering. With the use of work integrated learning and distance education frameworks, this study developed and evaluated the effectiveness of an online desktop-based learning environment that students could access off-campus, in delivering safety education and awareness, and the benefits of online learning. Fifteen engineering university students (6 female) participated in an optional module using a desktop-based industrial site simulation. Pre and post testing were used to evaluate effectiveness of the module. Results indicated that the module significantly improved understanding and application of the job safety analysis technique and improved on-site safety awareness. The use of flexible online education is versatile and effective. Students benefitted from desktop-based simulation experiences incorporating authentic engineering scenarios and tasks that could be accessed online.

Keywords: interactive learning environment, safety education, engineering education, module

Introduction

Many graduates lack employability skills (Graduate Careers Australia, 2015). Education and training are the main instruments available to governments and the community to prepare people for the increasingly demanding world of work (Singh & Gera, 2015), but university programs are not necessarily providing students with the skills to allow them to excel in the workplace. The traditional style of teaching, lectures, is still prevalent in universities across Australia with students graduating with strong technical backgrounds (Gilboy, Heinerichs, & Pazzaglia, 2015).

The structure of traditional engineering programs offers limited exposure to workplace culture and the professional skills required to function in the environment. The importance of professional skills such as critical thinking, communication, teamwork, and safety awareness are not necessarily explicitly taught in engineering programs, leaving graduates ill-equipped for the demanding workplace environment (Mills & Smith, 2014).

This study was part of an overarching project in Australia to address the challenges of engaging engineering students in practice (Male, 2015). The initiative focused on developing modules for students that can complement existing opportunities to work in industry. The modules created by the project were designed to support the development of the Stage 1 Competencies set out by Engineers Australia (Male, Cameron, & Pointing, 2016). An important aspect of the project was that students engage in simulated workplaces, meaning modules may be delivered in an online setting, not restricted to the classroom. This provides educators and teachers with flexible access to the modules.

This paper presents a pilot study of a computer-based training module which engages engineering students in completing an authentic engineering task incorporating a Job Safety Analysis technique. The training module utilised an established desktop-based interactive virtual environment. The study asked:

> How does an online training module designed to teach safety and risk management procedures, assist university engineering students to develop on-site safety awareness and confidence to conduct a job safety analysis?

Engineering Students

Face Issues Acquiring Sufficient Professional Placement Accredited engineering programs conducted by universities in Australia are required to meet national and international benchmarks. Programs must contribute to learning outcomes consistent with the *Stage 1 Competency Standards* (Engineers Australia, 2017, p. 2), which include; Knowledge and Skills, Engineering Application ability, and Professional and Personal attributes. To satisfy the learning outcomes, engineering students must gain exposure to engineering practice. This is commonly achieved in 12 weeks of engineering related work in the student's discipline. The process of securing a placement has traditionally been supported by universities through career events and guidance. However, the responsibility to acquire professional placements has been largely left to the student. Obtaining and participating in placements is seen as vital to their development as professional engineers. Students have reported these placements have effectively supported them in meeting Stage 1 Competencies, and increasing their motivation towards becoming engineers (Male & King, 2014).

Engineers Australia (2019a, p.13) reports the number of Australian engineering students has almost doubled in the last decade from 58,298 to 115,231 students. The rapid increase has been largely due to the influx of students from overseas, up from a total of 29.3% of enrolments in 2007 to 42.3% in 2017.

Engaging Students with Engineering Practice through Distance Education?

Distance education (also now known as online education) refers to teaching or learning methods generally presented through electronic media (Bing, Pratt-Phillips, Gillen, & Farin, 2011). This varies from traditional learning where students meet face-to-face with teachers. Online learning has gained popularity with the advancement in technology, offering flexibility and cost effectiveness (Perry & Pilati, 2011).

A meta-analysis conducted by Means et al. (2010) on 50 studies covering the topic of online learning from 1996 to 2008 concluded that students participating in online learning performed better on average than those taking the traditional face-to-face learning. The effectiveness of online learning was seen irrespective of the content taught and competency of the students. Undergraduate students, post-graduate students and professionals all saw similar results. Engineering students are prolific owners and users of digital technologies (Cagiltay & Ozalp-Yaman, 2013; Johri et. al, 2014) indicating they are well suited resource-wise for engaging in online learning. Although there is evidence supporting online learning, a study from the United States showed that less than one-third of faculty members believe in the value of online learning (Allen & Seaman, 2010, p.12), suggesting there are challenges in the adoption of online learning.

The widespread adoption of online education provides an additional way for engineering educators to provide engineering students with the opportunity to learn skills which are important for engineering practice in a manner which is widely accessible, through specially-designed online modules. For example, students may learn authentic safety procedures or methods for identifying hazards which are used in engineering practice, by completing appropriate online modules.

Safety Education in Engineering Curricula

Safety is a fundamental aspect of the engineering practice and has been identified as essential for graduate engineers to understand and possess skills in. This is reflected in the fact that safety aligns with Engineers Australia's Stage 1 Competencies and is essential to abiding by the Code of Ethics (Engineers Australia, n.d., p.3) and complying with industry codes. However, Hill (2016) states that there is a lack of safety education in engineering, leading to graduates that do not have adequate safety knowledge.

Typically, students in engineering education are only exposed to hazardous environments when conducting work in laboratories or in workshops. To conform to rules and regulations, most students are given an informal induction as the inherent risks are generally low. A study by Altabbakh, Alkazimi, Murray, and Grantham (2015) measured the attitude to safety culture in university design teams. Less than half of the students admitted to having formal laboratory training and could correctly answer general workshop safety questions. Engineering graduates need to be more aware of the consequences of neglecting safety to avoid a catastrophic mistake in their careers (Saleh & Pendley, 2011).

In the study reported in this paper, the lack of safety education in engineering education was addressed through an online safety module focused on teaching students how to conduct a Job Safety Analysis.

Methodology

Setting

The setting for the study was a research-intensive university in Australia. The study was not a part of the coursework for any specific engineering unit.

Participants

The module was open to all currently enrolled engineering students at University A. Invitations to complete the module were circulated through online noticeboards and university emails to enrolled engineering students. Students who expressed interest were given access to the desktop-based virtual learning environment software, and instructions for completing the module. A total of 31 students expressed interest in completing the module of which fifteen of currently enrolled engineering students completed the online safety module.

Table 1: Participant demographic information (*N = 15*)

Gender		Degree-Level		Type of Enrolment	
Male	**Female**	**Undergraduate**	**Postgraduate**	**Domestic**	**Overseas**
9	6	3	12	9	6

Participants were offered one hour towards their practicum for their engineering program and a $20 AUD gift voucher for their participation. The study was approved by the institution's Human Research Ethics Committee.

Virtual Reality Learning Environment

The software application used in this study was the desktop-based virtual learning environment developed by Norton et al. (2008). The application provides the user with a virtual environment of the (now closed) BP Refinery on Bulwer Island, in Queensland, Australia. The learning environment is interactive and allows a user to freely move between approximately twenty physical locations ('nodes') within the refinery. At each of the nodes, the application uses a collection of high resolution 360-degree images to allow the user to look around. This allows the user to be able to see the same as what a person who was located at the actual physical site would be able to see. The environment allows users to explore the processing plant and learn about various plant equipment. The BP Refinery VR can be run on any computer with Flash Player installed.

The software application has previously been used as an aid for teaching engineering students about aspects of engineering practice. For example, Maynard et al. (2012) used the learning environment in two undergraduate chemical engineering units to allow students to gain knowledge of industrial processing plants, maintenance procedures, and hazard identification procedures (among other reasons). Most students reported that using the learning environment increased their learning in comparison to paper-based case studies.

Description of Online Job Safety Analysis Module

The module was designed to be able to be completed by engineering students outside of class. Although educators may choose to adopt the module into a course, the purpose was to create a flexible module which could also be completed in a stand-alone manner. The module takes approximately ninety minutes to complete.

Using the desktop-based virtual learning environment developed by Norton et al. (2008), an authentic engineering scenario was established. A past study by Maynard et al. (2012) successfully used the environment as a learning vehicle for Hazard Operability Studies (HAZOPs). However, the HAZOP is a technique predominantly used in chemical engineering. To create a module which was multi-disciplinary and could be used by engineering students from a large range of disciplines, the discipline-independent Job Safety Analysis (JSA) procedure was chosen as the focus of the module.

In the module, participants take on the role of a graduate engineer at a risk consulting company. The task involved completing a JSA for the replacement of a motor shaft guarding for a Kerosene pump (804J) within the BP Refinery. Relevant information that is commonplace for similar jobs on worksites was presented. Participants were introduced to the importance of the JSA, and that it formed part of the Permit-To-Work system for the BP Refinery. Instructions to guide students through the process of using the software application and conducting the JSA were also created. The instructions were 5 pages in length and included screenshots of the application.

Procedure

Students who had elected to participate in the study were sent an email with a link to a location to download the Virtual Reality (VR) learning tool, a participation consent form, and the instructions for competing the module. Participants were informed that the module would take approximately 90 minutes to complete, although no time limit was set. Participants completed the module in their own time over a two-week period when data was collected during the first half of 2019.

Participants first completed a demographic questionnaire, and the pre-module questionnaire (Table 1). The demographic questionnaire, pre-module questionnaire and post-module questionnaires were all hosted using Google Forms. This allowed students to easily participate in the study without needing to engage with the researchers in a face-to-face manner at any stage. To evaluate the effectiveness of the modules at increasing students' ability to complete a JSA, a pre- and post-test quantitative approach was adopted, in addition to qualitative responses. Students completed questions 1-3 of the pre-module questionnaire again during the post-module questionnaire.

Table 2: Pre-module questionnaire

No.	Question	Question Response Method
1	How familiar are you with the Job Safety Analysis procedure (or similar)?	1 = *Have not used before*, 5 = *Used multiple times*
2	How confident are you with using the Risk Matrix?	1 = *Not confident*, 5 = *Very confident*
3	How confident do you feel in completing the Job Safety Analysis for your task?	1 = *Not confident*, 5 = *Very confident*
4	Have you had any experience working on-site?	Written response

Following this, participants completed an incomplete JSA risk matrix by identifying hazards and mitigation measures. The BP Refinery VR learning environment was introduced to participants and they were provided with the instructions which informed them how to reach the location of work (i.e. which node location they needed to access in the software application). Participants were provided with an example which was designed to guide and inform them on the completion of a JSA. The instructions also included thought-provoking questions related to working on-site to stimulate hazard identification and mitigation measures. Participants were encouraged to navigate the VR model to identify risks.

After completing the JSA, participants used their completed JSA to answer the post-module questionnaire. Participants were asked questions 1 -3 from the pre-module questionnaire again to evaluate the impact of the module.

Table 3: Post-module questionnaire

No.	Question	Response Method
1	How familiar are you with the Job Safety Analysis procedure (or similar)?	1 = *Have not used before*, 5 = *Used multiple times*
2	How confident are you with using the Risk Matrix?	1 = *Not confident*, 5 = *Very confident*
3	How confident do you feel in completing the Job Safety Analysis for your task?	1 = *Not confident*, 5 = *Very confident*
4	Did you identify any risks that were unexpected?	Written response
5	What do you feel is the most important thing to consider when working on site? Why?	Written response
6	What was your most significant learning regarding safety on-site?	Written response

Results

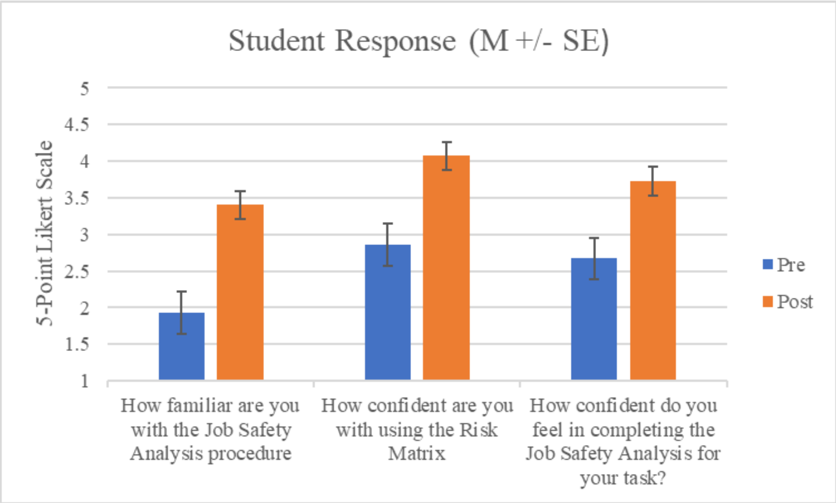

Figure 1: Student responses to questions about technical application

1. How familiar are you with the Job Safety Analysis procedure (or similar)? (1 = *Have not used before*, 5 = *Used multiple times*)
2. How confident are you with using the Risk Matrix? (1 = *Not confident*, 5 = *Very confident*)
3. How confident do you feel in completing the Job Safety Analysis for your task? (1 = *Not confident*, 5 = *Very confident*)

Analysis showed that participants gained more familiarity with the JSA technique, were more confident in using the risk matrix, and were more confident in completing a JSA after completing the module. The mean response increased substantially for each respective Likert-scale question (Figure 2) with a small standard error. A Wilcoxon Signed-Rank two-tailed hypothesis test was conducted on all three Likert-scale questions with $\alpha = 0.05$, to evaluate whether there was a statistically significant difference between pre-module and post-module results.

Table 4: Test of statistical significance and effect size between pre- and post-module Likert scale questions

Question	p-value	Z value	Cohen's *d*
1.	0.002	-3.0594	1.60
2	0.003	-2.9341	1.49
3	0.006	-2.7118	1.42

Table 5: Common themes for short answer responses

Question	Common Theme	Quotes
Did you identify any issues that were unexpected?	The module contextualised hazard identification on-site. Hazards such as spills and leaks that would not be evident in paper-based studies.	"Trip hazards in the form of puddles and wiring" "Foreign objects may fall into motor assembly"
What do you feel is the most important thing to consider when working on site? Why?	Safety was identified as the most important aspect of site work. Safety of employees is essential to ongoing process production.	"Safety. There are so many hazards that are present on site, and they all pose a risk to us and people around us. Hence why safety and considering all the hazards are vital."
What was your most significant learning regarding safety on-site?	Site work is inherently dangerous, insignificant hazards such as tools pose as life threatening risks.	"Site work has many hazards that could possibly be life threatening. However extensive use of tools and techniques such as the JSA and risk matrix should

Question	Common Theme	Quotes
	It is up to the employees to utilise safety procedures to identify and mitigate risks. Technology could possibly aid in hazard identification	be used to allow for safe work for years to come.”

As shown in Table 4, all p-values were less than α meaning the null hypothesis was rejected and the difference between mean values for each of the three questions were statistically significantly different. The magnitude of the significant difference was quantified by analysing the effect size. Cohen’s d was used to analyse the effect size between data (Cohen, 1977). The value of Cohen’s d indicates that for all questions the effect size was considered very large (> 0.80), suggesting that the module had a considerable effect on the learning of students.

Table 5 highlights common themes present amongst responses to the post-modules written questions. Students articulated a range of themes highlighting the importance of safety on-site.

Discussion

Efficacy of the module

Analysis of the results from Figure 1 and Table 4 demonstrated that there was an improvement in student knowledge of the JSA technique and risk matrix usage as a result of completing the module. After completing the module, participants reported that they were more confident with using the risk matrix (a mean increase from 2.86 to 4.07) and completing the JSA technique (a mean increase from 2.67 to 3.73). Moreover, the difference between pre- and post-module responses were statistically significant with large effect-sizes, suggesting that the online module was effective for allowing students to learn the JSA procedure. As expected, students’ familiarity with the JSA also increased as a result of completing the online module. The fact that the mean familiarity response increased from 1.93 to (only) 3.4 may reflect that students perceive that they require additional opportunities to apply the JSA technique to internalise the technique and become more proficient at applying it.

In addition, analysis of the qualitative feedback showed that all participants reported an improvement in awareness of on-site work. Participants stressed the importance of the safety of employees conducting work on-site, commenting that “ensuring safety as a top priority is important for employee wellbeing. Reducing the risk of injury can increase productivity on site and the overall quality of work” while another participant identified that there was a “degree of influence people have to safety on site and people being a safety risk themselves”. Students also articulated the importance of using risk assessment techniques to identify and manage risks.

Reflecting upon the research question, the outcomes demonstrate that the module allowed students to enhance their awareness of on-site safety, and to gain confidence using the JSA technique. The positive increase in proficiency aligns with elements of Engineers Australia Stage 1 competencies; in order to complete the JSA, participants must be able to identify and manage technical, health, environmental, safety and contextual risks as well as addressing constraints, such as human factors. Overall, the findings suggest that online modules may be an effective alternative method to in-class instruction for teaching engineering students about safety education.

Using technology to teach safety in educational settings

Several previously conducted meta-analyses have demonstrated that computer simulations and virtual reality technology can have tangible benefits on learning outcomes over traditional classroom instructional approaches (Merchant, Goetz, Cifuentes, Keeney-Kennicutt, & Davis, 2014; Smetana & Bell, 2012; Vogel et al., 2006). In a manner which reflects these outcomes, interactive learning environments can be invaluable as a pedagogical tool for teaching safety-related concepts.

The results of the study contribute to the existing literature which suggests that engineering students can gain valuable exposure to aspects of engineering practice, such as safety, through use of learning environments which allow students to experience and use virtual work sites. For example, Maynard et al. (2012) utilised the same desktop-based VR learning environment (as used in this study) in a 2nd and 4th year undergraduate engineering unit for teaching hazard identification. Maynard et al. (2012) concluded that the majority of students were able to identify more hazards when using the VR learning environment compared to a paper-based approach, and that the learning environment was useful in enhancing their knowledge of industrial plants. Several participants of this study also recognised that VR can provide a powerful way to conduct risk and hazard identification, stating "viewing a model of the location can expose overlooked hazards". The outcomes of this study add further evidence that the selected interactive learning environment is an effective pedagogical tool for engineering educators.

Another study which used VR technology to teach engineering students about a safety hazard identification tool, CHAIR (Construction Hazard Assessment Implication Review), reported that use of VR technology had enabled students to use the tool more effectively compared to being provided with still images of the worksite location (Male et. al., 2018). Although the studies were similar in nature there are a few key differences, notably the study used Head-Mounted Display (HMD) VR technology instead of desktop-based VR technology. There are key differences between HMD VR technology and desktop-VR technology. For example, one study found that while HMD VR technology has been found to be more intuitive by users, users actually performed more effectively using the desktop version (Santos et al., 2009). Building upon this, a systematic review by Jensen and Konradsen (2018) concluded HMD produced no significant advantages in learning when compared to technology with less presence (such as desktop-based VR). In some cases, it proved disadvantageous due to technological challenges and cybersickness. This idea is further reinforced in a recent study which concluded that increased immersion increased users' presence, but also overloaded and distracted the learners, leading to less opportunities to learn (Makransky, Terkildsen, & Mayer, 2019).

Moreover, not all studies show that use of immersive technology is useful. Leder, Horlitz, Puschmann, Wittstock, and Schütz (2019) compared immersive VR and PowerPoint as methods to deliver safety training.
They concluded that the learning achieved through using the PowerPoint method was similar to the immersive VR, suggesting that the improvements in learning from using the VR were not sufficient to justify the costs. However, a key benefit of virtual reality and interactive learning environments is that they can provide users with the opportunity to experience situations or worksites where they may otherwise be unable to do so (Freina & Ott, 2015; Slater & Sanchez-Vives, 2016). In the context of teaching safety to tertiary students, this is highly important as experiencing the respective worksite may be imperative to understanding key aspects of safety.

These outcomes are important for educators because they suggest that investing resources in HMD VR technology may not always be appropriate or effective, and that desktop-based interactive learning environments which are more readily accessible to a larger number of students (such as that utilised in this study), may be a more effective approach. In order to provide students with the opportunity to participate in learning activities which can enhance their engagement with practice, educators may therefore wish to spend more effort focusing on desktop-based learning environments unless there are clear, tangible, and specific benefits to using other technologies such as HMD VR or Augmented Reality.

Considerations for teaching safety through online education

There are important challenges when considering the use of online modules, especially if the modules are not integrated into curriculum. While students that participate in online learning generally achieve better results than students in traditional courses (Means et al., 2010), students must learn independently and be more self-motivated to learn the material. The increased flexibility in student learning also has its downsides; higher rates of attrition have been experienced for students in online education (M. Angelino, Williams, & Natvig, 2007), suggesting that students may be less likely to complete the module than if it is delivered in-class.

As there was no time limit in completing the module (as would be expected for an in-class situation), participants could set their own pace for completing the module. This is especially relevant for overseas students who are more likely to speak English as a second language and possibly have difficulty with English, allowing more time to understand the content.

Practical Implications

The results suggest that an authentic online learning module can significantly improve student knowledge on the application and appreciation of on-site safety tools. Specifically, the usage of the JSA technique and risk matrix was significantly improved post module. Appreciation and understanding of on-site safety were also noted as a common theme amongst participants, aligning with Engineers Australia's Stage 1 Competencies.

In addition, desktop-based VR experiences can be as (or possibly more) effective than HMD VR in terms of learning, while reducing resource cost in implementation. The flexibility of desktop VR allows educators to deliver content online, further increasing availability and accessibility. The online component provides numerous advantageous to students such as flexible delivery times and provides educators with desirable reduction in time investment in holding workshops for equipment-based VR.

Caution should be taken when implementing online delivery due to problems with attrition (Allen & Seaman, 2010). However, the benefits of online module learning outweigh the disadvantages due to its versatility, the modules can easily be implemented in credit bearing courses, or act as stand-alone module to students who are interested. As the BP Refinery learning environment used in this module has been used to teach hazard identification in this study and HAZOP in other studies with positive results, it may be robust enough to teach other engineering concepts.

Limitations

The number of participants *(N=15)* is not large enough to make wide generalisations about the effectiveness of the module. Further study will increase the sample size. Furthermore, as this study incorporated online learning, a comparison of results between online and face-to-face would be desirable. Although a similar face-to-face study has been completed, the module incorporated a different engineering technique, scenario, and visual tool to aid in student learning (authors blinded). Additionally, as the module could be completed online, participants that encountered issues only had email correspondence to troubleshoot issues. This proved difficult on numerous occasions in comparison to face-to-face contact where issues could easily be rectified.

Engineers Australia (2019a, p.13) indicates 42% of currently enrolled Australian engineering students are from overseas, the percentage of overseas students for this study is 40% showing a similar representation to engineering students overall. However the number of female students was higher than expected, Engineers Australia (2019b) quotes 12% of engineers in Australia are currently female whereas this study consists of 40% female participants. Studies have shown that females are more likely to respond to online surveys (G. Smith, 2008). The high number of postgraduate students in proportion to undergraduate students may have contributed to the positive results. Engineers Australia (2019a, p.13) reports 16.5% of currently enrolled engineering students are in their postgraduate degree whereas the current study, 80% of participants are postgraduates.

Future Work

The flexible nature of online modules allows educators to embed additional on-site safety concepts (such as the Take 5 and Permit-To-Work systems) into curricula in a way that could greatly benefit graduating students. Recruiting industry professionals to reflect with student participants on completion of the JSA would also provide further opportunities to understand the application of JSA in engineering practice. This could be conducted via online communication boards allowing flexible responses from both students and industry professionals.

Analysis of the presence which students experience may be evaluated as there is little emphasis on the benefits of changing presence in the desktop based VR, as even a previous study with PowerPoint VR proved just as effective as equipment-based VR (Leder et al., 2019). As the sample size was limited, incorporating the module into engineering curriculum for testing would allow for a larger sample size of students to validate the effectiveness of the module. Further testing for undergraduate students should be explored as the current study featured a small sample size of undergraduates. Future research may also evaluate the level of students' proficiency in completing a job safety analysis after completing the module, to provide a more accurate representation of the level of learning which was achieved.

Conclusion

This study presented an online training module developed to address the gap in safety education in engineering curriculum, and to increase students' opportunities for exposure to engineering practice. The module was piloted by engineering students at University A to evaluate the effectiveness of the module at teaching the Job Safety Analysis risk management procedure. Results suggest the usage of a desktop-based virtual reality learning environment of an authentic engineering worksite greatly improved understanding and application of the job safety analysis technique, and enhanced awareness of safety concepts on industrial sites. Online accessibility provides students and educators with the possibly of increased flexibility for completing the safety module. Educators may benefit from the findings as the findings inform design concepts that may be easier to implement for virtual reality education purposes. Learning environments with desktop-based virtual reality can significant contribute to student learning and may be as effective as HMD VR. Furthermore, online education can easily be implemented, allowing for versatile usage within credit bearing courses or as stand-alone modules, bringing along positive increases in learning for students.

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Evaluation of the use of VoiceThread for Assessments

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Although multimodality is increasingly used in teaching, learning and assessment, there is little in the literature that speaks to how VoiceThread (VT) is used for assessment purposes in higher education. This study contributes to this knowledge by evaluating how VT was used for assessment purposes at one Australian university and exploring how lecturers and students experience the use of VT in assessment tasks. Data were collected through interviews with lecturers, surveys and a focus group with students and review of the use of the VT tool itself. A five-part VT assessment process was identified and support structures for staff and students were mapped. The study found that despite the multimedia capability of VT, text only slides and text with visual slides were the most common design of student created media, while text, audio and video commenting were used across the six units in the study. Lecturers primarily used audio comments and grades in the feedback process. While assessment submission was not always straight forward, and students required extra support with this unfamiliar tool, the opportunity to engage in multimodal assessment tasks was received positively by students and staff as an opportunity to enhance the diversity of assessment and feedback.

Keywords: VoiceThread, Assessment, Multimodal, Educational Technology

Introduction

This paper presents an evaluation of the use of VoiceThread (VT) for assessment at Charles Darwin University (CDU), a regional, dual sector institution based in the Northern Territory of Australia. VoiceThread is a cloud-based application that is linked into the Learning Management System (LMS) via a Learning Tools Interoperability (LTI) configuration and is the recommended tool at CDU for multimodal assessments and discussions using multimedia. A Thread can have slides added using over 50 different types of media (VoiceThread, 2017). Each slide can have comments added in either voice, video or text. While considerable research has been undertaken in the use of VoiceThread for conducting online discussions in online education (Kirby & Hulan, 2016; Ma, Yu, Xiao & Thor, 2017), there has been little research on the use of VoiceThread as an assessment tool. This study addresses the gap in the literature relating to the use of VoiceThread for multimodal assessments.

VoiceThread was introduced into the Charles Darwin University LMS in 2016. In a two-year period ending February 2019 there were 2,558 Threads created (staff and students) and an average of 8 hours a day spent by all users in this tool. The term Thread will be used in this paper to refer to a VoiceThread created by the students for assessment purposes. The evaluation reported in this paper focused on online units that use VT for assessment tasks and did not include Threads that were used for teaching purposes only. The user-orientated evaluation was conducted across three disciplines and six units of study in two colleges at CDU during the first semester on 2019. Six lecturers participated in the study, all whom were responsible for teaching the online units that were the focus of this study.

The study examined how the capabilities of VoiceThread were used by students to create assessment work and by lecturers to provide feedback on that work. A VT assessment process has been proposed to assist lecturers understand the different activities that both lecturers and students engage in to design, enact and respond to assessment tasks. We identified six key stages in this process: assessment design, student creation and submission of work, lecturer receiving work and providing feedback and the support mechanisms in place for the use of the tool.

Literature Review

With students creating multimodal work with new educational technology tools, new ways of thinking are needed in the design of assessments and feedback processes. Wyatt-Smith and Kimber (2009) compared the term multimodal to print-centric and looked at how VT was used with image-verbal and other combinations of media including music, video and animation in texts. When students work in multimodality it helps to break down the separation between print-based and digital texts (Baldwin, 2016). As students need to acquire multimodal literacies in order to create these assessment pieces, providing them with explicit instructions, technical support and a theory-driven rubric for multimodal work is recommended (Buchanan, Sainter & Saunders, 2013; Hung, Chiu & Yeh, 2013).

Teachers need to be explicit in their teaching practices and expectations when incorporating multimodality into assessment design in order to guide students to present academic ideas in new ways (Gourlay, 2016). Svärdemo Åberg and Åkerfeldt (2017) identified that teachers' assessment practices need to encompass a pedagogy of multi-literacies and this can challenge students in the design process of the assessment work. Gray, Thompson, Sheard, Clerehan and Hamilton (2010) discuss that to support students use of Web 2.0 authoring for assessments teachers need to provide clear links to specified learning objectives, adequate support and relevant marking rubrics.

To be able to increase student engagement in the feedback provision and foster a more personalised learning there is a need to move from text-only feedback to other modes. Hung et al. (2016) discuss transforming feedback from unimodality (text) to multi-modality (text plus audio and video). The importance of feedback is identified in the Assessment Design Decisions Framework (Bearman, Dawson, Boud, Hall, Bennett, Molloy & Joughin, 2014) as is the design of assessment tasks and the assessment context.

Adoption of educational technology requires more than just installing a product. Change management processes that include providing teachers with information and examples of the differences between the new tool and the previous tools can impact on uptake (Roberts, 2008). Rolim and Isaias (2019) present evidence showing that distrust of e-assessment systems, the fear of technical issues and the lack of knowledge of the systems prevent some teachers from using technology for assessments.

VoiceThread is a flexible tool that can be used for a variety of teaching and learning applications. VT provides the flexibility of a choice of media for students and teaching staff to communicate with. VoiceThread has elements that are humanizing, and which enable the communication of "emotion, personality, and other nonverbal cues conducive to better understanding and interpretation of meaning" (Fox, 2017).

As well as investigating student and lecturer use and perspectives of VT in this study, VT was also the chosen media for conducting the focus group discussion with students. Moyle (2006) found that the use of technology in conducting focus groups can be beneficial to the nature and depth of the conversations held. As students involved in this study were familiar with VT, an additional benefit of using this tool was that no extra training was required.

Methodology

This study was guided by the key question: How is VoiceThread being used by students and staff for assessment purposes in Higher Education at Charles Darwin University? The study was approved by the Charles Darwin University Human Research Ethics Committee (approval H19029).

The evaluative research was conducted in six units across three disciplines in two colleges at Charles Darwin University (CDU). This allowed for a deep exploration of the media used in student submissions and the academic feedback methods in diverse discipline units. The research evaluation investigated the following sub questions:

- What media and types of comments were used by the student in the assessment creation?
- Did students experience any difficulties in using VoiceThread?
- Were students provided with enough support to use VoiceThread?
- Were the students satisfied with the format (or mode) of the feedback given on their submitted work?

The user orientated evaluative research approach (Denzin & Lincoln, 2017) adopted in this study enabled the research team to look at the use of VoiceThread through the eyes of the users, both students and staff. This approach enabled triangulation of the research findings and provided views of VoiceThread from different perspectives.

Methods

A mixed methods approach to data collection has been used. VoiceThread software provided data on how the tool was used. This information combined with lecturer interview details informed the questions for the focus group discussion with students. MyView is the standard student survey mechanism at the University. Lecturers were requested to add three customized questions related to the use of VoiceThread. Student focus group discussions were facilitated through a shared VoiceThread and provided data to expand understanding of the student experience. Data collected from the focus group discussions included audio and text comments by students. All data collected relate to units taught in the first semester of 2019.

Unit Selection

Units were selected for this study based on information obtained from the University ticketing system which records staff calls for LMS support. Fifteen staff members lodged 38 tickets relating to VT in 2018. Of these, six lecturers from the Higher Education sector were found to be using VT for assessment purposes in their teaching units and these lecturers all agreed to participate in the study.

Unit 1 (referred to as U1) was from the College of Nursing and Midwifery, Units 2 to 6 (referred to as U2 – U6) were from the College of Indigenous Futures, Arts & Society. Units spanned three disciplines: Nursing, Indigenous Studies and Languages and Linguistics. All units were online reliant which indicates that students must access the online unit for learning and assessing purposes. Some units had an intensive delivery component. Delivery of each of the units was through the LMS for students enrolled in external and internal mode.

Student and Lecturer Profiles

The lecturers (L1 to L6) had different levels of experience in teaching online and in using VT for assessment. L1, L3, L4 and L6 had used VT for assessment since its introduction into the LMS in 2016. The most experienced lecturer (L4) had the least experience in using VT but had used equivalent programs over the years and was able to apply this experience in using VoiceThread.

Student numbers enrolled in the units varied from three to more than 65 with a totally of 105 students enrolled in the six units included in the study. Students had the choice to opt-out of the study by completing a question in the LMS, and a total of seven students opted out. Five units were predominately delivered to students enrolled in external mode while U2 students were mostly enrolled as internal. U1 students made up 66% of the total student cohort to take part in the study.

Assessment Process

The process for using VoiceThread for assessment is shown diagrammatically in Figure 1 starting with Assessment Design. Students create a response to the assessment and may use a selection of different tools to do this. Submission is required through the LMS with a VoiceThread submission point that is linked to the Grade Centre. Lecturers receive the submissions and provide feedback in several ways. All work is given a numeric grade which is transferred from VT to the LMS Grade Centre.

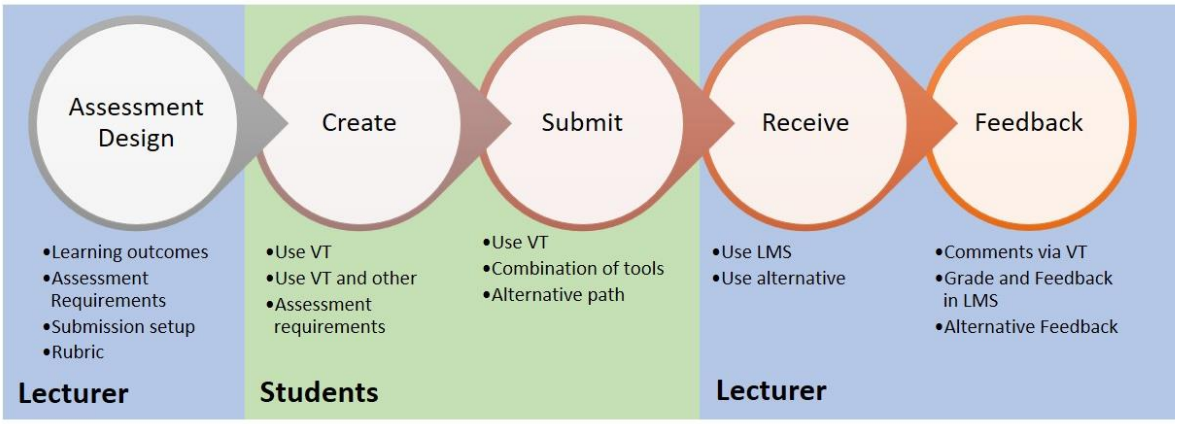

Figure 1: Assessment Process using VoiceThread

Figure 2 shows the various methods of gaining support for using VT: students (S) gain support from lecturers or call the LMS vendor student support. Lecturers (L) provide support for students and may call on University based educational designers for pedagogical support on assessment design or the LMS support team for technical support. The University internal LMS support team are skilled in all areas of the LMS and can escalate queries to the vendor technical support team which has a specific area for VT support.

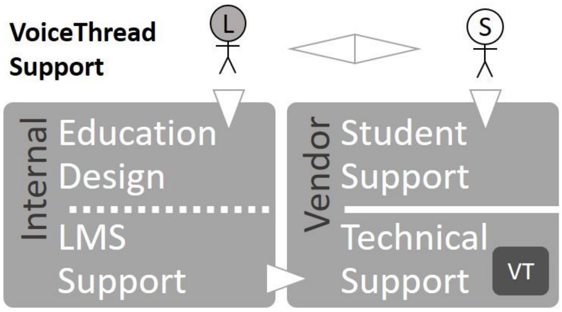

Figure 2: VoiceThread Support

The mixed methods approach enabled triangulation of the data collected (Denzin & Lincoln, 2017). No single method used could provide the level of detailed data required to answer the research question and hence, collection of data from various sources was deemed necessary. Table 1 shows how the data collected is mapped to the Assessment Process as shown in Figure 1.

Table 1: Data Collection Mapped to Assessment Process

Data Source	Assessment Design	Create	Submit	Receive	Feedback	Support
VT assessments	X	X	X	X	X	
Lecturer Interviews	X	X	X	X	X	X
Student Survey	X	X	X		X	X
Student Focus Group		X			X	X

Limitations

The researcher who conducted the interviews with lecturers was part of the University LMS support team and this may have biased the understanding of responses from the lecturers during semi-structured interviews. For future iterations, more than one member of the research team with complimentary skills (technological and pedagogical) will conduct the semi-structured interviews to reduce researcher bias.

The researcher observed from lecturer interviews that students are most likely to contact the lecturer if unhappy or something doesn't work. It was also noted that the majority of students who filled out the MyView survey were happy with VoiceThread. Future iterations of this research will keep the mixed methods approach to ensure these different perspectives are captured and verified.

As the online focus group was run after grade release, it is likely that this resulted in the small number of students that participated. Online focus groups will be conducted as soon after grading as possible and a different tool considered for a synchronous session to encourage dialogue.

Findings

VT is an educational technology tool that can be used in different ways. Assessment design needs to optimize on the functions of VT that can be used for the assessment task and associated feedback.

Support of students and lecturers is critical at different levels. Lecturers need the most support in understanding VT capabilities before designing an assessment task, understanding the student view of VT, and learning how to provide feedback in the tool. Students need detailed instructions on how to submit the assessment.

If alternative paths of submission are taken by the student (e.g. sending attachment via email instead of through VT) this results in alternative methods of receiving the work and providing feedback. This can increase workload for the lecturer and scatter the evidence of assessment work inside and outside of the LMS which can make it difficult to maintain evidence of assessment for internal and external auditing purposes. These key findings are supported by the discussion below.

Assessment Design

Lectures (L1 and L4) expressed optimism for the potential of using VT for both assessment and teaching and learning purposes. L1 advised that students liked the novelty factor of having an assignment that was different to other assignments. Students backed up this view by commenting 'enjoyed the variety' and 'love the way all the assessments are designed and planned' (U1 student, Survey).

Lecturers set requirements for the use of VT to respond to assessment tasks in different ways. While L2 required the students to use video to promote a conversational style response and in order to see the student, L4 uploaded slides for students to record answers in the target language. While L4 gave simple instructions for students to record audio comments, L3 encouraged a voice-over PowerPoint presentation to be created and then uploaded to VT. In U1 and U4, lecturers modeled the use of the VT through using it for teaching. This provided students with an example to follow, and gave the lecturer experience of creating a Thread. L1 mentioned that this gave the lecturer an appreciation of the student effort required to create a suitable Thread.

While L1 and L3 prepared a rubric for the multimodal assignment, others did not include a rubric but included requirements in the assessment description. Lecturer L1 customised a rubric over several teaching periods to include aspects of multimodal work and used this for marking transparency.

There was a discussion on the assessment design using the VT and online tools as compared to how assessment would take place in the classroom. L6 explained that in the classroom, students would stand up in front of the class to deliver their assignment, but was not aware that equivalent oral delivery of assignments could be done online using the sharing and peer review functions available in VT.

The student survey encouraged comments on areas of improvement in VT. One student from U4 succinctly said 'change voice thread'. Another student from U3 commented that more detail was needed of the oral assessment.

In summary, the assessment design process is critical to the student experience of VT, as is the need to provide explicit instructions to students on how to engage in a multimodal assessment task in VT. Lack of instructions (as in U2, U3 and U5) affected the way that students chose to create the assignment. L1 and L4's use of VT in teaching is a recommended strategy for all lecturers planning to use VT for assessment purposes. Extending this idea further, L1 shared a vision of having a conversation with the students in VT around the assignment work, although this is yet to eventuate.

Create

VoiceThread accepts a wide range of media types and these are summarized into five different styles: text only, text with images, images only, and video or audio. Table 2 shows that range of ways that students created material to add to a VT. While the most popular modality was text with images, U1 had the most variety in the design of the student created material. U2 shows that all students submitted a video, as required for that unit. U4 used lecturer (L4) created material and students added comments only (see Table 3).

Table 2: Student Numbers and VT Design

Unit	Student Numbers	Student Created Media	Text only	Visual and text	visual only	video	audio
U1	63	578	45%	52%	3%	1%	0
U2	4	3	0	0	0	100%	0
U3	3	31	87%	13%	0	0	0
U4	9	126	0	0	0	0	0
U5	4	54	69%	31%	0	0	0
U6	15	115	11%	85%	0	1%	3%

Table 3 describes the comments which were added to the slides in each assessment submission. The primarily method of comment was student spoken word (audio recording). Across the student submissions, all features of the tool were used: text, audio and video. U2 video comments are shown in brackets as the students uploaded a video recording but did not overlay that with any comments in VT. U1 had the strongest use of the VT text commenting feature. This was due to specific referencing requirements in the task where most students used the Text Comments to add required references.

Table 3: Student Comments on VT Media

Unit	Text Comment	Student spoken comment	Student Video
U1	19%	78%	3%
U2	0	0	(100%)
U3	0	100%	0
U4	0	100%	0
U5	0	100%	0
U6	0	100%	0

L1, L2, L3 and L4 reported that students felt stressed with using new technology and they felt that students in their course were not very IT literate. As reported above in Assessment Design, most lecturers allowed the students to create media with any tool and encouraged students to use all the VoiceThread Comments types (audio, video or text). However, only one student in U1 took advantage of this freedom to be creative by using an animation software with an audio comment to present the assignment.

L3 felt that it would be better for the students to just create the presentation with voice over in PowerPoint. However, students then had issues in submitting large file types. While VoiceThread provided the benefit of being able to accept large file sizes, the lecturer felt that VT provided no other benefit. A student commented from U1 that VT was a basic program compared to PowerPoint and a student from U3 commented in the survey that 'VoiceThread was a little bit convoluted'. L1 and L4 had prepared Threads for teaching purposes and this helped them recognise the work effort that was required by students to create a similar standard of Threads.

The University standard student survey tool was deployed, with four of the six Units adding questions relating to VT, with a 31% response rate. Figure 3 shows results with question 1 (Q1), which asked about the ease of use of VT. This question relates to the create section of the assessment process shown in Figure 1. Q2 asks students if they felt that the support provided was sufficient for using VT. The majority of results were on the agreement side. Q3 had the strongest positive result, asking students if they were satisfied with the feedback given for VT assessments.

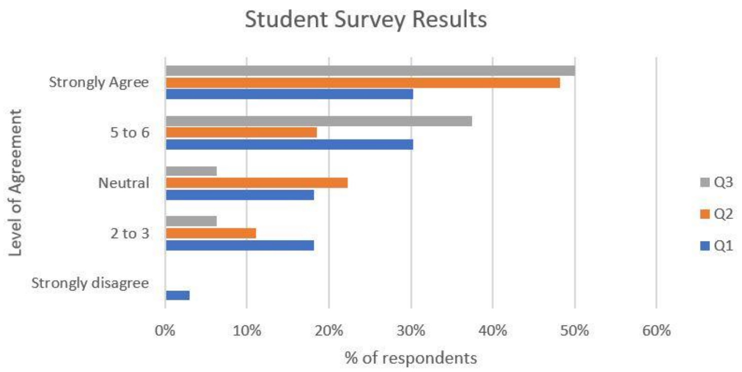

Figure 3: Results from Student Survey

Students were invited to participate in a focus group discussion run in VoiceThread. There was a low response rate (4%). The low participation rate in the Focus Group may have been caused by two factors. Firstly, asking students to voluntarily participate after they received their grades and secondly, while students were emailed from their respective study units, they had to follow a number of steps to get to the point of participation in the Thread. One student participated with a voice comment and said how appreciative they were of the extensive voice feedback from the lecturer and it helped to hear diction in the target language. Figure 3 shows one student's comment from U1 that shows that VoiceThread enabled student confidence in the subject content through the ability to record and re-record comments. This student recommended VT for future assignments.

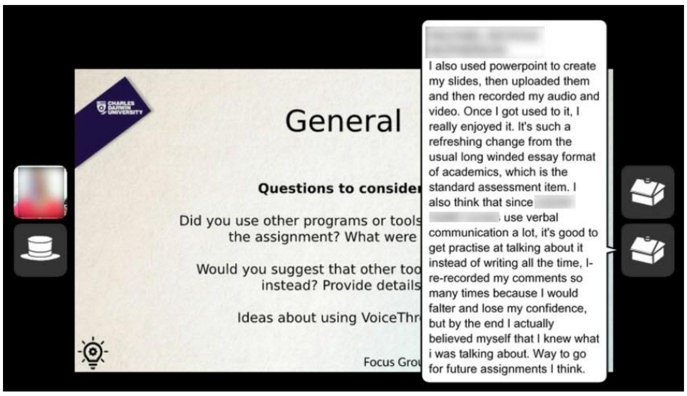

Figure 4: Student Comment from Focus Group VoiceThread

In summary, while most students used VT to add media and comments, many students used PowerPoint with a voice over and used VT to get the results to the lecturer. L3 and L5 believed that students preferred PowerPoint because the tool had been around longer than VoiceThread and they were more familiar with the features it provides.

Submit

Many students had issues at the submission stage. A lecturer (L6) reported that students would ask about different options when submitting and L6 was not aware of the correct answer to give. In one case, the student clicked the wrong option and other students could see the submission work. This reduced confidence of the lecturers in the VT submission process.

A student from U2 reported technical issues around submission time and this was unresolved after a call to the vendor support area. This is shown in Table 2 in U2 where one student managed to submit a blank VT. The work was submitted to the lecturer (L2) via email.

One aspect of submission that was mentioned by both lecturers and students was the impact the tool took on presentation appearance. When PowerPoint was used to create the presentation, uploading it to VT changed the placement and size of images and text. This impacted the lecturer's (L3) ability to provide accurate feedback even if the appearance was listed as part of the criteria of the assessment. L3 advised that one student in U3 provided the PowerPoint presentation as evidence of the text and image placement in that version. This supported the lecturer's belief that there was little benefit for the students in using VT. L3 and L5 mentioned that the only benefit was that VT allowed larger files to be submitted than the LMS standard submission points.

In summary, submission of assessment work often went wrong for students, either in technical difficulties or because VT changed the look of the presentation. Alternative methods of student submission included using email to submit work or creating the thread in a separate area and not using the VT submission area. If alternative methods of submitting work were taken, a higher workload for lecturer ensued in the remaining areas of the assessment process (refer Figure 1).

Receive

The researcher noted that lectures were required to access VT differently to other types of submission points in the LMS. L1, L4 and L6 reported that sometimes they could see student threads in the VT group folder but not in the submission point. Even if assessment work was successfully received, the lecturers found the different location of assessment work frustrating as the grading process did not allow them to give feedback in the same way.

While there was minimal mention by lecturers of any other difficulties or issues in receiving student assessments, it is important to note this step in the assessment process (shown in Figure 1) as lecturers' workload increased if an alternative path was chosen by the student at the submission point.

In summary, when alternative paths are used to submit assignment work, the lecturer requires alternative methods to receive and provide feedback on the work. This can increase the workload of the academic as different areas of the LMS or tools outside the LMS (such as email) are used.

Feedback

Lecturer feedback was variable across the six units. Table 4 shows that while L1 responded with a variety of comments in U1, in U4 and U5 students were not provided feedback in VT. L4 explained this as a holistic approach and feedback was provided on VT exercises leading up to the assessment.

Table 4: Lecturer Feedback in VT

Unit	Lecturer audio comment	Lecturer text comment	Lecturer media added
U1	26%	46%	27%
U2	100%	0	0
U3	0	100%	0
U4	0	0	0
U5	0	0	0
U6	83%	17%	0

L1, L2, L3 and L6 reported a high workload in providing feedback to the students in VoiceThread. They felt that for them there was no benefit from using VT for assessment, although they thought that students benefited in using VT to create multimodal work and responding to assessment questions with tools other than text. Providing customised audio feedback for students was a lot of work with comments being manually written down before being recorded.

In U1, L1 created a customised rubric which was developed over several semesters with the assistance of an educational developer. This supports the support model shown in Figure 2. L1 uploaded the rubric image into the Thread and augmented it with an audio comment to provide customised feedback to the student. This feedback was valued by students, as noted by their positive responses to question 3 in the Student Survey (Figure 3).

L2, L3, L5 and L6 were concerned that students were not seeing their feedback. As audio comments in VT had to be retrieved in a different way to all other types of assignments in the LMS, the lecturer was not confident that students heard the feedback and consequently preferred to provide feedback through the LMS gradebook. Some students reported to the lecturer that they had not seen any feedback.

In summary, while using VT for feedback created a high workload for lecturers compared to other types of assessment submissions in the LMS, students appreciated the feedback provided in multiple modes. VT provided a unique opportunity in the way that audio and text feedback could be integrated within the student submission.

Support

Some of the complexity of interfacing internal and external support areas with students and staff are shown in Figure 2. From the evidence of the staff interviews it was clear that students have multiple and different issues in using the tool. L1 and L4 reported that they spent significant time in supporting the student in using VT before and after assessment. The methods of support that were used to support students included using VT for teaching purposes to model the type of Thread required for assessment, giving detailed instructions and sending individualised emails to students. While external vendor support is available, L2, L3, L5 and L6 expressed doubts that students got the support they required as students had contacted them after contacting vendor support to complain. L3 expanded on this to state that students found it difficult to describe the actual issue and this made solution finding difficult. This was supported by student survey comments that advised that voice recording was difficult and there were issues that had not been resolved even after seeking student helpdesk advice.

L2 and L3 agreed with the researcher that they needed further support to understand the tool, that they were learning about the tool all the time and had taken part in self-direct professional development. Even then, they did not feel confident that they supported the students sufficiently. In relation to collegial support, L3 and L5 reported that it was easier for them to use the tool because they were in the same College and were able to assist each other. The other lecturers reported that they did not know of any other academics in their Colleges who used the tool and that using VT was an isolating experience for them.

While one lecturer (A6) reported that they felt that most students were technically savvy and would be able to work it out, the other lecturers reported that their students felt nervous when required to use a new tool such as VT for assessment.

In summary lecturers need to be familiar with all the support structures in place to support their students. Lecturers need a sufficient level of understanding of VT to be able to design assessment taks and troubleshoot student queries. Lecturers that have used VT for teaching have built their skills this way. Most students in this study were using VT for the first time and needed explicit support in order to create and submit their assignments.

Conclusion and Recommendations for Action

In conclusion, the six-part VT assessment process depicted in Figure 1 helped the authors to conceptualise how VT is used by students and staff and guided the data collection and analysis. This study found that all commenting VT functions were used across the units, but that assessment design has a large impact on how the tool is used. Students appreciated that VT allowed them to respond to assessment tasks in new ways, and that functions such as the ability to re-record comments allowed them to produce high quality work. Students primarily created media that was either all text or text and visually based, and many students used PowerPoint to create the underlying presentations that were uploaded to VT. Lecturers primarily used audio and grades for feedback purposes.

The success that students had in submitting assessment work through VT was variable. Accessing the correct support was also variable and this was exacerbated by students being unable to sufficiently describe the difficulties experienced in this unfamiliar tool. Students did not always gain the required support from the external vendor helpdesk but were usually able to work with the lecturer to resolve issues. VT facilitates timely, detailed, audio and interactive feedback which students acknowledged and valued, however, lecturers found a high workload in providing this type of feedback and felt little benefit in using VT over other ways of receiving assessable work.

The small student numbers in five of the six units in a single University in this study, and low student response rates in the student survey and focus group limited the data about the range of ways that VT is used at CDU. While the student survey data was largely positive in relation to VT, the design of the comments section in the survey only encouraged responses that related to what needed improvement. A larger student response rate to the survey may have delivered more details. The focus group had low representation as students did not return to the Thread to have a dialogue with the researcher. This limited the ability of the researcher to clarify some of the responses provided in the survey.

While we acknowledge these limitations, this study has provided a clear and detailed picture of VoiceThread as a powerful and multifaceted tool that students can use to respond to assessment tasks. The practical implications from this study can be seen in the following recommendations for actions which address some of the findings:

1. Provide extra support to students in using unfamiliar tools for assessment. Ensure that submission instructions and support options are clearly detailed in the online units and not hidden behind multiple clicks.
2. Provide detailed support for lecturers at the assessment design stage. Staff in the pedagogical and technology LMS support areas could provide examples of feedback methods and how different VT assessments can work.
3. Facilitate interdisciplinary knowledge about VT. Using existing University-wide mechanisms, create an online space where lecturers and support staff can interact to share knowledge of how VT is used for assessment. For example, experienced staff could share efficient ways to create feedback.

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A Course Level Analysis of Academic Performance on Adult Learners

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Thanks, in part, to the rapid development and widespread adoption of the Internet and other online technologies, academic institutions are increasingly using analytics to enhance learning and teaching. Through the use of data mining techniques, this study examines some of the determinants at a course level that affect the academic performance of adult learners (which we will refer to as students in this paper) in the Singapore University of Social Sciences (SUSS). Formerly known as SIM University, SUSS is an institution that caters mainly to the learning needs of working adults although it offers a number of full-time undergraduate degree programmes to fresh school leavers. The data analysis found that students taking introductory blended courses performed better than those who took face-to-face courses of the same level. Furthermore, students of similar age taking level-2 courses outperformed students taking similar courses where the age difference was more significant. The findings indicate that no single optimal course design will lead to improved academic performance across all courses. Instead, educators should be ready to consider the nature, level, discipline and coursework component of each course to cater to the various students' needs.

Keywords: blended learning, course design, data mining, academic performance

Introduction

The Singapore University of Social Sciences (SUSS) is a university dedicated to providing lifelong education to equip learners to serve society. It offers part and full-time degree programmes and courses to both working adults and fresh school leavers. To cater to the distinctive needs of these two segments, SUSS offers face-to-face and, increasingly, blended courses that combine the unique features and benefits of face-to-face and online delivery and seeking, in the process, to increase its students' learning and academic performance and, ultimately, its retention rates.

To date, the literature on determinants associated with academic performance are mainly at the students' level and there appears to be a dearth of research on the determinants that impact the students' academic performance at a course level. This study aims to bridge this gap by focusing on the determinants that affect students' performance at a course level. Using data mining techniques such as decision trees, this research examines how certain course characteristics such as course delivery mode (blended or face-to-face), course discipline, nature of the course (qualitative, quantitative or mixed), assessment method (written examination or project) and course level (1 to 4), can be combined with socio-demographic data to identify groups of students whose academic performance, represented by their average final score, is superior to that of other groups. The remaining sections discuss the literature relevant to the scope of this study, the methods used and the data analysis that was carried out to derive the findings that are then explained and discussed in the context of SUSS.

Recommendations for the design of courses based on the research findings and suggestions for future research are presented in the concluding section.

Literature Review

Blended Learning

Garrison and Vaughan (2008) define blended learning as "the thoughtful fusion of face-to-face and online learning experiences" where "face-to-face oral communication and online written communication are optimally integrated such that the strengths of each are blended into a unique learning experience congruent with the context and intended educational purpose."

In terms of delivery modes, courses can be categorised along a continuum delimited, at one pole, by traditional, face-to-face courses and, at the opposite end, by fully online courses, with web-facilitated and blended courses falling somewhere in between (Rovai & Jordan, 2004).

Although such an exercise remains somewhat subjective, there have been attempts to determine the characteristics that distinguish each delivery mode category. For instance, Allen and Seaman (2015) suggest a classification based on the proportion of the content of a course that is delivered online. According to them, a traditional course is a face-to-face course if none of its content is delivered online (0%). On the other hand, it is a web-facilitated course if it is a face-to-face course that has anywhere from 1% to 29% of its content delivered online. It becomes a blended course when it blends face-to-face and online delivery and has between 30 and 79% of its content delivered online and finally, it is an online course if most of its content is made available online (80% and above) and if it does not feature any face-to-face teaching at all.

More recently, a number of other authors have subdivided blended learning into blended synchronous and blended asynchronous learning (Bower et al., 2014; Wang, Choon & Hu, 2017). A blended synchronous learning environment is one in which the same lesson is delivered simultaneously to both classroom and online students while in a blended asynchronous environment, a face-to-face session is carried out in the physical classroom and another is delivered online via technologies such as a learning management system (Wang, Choon & Hu, 2017). Up until 2010, most SUSS courses were delivered exclusively through six classroom-based, three-hour, face-to face sessions that combined one-way, lecture-style instructions and instructor-led tutorials. Following Allen and Seaman's delivery classification, these were essentially traditional courses.

In 2010, however, SUSS started a transition towards its own blended teaching and learning model so as to better meet the learning needs of its students and enhance their learning experience. The initial six classroom-based, three-hour face-to-face sessions of most courses have been converted into 6 asynchronous online chunked lectures (series of short, pre-recorded lectures) that students view at their own time and pace. These six fully-online sessions are complemented by 3 face-to-face, classroom-based seminars featuring frequent instructor-students and student-student interactions. According to Allen and Seaman's classification, the university moved away from traditional, face-to-face courses and is now offering what are essentially blended asynchronous courses.

At the same time, depending on whether the nature of subject required more face-to-face interactions (strategy and business negotiations, for instance), certain courses still offer six face-to-face sessions instead of 3, while keeping the same other delivery features of the blended courses. In the context of this research, these courses are known as face-to-face courses.

Academic Performance and Its Determinants

Any undertaking aimed at predicting academic performance must begin by determining the means to assess it. The measure of academic performance is based on the achievement of learning outcomes.

The learning outcomes of many courses, including those offered as part of degree programmes offered by SUSS, are developed according to Bloom's taxonomy of the cognitive domain, one of the three domains of learning (the other two being the affective and the psychomotor domains). Bloom's taxonomy divides the cognitive domain into six learning hierarchical categories that rank cognitive processes from the simplest to the more complex intellectual skill development: knowledge, comprehension, application, analysis, synthesis and evaluation (Bloom, et al. 1956).

Along with standardised admission tests such as the SAT (previously known as the Scholastic Achievement Test or the Scholastic Aptitude Test) and the American College Testing (ACT), the grade-point average (GPA) is the most common quantitative measure of cognitive skills and abilities acquisition that educational researchers have used as a proxy for a student's academic performance (Richardson et al., 2012; Plant, 2005; Chemers, 2001). The GPA is the weighted mean of the final mark that a student obtained from each course in the basket of courses that s/he completed towards the completion of a formal academic qualification (Richardson et al.,2012). Despite its popularity, the GPA is not without its flaws as a measure of academic performance: grade inflation affects its validity in longitudinal studies and its reliability is particularly low for studies comparing GPA differences across institutions (Didier, et al. 2006).

A number of correlational analyses have used the GPA at different stages of a student's study progression, either as a dependent or as an independent variable. For instance, in studies examining the factors that may influence the students' academic performance at the university, researchers have used the high-school or pre-university GPA among the independent variables that may affect the students' undergraduate academic performance, expressed in terms of their university final or cumulative GPA, the dependent variable (McKenzie, 2001).

Vulperhorst et al. (2018) concluded that students' high school grade point average (GPA) is a good predictor of academic performance in higher education.

Evidence to the critical importance that policy-makers, employers, educators and students lend to academic success, the body of research seeking to examine the factors that influence a student's undergraduate academic performance is both large and varied.

In the literature, the effect of socio-demographic factors on performance is somewhat inconclusive. Age, for instance, seems to matter as some studies found that older students do academically better than their younger counterparts (Clifton et al., 2008; Etcheverry, Clifton, & Roberts, 2001). Other studies, however, did not reach the same conclusion as they could not establish the same relationship (Farsides & Woodfield, 2007; Ting & Robinson, 1998). In a more recent study, El Massah & Fadly (2017) examined the academic performance of female finance students and found age to have an insignificant effect on performance. On the other hand, a number of studies did find that women and students from higher socio-economic background in the US and Europe tend to achieve higher GPA than other students (Dennis, Phinney, & Chuateco, 2005; LaForge & Cantrell, 2003; Smith & Naylor, 2001).

Similar to the case of age, the effect of gender on academic performance is also inconclusive. Hyde and Kling (2001) concluded that female students often performed better than male students in all measures of success in higher education. Sheard (2009) also shared similar findings that female students outperformed their male counterparts for each measured academic assessment criterion. In an earlier study by McCrum (1994), he suggested that males performed academically better than females as there were more males who obtained firstclass honours degrees than females at Oxford University and Cambridge University. In a more recent study, Danilowicz-Gösele et al. (2017) found that gender was not a significant factor in determining students' academic performance.

Prior academic performance and aptitude tests results have also caught the attention of researchers seeking to identify what may help predict academic success. In that respect, a number of studies identified some of the traditional measures of cognitive capacity (SAT and ACT) and high school results as reliable predictors of university academic performance (Ellias, 2007; Plant, 2005; Robbins, 2004), although some found that of the two, high school GPA appears to be a stronger predictor than standardised tests such as SAT and ACT (Richardson, 2012).

The influence of the delivery mode on academic performance has been at the centre of "No Significant Difference" in the academic performance debate between educators who promote online and blended (sometimes called "hybrid") learning and those who largely dismiss them as less-than-effective teaching and learning models.

According to Russell (2001), the findings of a very significant body of research and meta-analyses generally concur that there is indeed no significant difference in students' learning outcomes based on delivery mode. The conclusions of more recent meta-analyses and studies are not as definite. Means et al. (2010), the authors of a US Department of Education report, conducted a meta-analysis of 45 prior studies done between 1996 and 2008 on the topic of delivery modes and learning outcomes. Comparing blended and fully online courses, they concluded that 7 studies found no significant difference between these delivery modes, 2 found statistically significant advantages for purely online instruction, and one found an advantage for blended instruction. However, study findings comparing blended and face-to-face delivery modes were clearer: on average, students who took blended courses perform significantly better than did those taking traditional, face-to-face courses (Al-Qahtani & Higgins, 2013; Lack, 2013; Melton, Graft & Chopal-Foss, 2009).

Method

In this study, the final grade distributions of 837 courses were obtained for 2015. Student information such as gender, age, race (Chinese, Malay, Indian and others), school of enrolment, prior academic institution and prior academic performance, as well as O-Level (Secondary 4) English and O-Level Mathematics performance were aggregated to the course level (e.g. proportion of male students and average age of students in a course). Course level information such as the school offering the course, the semester the course was offered, course discipline, course level, mode of final assessment, weighting of the final assessment in the final grade, qualitative flag, quantitative flag and course delivery mode, together with the student information, were included as inputs in this study. Details of the variables are provided in Table 1. These inputs are evaluated with respect to the performance of the students. The descriptive statistics of the courses are summarised in Table 2.

A total of 541 undergraduate courses in SUSS (or 64.6% out of the 837 courses in 2015) were included in the analysis. These courses had at least 50% of complete student information. An average grade point based on the final grade distribution of the students was computed for each course, using the same algorithm as that for the computation of honours classification. This average grade point was further grouped into 2 categories: courses with an average grade point corresponding to the second class honours classification and above (termed as "Better" for ease of reference) and courses with a lower average grade point (termed as "Average"). This variable "Class" comprises the variable of interest, or target (variable) in the analysis. Of the 541 courses included in the study, 217 courses were classified as "Better" and the remaining 324 courses "Average".

Table 1: Variables used to evaluate the performance of students at a course level

Variable Names	Description
Class	Average performance of students in the course
School	School offering the course
Discipline	Discipline to which the course belongs
Level	Course level
ExamMode	Mode of final assessment
Weighting	Weighting of the final assessment to the final grade
Qualitative	Whether the course is qualitative in nature
Quantitative	Whether the course is quantitative in nature
CourseMode	Delivery mode of the course
Female	% of students in the course who belong to the gender
Male	
Race 1 to 4	% of students in the course who belong to the race
School 1 (mainly social services)	% of students in the course who enroll in the school
School 2 (mainly social sciences)	
School 3 (mainly business)	
School 4 (mainly science and technology)	
Prior institution 1 to 6	% of students in the course who previously study at the institution
Age Mean	Average age of the student
Age Standard Deviation	Standard deviation of the students' age
'O' Level Math Mean	Average prior Math performance
'O' Level Math Standard Deviation	Standard Deviation of the students' prior Math performance
'O' Level English Mean	Average prior English performance
'O' Level English Standard Deviation	Standard Deviation of the students' prior English performance
Prior Academic Mean	Average prior academic performance
Prior Academic Standard Deviation	Standard Deviation of the students' prior academic performance

Collection and analysis of data associated with learning comprise the core of learning analytics (Brown, 2011). The last decade has witnessed an increase in the adoption of learning analytics in educational institutions. This is not surprising as learning analytics offers a promising approach to better discern students' learning behaviours to improve their retention and success through appropriate intervention (Tseng and Walsh, 2016). In this learning analytics study, data mining was used to analyse the data to gain a better understanding of the learning environment and its outcomes.

Table 2: Descriptive statistics of the course variables

Variable Name	Possible Values	Count	Percentage
Class	Average	324	59.9%
	Better	217	40.1%
Course School	Sch1 (mainly social services)	77	14.2%
	Sch2 (mainly social sciences)	86	15.9%
	Sch3 (mainly business)	141	26.1%
	Sch4 (mainly science and technology)	237	43.8%
Discipline	29 unique disciplines		
Level	1 (introductory)	113	20.9%
	2	214	39.6%
	3	199	36.8%
	4 (advanced)	15	2.7%
ExamMode	Project/Take-home examination	81	15.0%
	In-Class written examination	460	85.0%
Weightage	High (>50%)	240	44.4%
	Low (<=50%)	301	55.6%
Qualitative	0	93	17.2%
	1	448	82.8%
Quantitative	0	421	77.8%
	1	120	22.2%
CourseMode	Blended	295	54.5%
	F2F	246	45.5%

Data for all the 541 courses were used to build the model. Decision trees (C5.0, CHAID, C&RT and QUEST) were used to evaluate course performance and its determinants in blended and face-to-face courses. CHAID emerged as the best model to explain the students' course performance with an accuracy rate of 67.1%. N-fold cross-validation was used to compute the model's estimated error rates with as little bias as possible (Braga-Neto& Dougherty, 2004).

In n-fold cross-validation, the dataset is randomly split into n mutually exclusive subsets (also known as folds). The model is then built with n-1 folds based on the decision tree parameters and an accuracy rate is calculated by testing the model using the remaining fold (Rodriguez et al., 2010). The model accuracy rate is then aggregated across n folds to give the overall accuracy rate for the validated model. In this study, we have chosen n to be 5.

An illustration of n-fold cross-validation is shown in Figure 1, where the folds in continuous line are the ones to build the model and fold in dotted line to validate the model.

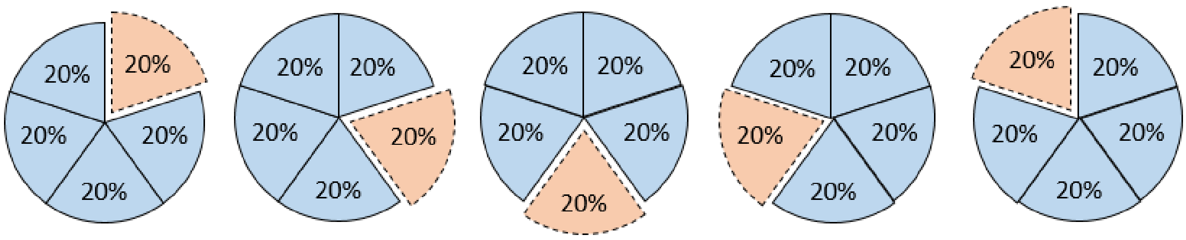

Figure 1: Graphical presentation of the 5-fold cross-validation procedure

Results and Discussion

As mentioned earlier, the CHAID decision tree is selected as the final model with an overall accuracy rate of 67.1% (see left side panel in Figure 2). The n-fold cross-validation overall accuracy rate is 67.5% (see right side panel in Figure 2). Figure 2 shows a summary of the results.

CLASS	Average	Better
Average	227	97
Better	81	136

Overall Accuracy =	67.10%
Accuracy for Average =	70.06%
Accuracy for Better =	62.67%

CLASS	Average	Better
Average	236	88
Better	88	129

Overall Accuracy =	67.47%
Accuracy for Average =	72.84%
Accuracy for Better =	59.45%

Figure 2 In-sample and holdout - Accuracy rates of the model

A better understanding of the course performance and its determinants in blended and face-to-face courses can be seen from the decision tree in Annex A. This study focused on the determinants that affect adult students' performance at a course level. Three main findings can be discussed.
For level-1 (introductory) courses, students performed better in blended courses than they did in face-to-face courses (see Nodes 4 and 5). When viewed from a learning outcome perspective, such a conclusion is not surprising.

As explained in the literature review, the learning outcomes of the courses offered by SUSS follow Bloom's taxonomy. The learning outcomes of level-1 SUSS courses focus on knowledge recall as well as on the basic comprehension of the more fundamental concepts and theories underlying a particular subject or discipline.
The learning outcomes of levels 2, 3 and 4 SUSS courses, on the other hand, target increasingly more sophisticated intellectual skills as they seek to develop the students' ability to understand, apply, analyse and evaluate the material that they study. Melton, Graf, and Chopak-Foss (2009) explain that students in blended learning courses are more responsible for learning content on their own time than in classical, face-to-face, classroom-based teaching and learning situations. As such, to achieve the more basic learning outcomes of level-1 courses where knowledge acquisition and comprehension are the aims, students need to invest their own time to simply read and absorb the morefundamental theories and concepts contained in the course material.
Because these two tasks cannot be effectively delegated to a teacher, students taking level-1 course would normally require fewer interactions with their instructor and lesser discussions with their peers than they would need for level 2, 3 and 4 courses where the learning is deeper and the material covered, more advanced and more complex.

Early each semester, students taking level-1 blended courses at SUSS are reminded that the only 3 face-to-face sessions will be dedicated to class discussions and small-group activities that are tapping on the knowledge thatthey are expected to have acquired prior to coming to class. This study findings seem to confirm that these students heed this advice as they do better than students taking level-1 courses using a traditional delivery approach.

It is conceivable that students taking level-1, traditional face-to-face courses with 6 face-to-face sessions do not perform as well because they tend to be over-reliant on their instructor's guidance instead of putting in their own time and effort to absorb the knowledge contained in the course material.

As to the age-academic performance relationship, the decision tree does show that the more homogeneous the age of the students taking level-2 courses, the better their academic performance was (see Nodes 6 and 7).
The link between age differences, course level and academic performance is somewhat harder, but not impossibleto explain when also considering the students' profile and their study progression.

It is often during the very first semester of their programme of study that students take level-1 courses at SUSS.As working adults enrolled in part-time studies, they have little time to mingle with their peers so unless they believe that they cannot cope alone with the demands of their courses, they prefer learning on their own. Level-1 courses are ideal for this opportunity. As discussed earlier, their learning material is relatively easier to absorb and their

learning outcomes less ambitious than higher level courses so students are able to and given their other work, family and other commitments, they prefer studying alone.
SUSS offers learning opportunities for working adults who are 21 years old and above. While the average age of SUSS students is 27, one can find, in any course, students who are anywhere between 21 and 55 or even older.

Empirical evidence suggests that students tend to mingle and collaborate with those who are more of less of the same age, possibly because they might more easily relate to one another on a personal basis.

In situations where the age difference between the students is low, students can more easily pair up with others of a similar age, help one another study and learn better. For those reasons, students perform better in these courses.

Finally, students tend to perform better for more advanced qualitative exam-based courses offered by Schools 1,

3 and 4 (See Nodes 20 and 21). This finding came as a surprise as the bulk of the courses are from School 4 which offers mainly Science and Technology courses. One possible explanation could be that the courses are mainly management related such as aviation change management and project management and these students are able to apply what they have learnt from their jobs to their studies.

Conclusion

This study aims to gain a better understanding of the determinants associated with the performance of adult learners at a course level. A notable finding is that blended courses might improve learning and performance only for specific courses that are at a level 1 (introductory) level.

For more advanced level courses, face-to-face delivery might be more suitable. Also, based on the findings, universities can consider grouping students who are more homogenous in age for lower level courses to help them get into peer and group learning. (Further analyses on
age differentials by course, course level and school for the various relevant nodes were conducted and no significant age differential was found.) Finally, blended courses seem to be more appropriate for courses that are qualitative in nature.

Further studies can be expanded to use larger datasets to include more courses and students to enhance the generalisability of the findings. Future research can also consider the role of faculty and course assessments in comparing the students' learning experience and academic performance.

It is hoped that this study has provided insights into the effects of the course and student attributes on the academic performance of students, and the determinants of such effects at a course level.

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Dashboards for Decision Making in Higher Education

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Dashboards are used as a graphical user interface that provides at-a-glance views into key measures and trends to assist decision makers in the Singapore University of Social Sciences (SUSS) to enhance learning support for students.

A student's first contact with SUSS often starts at the point of application (i.e., applying for places in the University). Hence, the process of application, selection and offer has been identified as the business problem in this project. An effective dashboard will empower users to make more informed decisions with a visibility to data and ease in generating insights, ultimately streamlining the selection and offer process. The users in this project are the stakeholders who deploy the dashboard in the process of and decision making related to selection and offer.

Quality of information on the dashboard is highly dependent on the state of data, including their completeness and accuracy. Quality of a dashboard can be measured by how much impact it can make, which is directly related to actions taken by users with information extracted from the dashboard. With the right knowledge and skills in developing an effective dashboard, business objectives can be met and user requirements can be catered for. If every decision maker is able to customise his/her own dashboards that meet business objectives and user requirements, the University will be empowered at a functional level, with various departments supporting students through their respective roles and functions. Challenges in data and people issues will be discussed in this paper alongside the future directions in overcoming these issues.

Keywords: data-driven decision making, streamlining of the application and selection process, dashboards, enhanced learning support

Introduction

The Singapore University of Social Sciences (SUSS), a university dedicated to provide lifelong education and to equip learners to serve society, was established in April 2005 (then known as SIM University). It offers part-time and full-time degree programmes and courses to both working adults and fresh school leavers. Applicants who meet the specified minimum admission criteria are enrolled into SUSS's part-time programmes, with little need for shortlisting and selection. The degree programmes for working adults are offered on a part-time mode with blended learning, where classes are held in the evenings and on weekends. Currently, SUSS has about 13,000 part-time students.

In 2014, three full-time degree programmes were launched in SUSS for fresh school leavers, namely, Accountancy, Finance and Marketing. New programmes in Human Resource Management, Social Work, Business Analytics and Early Childhood Education were subsequently launched in later years. Applicants are shortlisted based on their performance in prior education. As programmes are oversubscribed with more applicants than the number of available places, SUSS puts in place a series of selection tests for shortlisted applicants. The selection tests comprised a computerised cognitive test, an individual interview, a group interview, and an essay. There are also specific additional requirements for various programmes.
Qualified applicants are usually offered a place if they exceed the threshold of the selection test scores. However, the number of qualified applicants frequently exceeds the number of university places for the choice of programme. Further assessments then have to be made, to decide which applicants to offer which programme. To make such decisions, the decision maker needs information. But to make efficient and effective decisions, the decision maker needs more than just information; he/she needs information that is easy to find, complete, up-to-date, and consistent in presentation and format (for ease of use).

In SUSS, the Business Intelligence & Analytics (BI&A) department was set up to provide such a platform for decision making. Its mission is to provide information for data-driven and evidence-based decision making and planning in SUSS. This covers not only the digital warehousing of critical data, but also the twin functions of reporting and analytics. BI&A also provides training to faculty and staff to build up the University's capability in dashboard development and in data mining/analytics.

From the collaboration between BI&A and the Office of Admissions (OA), a dashboard that presents data from the point of application to the point of offer (including applicants' demographics and prior academic performance) is deployed to aid decision making. In addition, applicants' predicted cumulative grade point average (CGPA), an output of predictive analytics, is also reflected in the dashboard. Hence, the dashboard contains not only information of the applicants but also additional information generated with predictive analytics.

This paper discusses the conceptualisation of the dashboard along with an overview of the dashboard. It also illustrates the use of the dashboard by both OA and the faculty. Finally, the last section discusses the challenges and future directions.

Background information

Dashboards, known for their use to manage the performance of organisations more effectively, have recently been employed by SUSS to support decision making. The use of dashboards to support decision making in higher education is not new (Harel 2003, Muntean 2010), and there has been success stories in some of these educational institutions (UC 2000, Harel 2003, NTU 2019). Harel (2003) reported that close to 200 campus administrative system users began using their dashboard within 90 days of their rollout, and he attributed this success to the dashboard's ease of use and holistic support given. Locally, there has been a lack of studies on institutional dashboards in Asian higher education, with most focusing on learning analytics (Tan 2017, Corrin 2014, Ochoa 2014), and NTU announced that it was the first University in Asia to implement a cloud-based enterprise technology focused on improving administrative processes, which allowed users to turn the University's data into 'quickly accessible, executive level reports', poising them to be ready for the next stage of growth in the higher education landscape (NTU 2019).

Other studies have also reviewed the institutional use of dashboards. Wolf (2016), for example, reported that George Washington University (GWU) had a data warehouse and enterprise BI services in place. Before delivering dashboards to their deans for decision making, GWU implemented a data governance process with a centralised repository of data definitions and business terms, and established a BI Community of Practice. Also, GWU identified and prioritised strategic information to be presented. Using Scrum's iterative method of developing dashboards, they spent less time gathering data and more on analysing them. A strong community was also established to share skills, information and mutual support, and information demo session were held to share ready dashboards. Wolf (2016) concluded that dashboards had to be well-summarised to meet specific needs for them to be well-utilised.

In the other three universities reviewed by Wolf (2016) (namely, New York, Purdue and Rochester), the infrastructures needed were largely similar to that of GWU. Crucial stakeholders who worked with their division's data frequently had to be identified and tasked as a core group in developing dashboards. Sharing of information and skills had to be done frequently to ensure cohesion among departments, and to push the transition from manual to automated reporting of data. Dashboard prototypes were designed using short iterative phases and were launched as early as possible. Dashboards had minimal visualisations, yet were effective and had sufficient information for the different scopes of operations used for making academic and administrative decisions. The challenges were to simplify visualisations but at the same time carry important metrics for them to be useful and relevant. Also, merging multiple sources of data to concisely display 'cleaned' data on the dashboard needed meticulous and diligent planning, validation and verification. Data dictionaries should be openly and readily available, which was crucial to the success of collaborations.

This paper reports the development of dashboards that help decision makers in the selection of prospective students who have a better chance of doing well in and graduating from their programmes. In particular, dashboards can provide historical academic results and student profiles, enhanced with charts that provide insights on expected student performance. For example, results generated from prediction models can be incorporated into the dashboard to further differentiate applicants with similar application scores. Data on performance of graduates can be used to predict how well a student may perform after enrolment. Through this paper, we also hope to address the lack of studies regarding dashboards used for decision making in shortlisting applicants and offering university placements, especially in an Asian context.

Dashboard Implementation in the Application and Selection Process

Since the launch of the University's full-time programmes (in 2014) and the government's announcement of SUSS as the sixth autonomous university in Singapore (in 2017), SUSS has been managing a rapidly increasing number of applications for its full-time undergraduate programmes. The University wants to be efficient and effective in its processes and make data-driven and evidence-based decisions. In selecting full-time students, the University has much information to assess before making timely decisions on which applicants to offer a place.

Such decisions can be facilitated by a well-designed dashboard that provides a central location for users to access, interact and analyse up-to-date data. A dashboard gives an easy-to-read summary of information and has many important benefits. In particular, it is customisable according to business objectives and user requirements; its intuitive data presentation allows easy and smooth navigation to get the required information; its all-in-one ability replaces the conventional way where users spend a large amount of time reviewing and analysing different reports to get to a conclusion; and its dynamic feature allows drilling into detail, enabling user to get deeper into information by simply selecting or filtering variables. An effective dashboard will improve the efficiency and effectiveness of processes through empowering users and facilitating data-driven decision making.

The iterative approach of business understanding, data understanding, data preparation, modeling, evaluation and deployment is used in this dashboard project. It is adopted from the Cross-Industry Standard Process for Data Mining (CRISP-DM), as illustrated in Figure 1. This approach is modified slightly to tailor to this project.

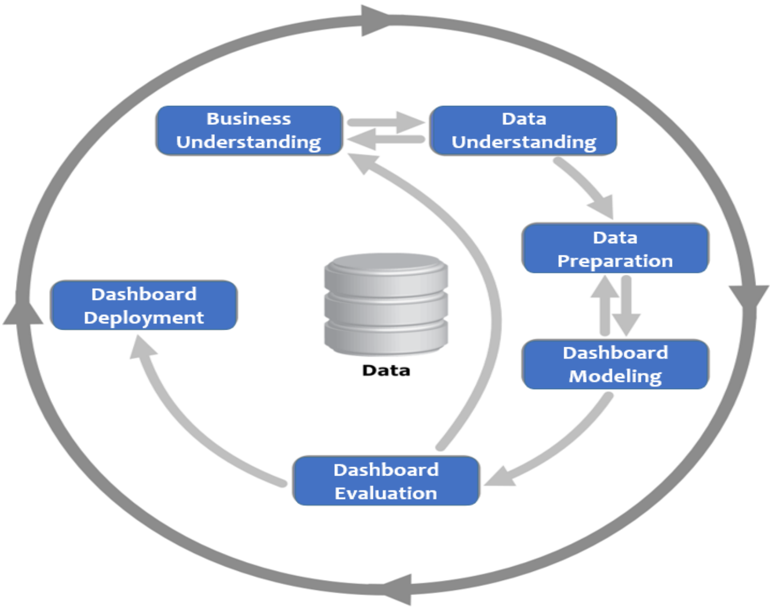
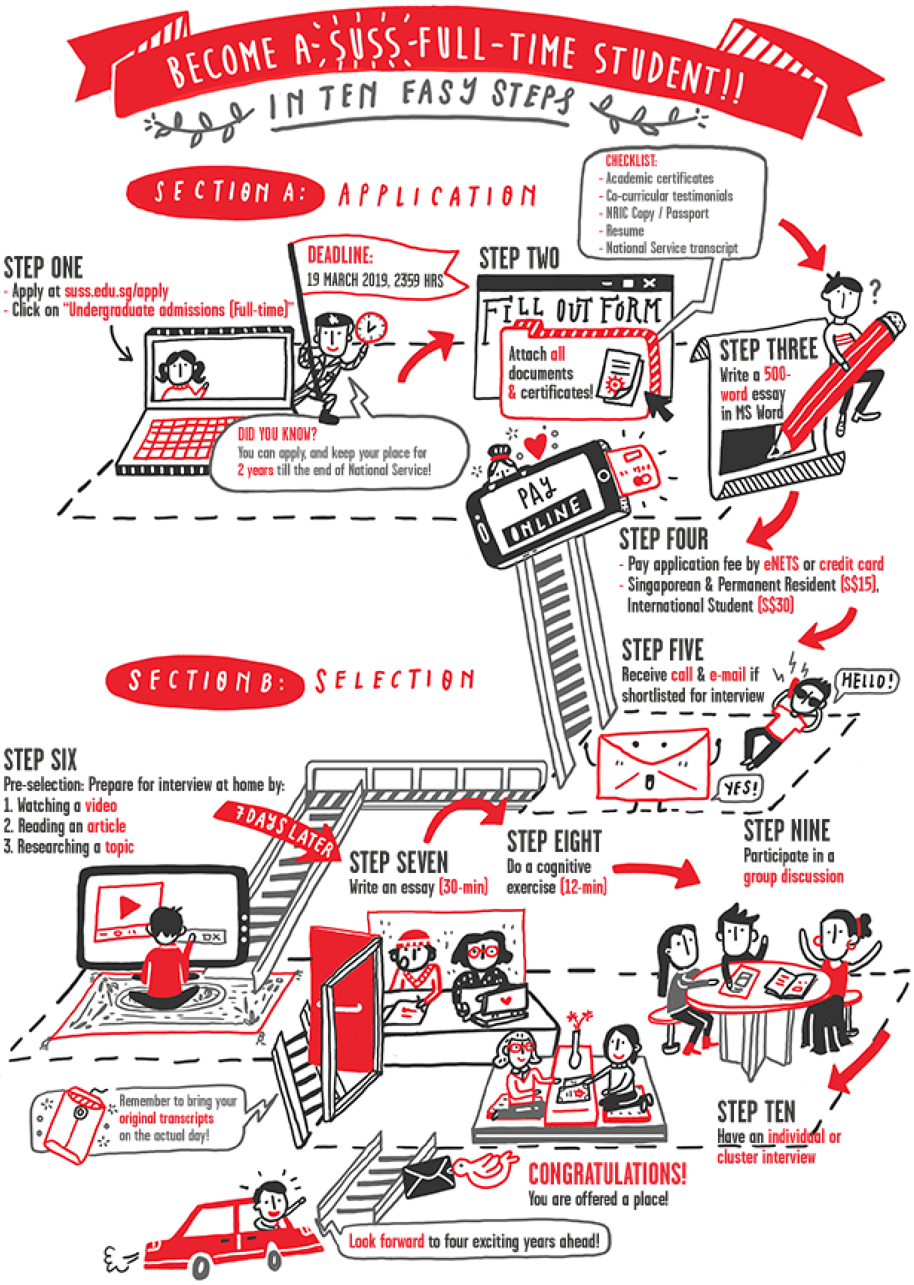


Figure 1: Adopted from CRISP-DM
Extracted from https://en.wikipedia.org/wiki/Cross-industry_standard_process_for_data_mining

Business Understanding

Understanding the current application and selection process is necessary before developing the dashboard. The process is managed by OA who presents related information to the schools so that they can decide whether to accept or reject an applicant. The application and selection process of a full-time student is depicted in Figure 2. There are four stages in the selection process for SUSS full-time students, comprising a 30-minute essay, a 12-minute cognitive test, a group discussion, and an individual or cluster interview. This paper focuses on the internal process of selection.



extracted from https://www.suss.edu.sg/full-time-undergraduate/how-to-apply

Figure 2: SUSS Application and Selection Process for Full-Time Undergraduate Programmes

The Stakeholders

OA and faculty are stakeholders and users of the dashboard. During the application and selection period, as frequent as daily meetings are held, in which OA presents information required for decision making in the form of excel spreadsheets and other files. The required information is extracted with assistance from Campus IT Services (CITS) that manages the University's operational database, the Student Management Information System (SIMS). Periodically, data generated from the decisions made are input into SIMS.

Data Understanding and Preparation

For decisions to be made in this context, the University assesses the applicants' scores for all the selection tests (i.e., 30-minute essay, 12-minute cognitive test, group discussion, and individual or cluster interview) in addition to programme choices and records of prior education. During the application and selection period, these data are stored in different sources. Data generated from the selection tests are stored independently by OA, while data relating to application, prior education and demographics are stored in SIMS. There are also variables derived by OA that do not flow back to SIMS as the database's current structure does not cater for them. For example, the computed final university score that is derived to standardise applicants' academic performance of their prior education and the start dates and dates of subsequent weeks of each application period are recorded separately outside SIMS.

After identifying the required information for decision making and tracking the data sources, the relevant data are extracted and verified. During verification, data cleaning is conducted, and various data derivation are performed to prepare the data to be stored in the Data Warehouse, a data repository for the purpose of supporting decision making.

Dashboard Modeling

A well-designed dashboard can meet business objectives, cater to user requirements, empower users, and ultimately facilitate data-driven decision making. The dashboard is structured according to the workflow in the application, selection and offer process. Hence, it contains three sheets, with the first sheet presenting information at the point of application (Application-data), second sheet information at point of shortlisting (Shortlist-data) and the third sheet information at point of offer (Offer-data). The structure, layout and design are developed in collaboration with the stakeholders, ensuring that it is intuitive and informative, and yet not overwhelming. Only information relevant to decision making in the selection process is incorporated into the dashboard, and this information relates to Application-data, Shortlist-data and Offer-data.

Shortlisting

Application-data and Shortlist-data provide information to make decisions in shortlisting applicants. Application-data include information provided by applicants, from their demographics and prior education to what they are applying for in SUSS; as well as other data generated at point of application such as application ID and payment status. Shortlist-data are generated when decisions are made for shortlisting, for example the shortlist status and the programme an applicant is shortlisted for.

Offering

Application-data, Shortlist-data and Offer-data provide information to make decisions in offering places. Offer-data (which document decisions regarding offers) include the offer status and programme offered to applicants.

Dashboard Evaluation and Deployment

Modelled after the process flow of application and selection, the dashboard is evaluated by the stakeholders and enhanced by the developer according to stakeholders' feedback and input. The evaluation is conducted with formal documentation through a User Acceptance Test (UAT). Evaluation and maintenance of the dashboard is an ongoing process, so that customisation and improvement are implemented as requirements change or objectives refined.

The dashboard that is evaluated and accepted by users consists of the following three sheets.

Dashboard: First sheet (Application-data)

Application-data are captured on the first sheet of the dashboard (see Figure 3). This sheet contains information on demographics like race and gender, information on prior education such as the awarding institution and final university score, and information on application details like payment status and programme applied for.

Other relevant information shown includes total number of applications, application intake and joined intake. These visual representations of Application-data will enable stakeholders to easily access and assess the overall profile of applicants.

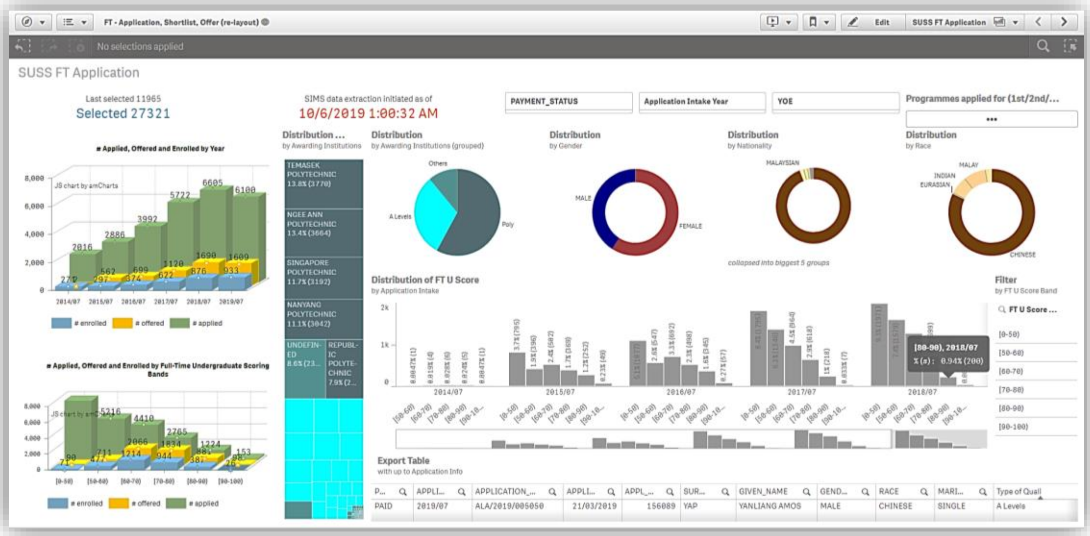


Figure 3: Dashboard on Application-

Dashboard: Second sheet (Shortlist-data)

Shortlist-data are represented on the second sheet of the dashboard (see Figure 4). This sheet presents information relating to data generated at point of shortlisting, such as applicants who are shortlisted by week or by programme, and the total number of applicants who are shortlisted as compared with the total number of applicants. It demonstrates the integration of reporting and analytics as it also presents the predicted CGPA of the shortlisted applicants. These value-adding results from predictive analytics provide additional information to facilitate data-driven decision making in the shortlisting process.

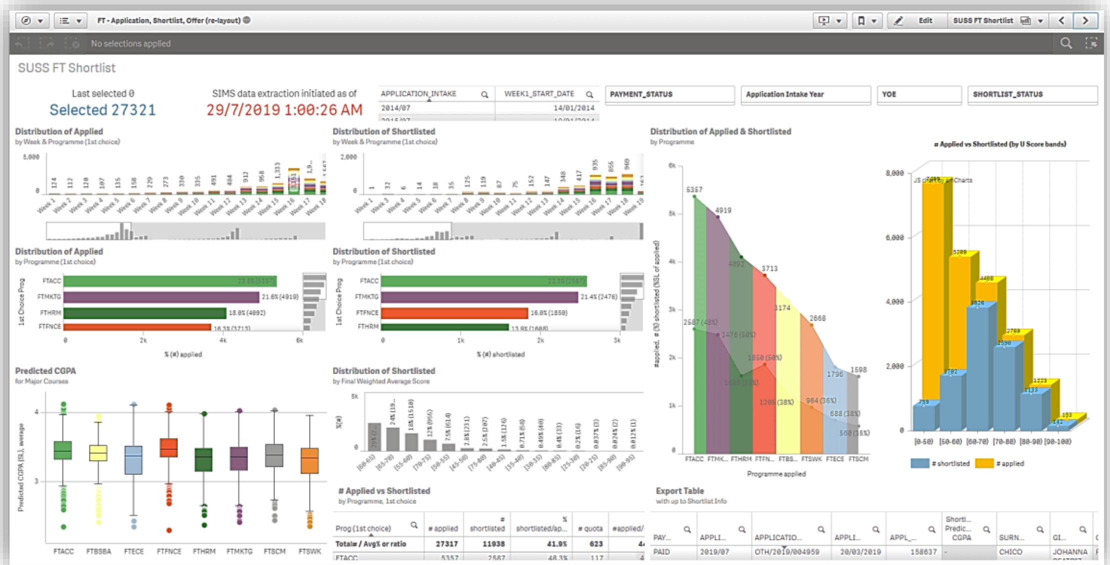


Figure 4: Dashboard on Shortlist-data

Dashboard: Third sheet (Offer-data)

Offer-data are shown on the third sheet of the dashboard (see Figure 5), where information and patterns related to offers are generated at the point of offer. Such data include the number of applicants who are offered by week or by programme, the total number of applicants who are offered against that of applicants who are shortlisted. They provide necessary information for users to make decisions in offering places. This sheet also demonstrates the integration of reporting and analytics as it also presents the predicted CGPA of the offered applicants. These value-adding output from predictive analytics provide additional information to facilitate data-driven decision making in the offer process.

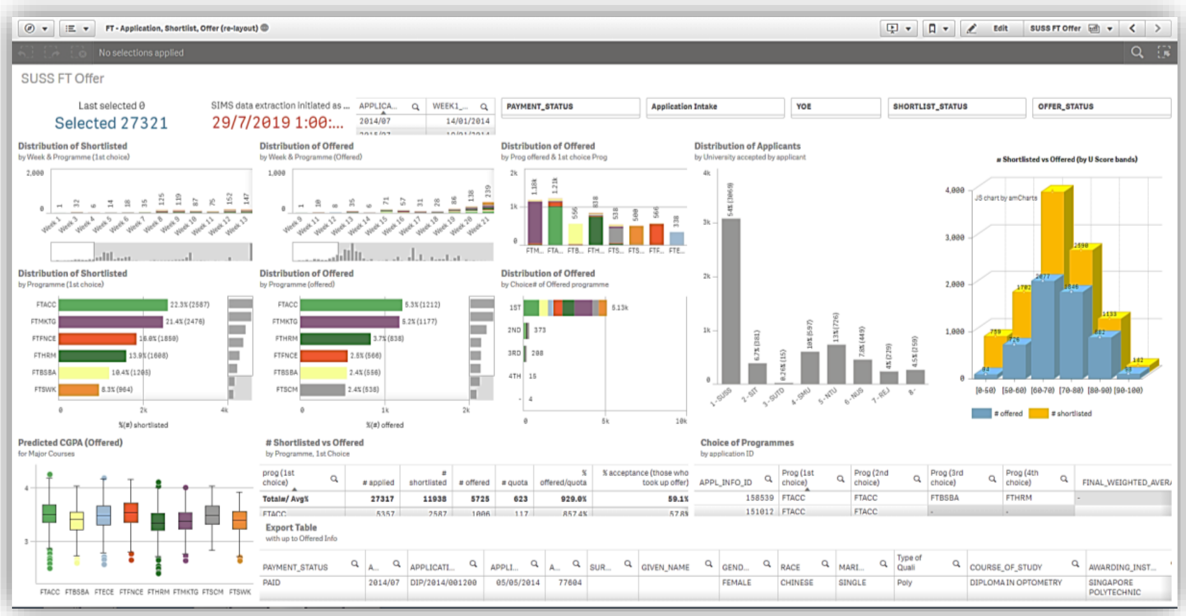


Figure 5: Dashboard on Offer-data

The dashboard is deployed in a secured environment through the campus server, with each account tagged to an individual staff's login credential. Access to it can only be made on campus intranet. The deployed dashboard is made accessible to OA, and to the schools offering full-time programmes. In deployment, training is also conducted for stakeholders, to equip them with the skills and knowledge in developing customised dashboards, and interpreting and creating visualisations.

Uses of the Dashboard

By using the dashboard, it is easier to compare the application statistics across the years, or even Year-on-Year (YOY). Before the dashboard, OA would have to extract data from SIMS based on the data criteria (for example, Application Intake and Paid Status) and then do the necessary data cleaning before presenting the statistics in a report format. The dashboard allows users to select the criteria filters and then use the visualisation features for presentation and reporting, which is much simpler.

The benefit for the Heads of Programmes (HoPs) in each school is the accessibility of data. In the traditional format, the HoPs needing statistics and will require more time to seek OA's help to prepare the data. With the dashboard, they can view the statistics and have a more real-time update of their programme applications or offers at any point of time.

For all SUSS full-time programme applications, OA processes and shortlists the applicants. It also tracks the volume of applications on a weekly basis. This is easily mapped out on the dashboard based on the programme, and status of payment on a week-on-week basis. This helps OA and HoPs understand the application trend for each programme and they can tweak the marketing messaging or advertising feature for the programmes with weaker application numbers over the marketing campaign period.

In addition to this, OA is able to track the number of applications, and those who are shortlisted, and/or offered by their prior education institutions. It helps the recruitment team understand the impact of the effort put into outreach activities at the various education institutions. If the number of applications is relatively high from a certain institution but the number of offers does not commensurate, the team will be able to deep-dive into the details to analyse if the unsuccessful applicants from that particular institution did not do as well for the 4-stage admission process. With the relevant information, it can better guide the Education and Career Guidance (ECG) counsellors and teachers to better prepare the next intake of students applying for SUSS full-time programmes. If the scenario is instead high applications and high offer rates, then the statistics will be useful for the team to present to the education institution to collaborate more in the ECG approach.

Shortlisting

OA shortlists applications on a daily basis. The trending of this will aid the team in planning their resources and faculty interviewers for the admissions interview process. Certain weeks will have fewer applications being processed and shortlisted while the volume of applications will usually increase nearer to the end of application period.

Offering

The predicted CGPA, an output from predictive analytics, is incorporated and value-adds to the dashboard. It is a forecast that will help HoPs and schools predict the academic performance of students, and identify students who may need more learning support after enrolling into SUSS. This becomes a trigger for schools to be more proactive in supporting students who potentially may have difficulties in their study.

Challenges and Future Directions

Data Issues and Future Directions

Data are streamed into the dashboard server from the data warehouse, which in turn goes through an ETL process to extract, transform and load the data from the main sources of data, i.e. the operational databases. Hence, data accuracy and completeness on the dashboard is dependent on the main sources, as well as the ETL process. It is also dependent on the stability and performance of the servers.

Consistent maintenance of the dashboard is required, not only for review and evaluation against changing business objectives and user requirements, but also in detecting data inaccuracy and incompleteness. When any data issues are detected in the dashboard, it is necessary to go through a series of investigations before the root causes of the data issue can be identified, whether it is the data warehouse, ETL process, servers, etc.

By integrating business processes with data and analytics in an effective and timely way, the University can make more informed decisions and enhance effectiveness to better support students and improve their learning outcomes. Data visualisation through dashboards has great potential to empower decision makers in different roles. In empowering users, the functionalities in the dashboard will reduce reliance on IT or external help for customising reports.

To exploit data fully and to drive efficiency and effectiveness, datasets across different functions of the University have to be integrated. The University has commissioned CITS to develop a new Student Information Management System that will cater for an integrated database.

People Issues and Future Directions

Because a dashboard can be used for different purposes by different people, it should be highly customisable for different users with different objectives. It should display only the appropriate information required by decision makers to do their job. A dashboard should not be overloaded with information as it will look cluttered and be distracting to users. The user interface should be designed such that it is easy for users to navigate through the dashboard. Equipping users with the relevant skills and knowledge will empower them to develop customised dashboards that are effective for their respective functions.

As part of its role, the Business Intelligence & Analytics (BI&A) department provides training for staff to build up the University's capability in analytics and dashboard development. BI&A was setup in August 2016 to provide information for data-driven and evidence-based decision making and planning in SUSS. This covers not only the digital warehousing of critical data, but also the twin functions of reporting and analytics.

It is hoped that this paper provides information for readers to generate ideas and insights in developing and implementing dashboards that can facilitate in decision making in shortlisting applicants and offering university placements.

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A three tier model to promote the institutional adoption of learning analytics

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Many institutions are making significant investments to build their learning analytics capability. However, creating a successful platform for large scale adoption of learning analytics (LA) is not simple. In this case study we describe the adoption of a three tier model designed for cross institutional engagement and implementation of LA at a medium sized tertiary education institution. We outline the actions taken at the three differentiated but interconnected levels of governance, projects and community. We analyse the results from activity in each of these three areas and, mark out a set of recommendations for future action that we anticipate will continue to drive and gain value from LA deployment across the institution.

Keywords: Learning Analytics, governance, principles, tools, community of interest.

Introduction

Despite the increasing investment across institutions in advancing their learning analytics (LA) capacity there remains a gap in documented large-scale implementations in higher education that detail successful strategies and activities (Ferguson *et al.* 2015). In this paper we describe a case study of an ongoing multi-level institutional approach to promoting the adoption of LA and developing organisational capability in this domain. This effort has been organized around three interrelated tiers of activity. In the study described here, the development of LA capability forms an important part of the institutional commitment to strategic goals, in particular those articulated within the learning and teaching strategy, digital transformation road map and, the deep commitment to student success and progress.

A multi-tiered approach was designed to ensure that learning analytics was brought into the organisation in as an efficient and effective a manner as possible. One of the key aims was to avoid this enterprise falling into one of the two camps identified by Dawson *et al.* (2018), namely: (i) an instrumental approach to adoption led by top-down leadership, with large scale projects comprising high technology footprint with limited staff uptake or (ii) an emergent ground up activity with a strong consultation process but suffering major issues in scaling up and communicating its' value to all stakeholder groups.

Although the case study uses learning analytics as the key term for analytics activity, we were careful to acknowledge the differing domains of LA across the organisation. Indeed, one of the critical aims of this project was to align discourse and understandings around a complicated theoretical and technical domain that has recently emerged and is still evolving. Our starting point was to make a broad distinction between analytics that affect the wider functioning of the institution from those interventions that enhance the regulation of the teaching and learning environment and those methods and tools that are intended to help teachers (and potentially students) carry out their tasks more effectively (Griffiths, 2013).

Approach

An overview of the three tiers is shown in Table 1. The goal was to scope and define distinct layers of activity to help make the transition from existing discrete and dispersed pockets of activity towards aligned and embedded learning analytics deployment across the institution. Fundamentally, to support meaningful data driven interventions that would empower our teaching, academic, administrative and student stakeholders.

Table 1: Three tiers of cross institutional activity

	Level	Aims
Tier 1	Framework and Governance Model	To address the need for a strong governance model and develop a framework and principles to enable learning analytics to flourish.
Tier 2	Small Scale Projects	To support and manage pilot activity on the ground, building capability and testing proof of concept around LA tools and approaches and, explore the types of interventions that the institution could develop and support.
Tier 3	Community of Interest (see Fischer, 2001)	To build broad community engagement to sensitise and develop participatory understandings of learning analytics. To act as a sounding board for projects and policy development. To build capacity.

Method and Results

In this section we present an overview of the activity and progress achieved within each of the three tiers of activity described above.

Tier One: Learning Analytics Framework and Governance Model

It was apparent at the start of the project that deploying learning analytics tools and processes raises serious concerns around data governance, access to data and potential ethical (and moral) challenges to the way that a university operates and is made accountable (Corrin *et al.* 2019; Griffiths *et al*., 2016; Slade and Prinsloo 2013, Tsai and Gasevic, 2016). Here, we drew on previous European research on LA adoption in Higher Education which identified the need to develop:

> "a comprehensive policy that meets the requirements of learning analytics and considers multiple dimensions including an institution's context, stakeholders therein, pedagogical applications, institutional capacities, success evaluation, legal and ethical considerations, and a strategy that aligns with the institution's missions" Tsai and Gasevic (2016).

Within our context, where initially LA had a small profile across the institution, we decided to launch a policy initiative project. Our aim was to build a framework and a set of LA principles by working with key stakeholder groups, identifying relevant extant policy, associated relevant committee structures and use these data to help guide the building of an appropriate governance model.

Learning Analytics Policy Initiative (LAPI)

A key goal of this project was to develop a learning analytics framework, principles and guidelines for the implementation of LA across the university, in order to inform and enhance learning and teaching activities and outcomes based on using student data. To accomplish this, we adopted the SHEILA (Supporting Higher Education to Integrate Learning Analytics; Tsai and Gasevic, 2016) policy development framework that was adapted from the ROMA- Rapid Outcome Mapping Approach (Young *et al*., 2014). ROMA (see Figure 1) is an approach which is designed to develop effective strategies and evidence-based policy in complex environments.

Figure 1. Adapted version of the ROMA model used by the SHIELA project (Tsai *et al.,* 2018) and by Hainey *et al.* (2018).

This was conducted through a series of semi-structured interviews, focus groups and workshops with members of the University Senior Leadership Team (n=12), Faculty Deans and Associate Deans, academic and professional staff of the University Faculties and Central Service Units (n=39), and students (n=6). The data collected was analysed along the six dimensions, of: (1) mapping of (political) context; (2) identifying key stakeholders; (3) identifying desired behaviour changes; (4) developing an engagement strategy; (5) analysing internal capacity to effect change; and (6) establishing monitoring and learning frame-works (as demonstrated in Figure 1). All data was validated by the LA roundtable group (see details below).

There were three major outcomes from this piece of work:

First, by doing this ground work prior to adopting specific approaches to implementing LA, we were able to (1) be in a position to identify and implement solutions that would support our learning and teaching vision and values, and (2) bring academic and professional staff along, from the get-go, to the development of an environment where student, staff and organisational data are used in a thoughtful, deliberate, transparent and ethical way.

Second, we were able to develop a LA Principles and Framework that was validated through our community of interest (see Tier 3 activity described below). The purpose of this framework was clearly outlined in two key introductory statements within the document:

1. *Learning Analytics will support ongoing enhancement of learning and teaching practices and processes and should ultimately benefit all students*. The use of Learning Analytics has the potential to enhance student learning by enabling flexible, timely and targeted learning support interventions; contribute to better course and program design and planning; offer new ways of evaluating instructional materials and approaches; give student meaningful timely information about their own learning.
2. The purpose of this Learning Analytics Principles Framework is to ensure that all University Learning Analytics practices are carried out ethically, in a transparent way and in accordance with the University's core values of respect, fairness, empathy, integrity and responsibility.

The framework incorporated a number of the University of Edinburgh Learning Analytics Principles (2017) but contextualized to our specific New Zealand institutional and cultural context. These principles were gathered under the following headline sections:

1. The use of Learning Analytics will benefit the University culture of teaching and learning (with a special emphasis on Akoranga – collective responsibility for learning).
2. Student agency in Learning Analytics is acknowledged and supported.
3. Learning Analytics will be used in an ethical and transparent way.
4. Learning Analytics will be practiced responsibly, in line with the principle of Kaitiakitanga (Protection)
5. Good Governance (Kāwanatanga) will be core to our approach to Learning Analytics.

Third, it provided an evidenced and consultative platform from which to build a proto-governance model that could be worked through with senior leadership at the university (Figure 2). To support this governance model we mapped the key strategic drivers for LA adoption to the desired operating model (Table 2).

Table 2: Mapping strategic drivers to governance and the desired features of the target operating model

Strategic drivers	Governance	Operating Model – addresses:
• Student Success • Revenue • Learning and Teaching • Capability Development	• Bring analytics safely to scale • Ensure adoption of whole of student journey approach (focus on retention and completion) • Apply Learning Analytics Principles • Enable the development of a data ethics, policy and framework • Enable key learning analytics project to deliver on outcomes	• Data access • Interfaces • Agency & authority • Roles and responsibilities • Transparency & explainability (e.g. of any algorithms deployed) • Assurance - operationalization of data ethics principles • Indicators and metrics

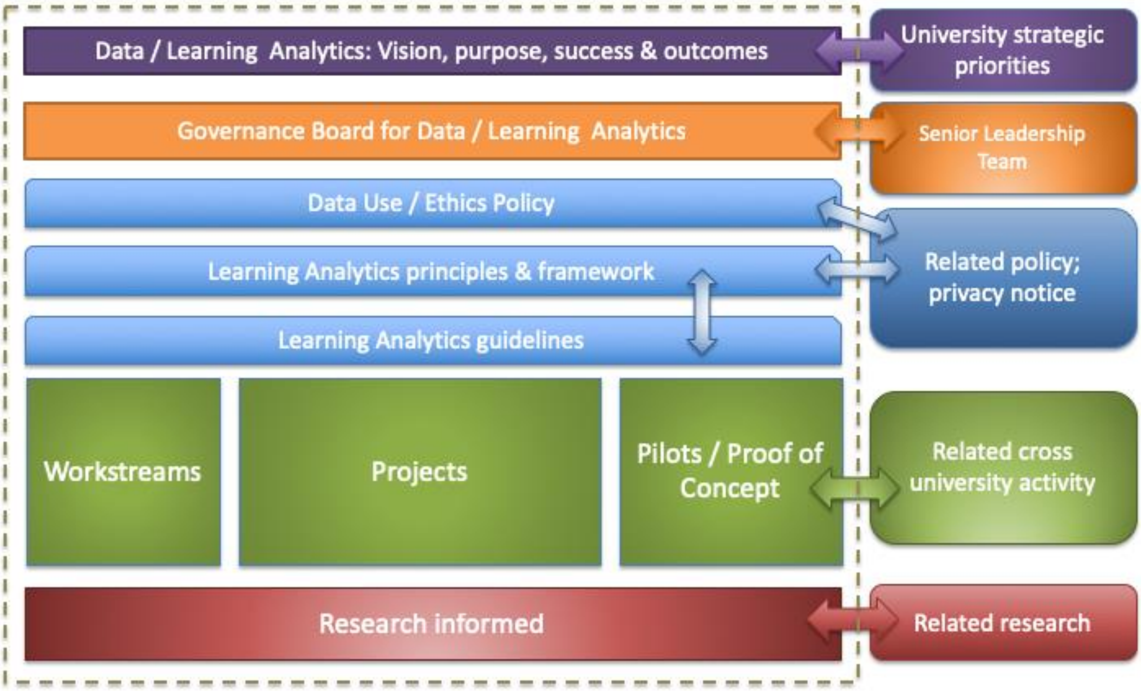

Figure 2: Proto-governance model for LA anchored to intuitional processes, policy and leadership. The model delineates activity associated with data and learning analytics (within dotted line) and maps each layer to the wider institutional strategic drivers, governance and related cross institution activity.

Finally, the adapted ROMA approach provided a mechanism by which to sensitise various parts of the institution to the potential for small scale pilot activity as described below. This process was particularly important in uncovering the internal capacity for change (ROMA Item 5) and linking the desired behaviour changes we might want to see (ROMA Item 3) to the engagement strategy (ROMA Item 6).

Tier Two: Small scale pilots

For this tier of activity, the scope was confined to tools and approaches that utilize learning data to support, understand and optimise learning. The key stakeholders in these five pilots were academics and students. We explored the following areas in a rapid, agile manner to determine their potential for future, larger scale project initiation (Table 3).

Table 3: Five small scale pilots to test LA approaches and tools

	Tool	Description
1	Learning Management System (LMS) and Lecture Capture embedded tools	- the set of dashboards and data visualizations of student activity and performance that can be used to inform teaching staff about student learning and course content design.
2	StudentVis	- a tool developed by the School of Engineering and Computer Science that provides a range of visualizations on student assessment progress through courses, used to support identification of students at risk of non-completion or areas of course assessment design that may require modification.
3	OnTask	- a tool for providing mass personalized feedback to sub-populations of students based on performance and activity conditions within a course (see https://www.ontasklearning.org/).
4	AcaWriter	- a formative feedback tool that uses Natural Language Processing (NLP) to provide automated feedback to students on academic writing (see https://acawriter.uts.edu.au/).
5	Quantext	- a text analysis tool for quickly extracting insights from written texts including short answer test questions, teaching evaluations and textual feedback data (see https://quantext.org/index).

This was an exploratory activity with a small number of engaged academics, students and support staff being selected for each pilot area to critically engage with the tools over a short two months timeframe. Participants were asked to reflect on their perception of value of the tools, what limitations or challenges they presented and what desires they had for improvements or changes to the tools that would better serve their needs. In addition, they were asked to reflect on requirements for operationalizing the tools, or similar type of tools, within their faculties. The general pilot approach involved a brief introduction to participants on the respective tools, an offer of support for using the tools during the pilots, as needed, and a subsequent process for gathering feedback - either through interviews or written feedback to scripted questions.

From the data gathered we were able to make judgements about both the perceived value of LA tools and approaches that were worth pursuing as full pilots:

Application-specific findings

- Though the LMS is a primary source of data on student activity for most faculties, it is apparent that the embedded analytics tools are too complex and don't meet the needs of lecturers to monitor students' progress. The Performance Dashboard was the most favoured tool because it quickly provides data on students with a single click but the range of data points displayed are too limited and the dashboard unable to be customized to meet specific needs . Participants were generally satisfied with Lecture Capture video viewing activity dashboard but indicated that monitoring viewing activity was less priority than other areas.
- The StudentVis application and corresponding support model provides the university with history of practice that can be drawn on to support efforts around monitoring and responding to student progress.
- OnTask: Generally, participants were enthusiastic about the tool, recognizing its power to administer personalised feedback within large courses to specific subsets of students based on assessment and activity conditions. The granular control and customization of OnTask was recognised as particularly suited to supporting lecturers and course staff in their teaching feedback tasks. The learning curve to use the tool is significant and requires fairly technical instructors and / or adequate support both for sourcing and importing data into the tool, setting up the conditional rules and understanding the when and how of effective feedback.
- AcaWriter: Participants were enthusiastic about the tool, while recognizing the demonstration version had limitations. Students noted the value of the tool to support student agency and timely feedback. Participants see the tool supporting a number of use cases including: for prospective students thinking of undertaking academic study, students early in academic study, mature students unused to academic writing, non-native language learners as well as higher level learners submitting journal abstracts. In addition, the tool can help academics and tutors grade fairly and avoid biases. Concerns were raised, however, around the potential of the tool to persuade students toward formulaic writing. The language used in the analysis report and feedback needs additional explanation, or changed to fit the local institutional context. Additional genres of writing, additional feedback and resource examples are also desired. Some interface issues were also identified.

- Quantext: Participants were generally positive about the tool and thought that it had the potential to offer new insights into how students learn in the course, their levels of understanding of subject-specific concepts and terms. They also thought that the tool could provide useful feedback on the quality of assessment (questions and instructions) and teaching materials, and could help them improve the contents of lectures and tutorial. The main limitation that participants commented on was the time-consuming nature of the data analysis and its interpretation. They felt that one-on-one support would be needed, especially in the early adoption stages, in order to understand the available options and functionalities. They thought that the most effective way of using the tool would be in conjunction with an academic developer, who could help them with the interpretation of the results and suggestions on how to improve the course and teaching.

General LA pilots' findings and conclusions

- For LA practices to be successful, capability development as well as technology implementation need to be addressed. Though participants in the pilots were largely hand-picked from engaged academics and students, many complained of lacking the time or capacity to learn how to use the tools, interpret and act on them effectively. This is true not only of lecturers but also students who need support to learn how to use LA tools effectively to support their learning.
- Academics desire a just-in-time, one-to-one support model that can help them explore options for meeting their analytics needs as well as provide how-to support.
- Overall, there is a need to coordinate efforts in the LA space across different university strategic drivers and service areas. We noted overlaps between StudentVis, CRM Advice (another system being piloted within student academic services) and OnTask. While the drivers and scope may be different, participants in the LA pilots saw these tools serving a similar need and are seeking holistic approaches to monitoring student progress and support.
- Effective LA tools are characterised as easy to use, fast, customisable, accurate, intuitive and, preferably, aggregated in a single location.

Tier Three: Open community building and shared research enterprise

In parallel with the LAPI project described above we instantiated an open forum for sharing LA practice with the aim of building consensus around the terminology, discourse and sites of activity across the institution. This community of interest was developed through a regular (quarterly) series of hosted roundtable meetings. These followed a distinctive pattern of invited speaker, sharing of new and ongoing work, ending with an open forum discussion on broader analytics themes. In order to establish grounds for future cross-university LA cooperation, having an iterative and open conversation was critical. This is because personal interactions help to establish anthologies of meaning for a common cooperative language and to find common gaols (Weiseith *et al*., 2006). Conceptualising this cooperation as social practice, we aimed to promote institutional learning (Creamer & Lattuca, 2005). Participant numbers averaged around thirty with a wider mailing list of over 100 interested individuals across the organisation. The LA principles were validated through repeated exposure to this group, over a period of 12 months. The attendees acted as a catalyst for discussions within their own faculty and CSUs and became the LA champions for change. Membership of SOLAR (Society for Learning Analytics Research) was seen as an important enabler, providing staff an avenue to access capability development opportunities. Through this work we were able to map the analytics related activity across the organisation at a very early stage (Figure 3).

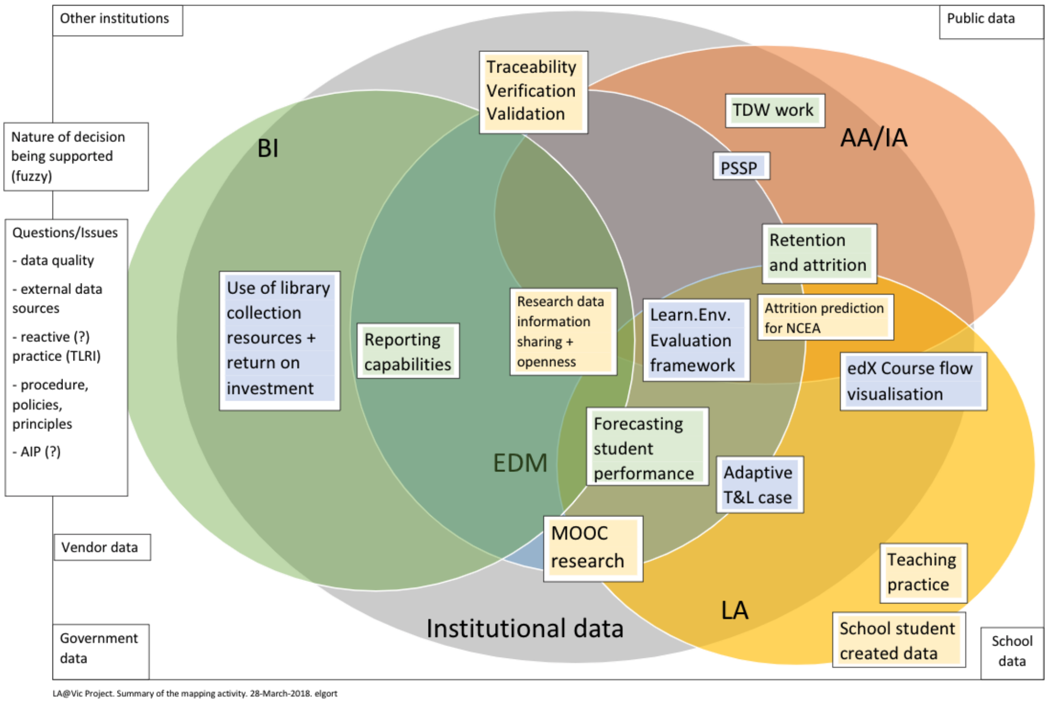

Figure 3: Mapping LA domains across the institution (BI – Business Intelligence; EDM – Educational Data Mining; AA/IA – Academic/Institutional Analytics; LA- Learning Analytics)

Discussion

The work here speaks to the five critical areas identified in Colvin *et al.* (2017) for developing maturity in LA that cover: technological readiness; leadership; organisational culture; staff and institutional capacity; strategy. The eventual benefits of adopting a multi-tiered approach have far outweighed the initial challenges experienced in pulling together disparate and sometimes competing academic and business areas of the institution. Patient and sustained engagement across all of the levels of the organisation have promoted deeper understanding of the value of LA and the identification of clear areas of organisational activity (Table 4). It has allowed a steady alignment to institutional level strategic goals via the instantiation of a consultative governance board to enable and steer the benefits of managed data use towards institutional outcomes understood by senior leaders.

The three tier approach described in this case study eschews the linear maturity model such as that described by Siemans, Dawson and Lynch (2013) in their Learning Analytics Sophistication model where capability and systems are integrated on a maturity continuum. It resonates more with process style models that operate at a programme level (Ferguson *et al.*, 2015). The important added dimension that the three tier design acknowledges is that LA implementation should be iterative, dynamic and sustainable. Here we note Colvin *et al.*'s (2015) model of Strategic Capability whereby the actual performance of LA implementation helps generate future capacity in the ability to conduct LA. As observed by Colvin *et al.*, (2015) and apparent in the approach accentuated in the model described here, the use of user-centred, rapid, prototyping and iterative activities (Gulliksen, 2003) has been a pivotal mechanism for gaining traction and stakeholder buy-in.

As described elsewhere in the literature, the establishment of a clear vision and purpose for learning analytics is vital and can be successfully achieved through the development of policy and procedure (Colvin *et al.* 2017). The instantiation of a governance board with clear line of sight to senior leadership has been a critical step and, was a direct response to avoid the documented failures that can occur in LA projects if this layer is not put in place (Macfadyn and Dawson, 2012).

In terms of taking learning analytics and principles through to policy development, this is a complicated area. Like many institutions, our own policy setting processes and procedures require visibility across multiple institutional touchpoints and navigation through several committee layers. One of the challenges has been to untangle this route and find agreement across many interested parties while championing transparency of major concerns such as privacy, security, data ownership and control.

Institutionally sited research (Elgort *et al*., 2018; Lundqvist *et al.*, 2018) has remained an important component in supporting LA activity, though we have acknowledged the tension that the rapid but often independent progress in the LA research domain can create in the gaps between findings and their translation into practice (Dawson *et al.*, 2015). Overall, we have uncovered a strong desire for effective LA tools that can enhance teaching and learning practices and student support, as well as a growing interest in how these tools can link learning design with LA (Corrin *et al*., 2018). The importance of community building cannot be underestimated, and functioned as a driver to sharing knowledge and consensus building. This was critical in helping cross pollinate institutional activity and, for example, raising the level of conversation to key drivers such as the importance of linking pedagogy to analytics.

Table 4: Institutional analytics organised across four pillars of activity

Pillar 1 - Student focused institutional analytics:	Pillar 2 - Learning Analytics:	Pillar 3 - Data Analytics:	Pillar 4 – Research:
- Macro/meso level; - Retention metrics; - Defined success via KPIs; - Completion of courses across the university as a whole; - Audience/s: -Support services -Student - Governmental level reporting; - Crosses prospects and current students.	- Micro level (e.g. specific courses and degree programmes); - Focus on the learning and teaching practices; - Audience/s: - Staff (lecturers, tutors, course administrators) - Students - Maturity in LA principles and framework is an important enabler; - Staff capability and engagement are critical success factors.	- Macro level; - Educational data mining; - Predictive modelling; - Academic Analytics; - Maturity in data governance is an important enabler.	- Individual/Group; - Actively encouraged and supported; - Human Ethics Committee line of sight; - Driven institutionally by research strategy and associated priorities; - May inform central university data analytics programmes.

Conclusions

The value of a multi-tiered approach has been in helping address the complexities of cultural change, organisational capability building and advancing our technology maturity. Our current situation is one of increased awareness in the potential for learning analytics across the whole institution. As we transition from a data siloed to a data informed organisation these tools, activities, process and conceptualizations are becoming increasingly aligned and supported.

Four areas critical for success have been identified going forward:

- Tools: Undertake further appropriately resourced additional pilots of LA tools to gather sufficient data to verify conclusions and establish requirements for operationalizing solutions across the institution.
- Data: The criteria for the selection of future enterprise software solutions should include the availability and potential to support learning analytics. Where limitations are identified within core platforms, alternative tool solutions should be sought to fill the gaps such as third-party integrations or data platform solutions that can harvest the data and provide meaningful dashboards and visualizations.
- Support: Establish and embed a model for supporting LA that includes: functional and pedagogical support for lecturers and students using campus-wide deployed LA tools; just-in-time support for lecturers requiring help with *ad hoc* LA-related questions and exploration tasks; and continuous capability development activities.
- Governance: Ensure a coordinated approach to analytics tools investigation and implementation across academic, service and reporting areas to ensure an integrated, connected approach to addressing LA outcomes.

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Online Versus Face-to-Face: A Quantitative Study of Factors Influencing Students' Choice of Study Mode using Chi-Square Test and Binary Logistic Regression

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For online learning in the January 2019 semester, students at the Singapore University of Social Sciences were able to choose whether they want to study in virtual or face-to-face mode in two courses. Virtual refers to full online learning whereby students study, in a six-week term, without the need to meet face-to-face with the instructor while face-to-face refers to blended e-learning whereby students received either six or three face-to-face lessons with e-learning resources. In full online mode, students will meet the instructor virtually via video conferencing on a weekly basis. Data were obtained to find out which variables actually had an effect of students' choice of learning mode. 370 students were analysed and the variables including gender, marital status, race, nationality, course, qualification, school, programme, intake, age (now), age (joint) and cumulative grade point average (CGPA) were examined. Each variable was compared with the students' mode of study in order to identify if they are dependent (e.g. gender versus study mode, race versus study mode, etc.) based on a chi-square test. The significant variables were further investigated using a binary logistic regression model. It was found that qualification, intake and CGPA were found to be significant for students' choice of learning.

Keywords: Virtual, Face-to-face, Mode of study, Chi-square test, Binary logistic regression

Introduction

Two courses, Customer Relationship Management (BUS354) and Starting and Managing a Business (BUS357), offered by the School of Business provided two modes of study for students to undertake in the semester of January 2019. One was virtual whereby the students learned online with virtual face-to-face interactions with their instructors and peers while the other being physical face-to-face based on the blended e-learning approach of combining either six or three face-to-face lessons with e-learning contents over a term of six weeks. Students taking these courses were studying part-time taking classes in the evening and they had the option to choose their mode of study. All students taking these courses will take a common examination at the end, but the continuous assessment components will be different. Data from the Student Information Systems provided students' background information including demographic and academic details. 370 students were analysed and the variables that was extracted would include gender, marital status, race, nationality, course, qualification, school, programme, intake, age (now), age (joint) and cumulative grade point average (CGPA). The purpose of this paper was to find out from the data if there were significant variables that influenced students' choice of study. Insights drawn from this study will be helpful in planning for course offering in various modes. We believed the statistical analyses of the chi-square test and the binary logistic regression would be appropriate to obtain the findings for this study.

Literature Review

Online and face-to-face learning have been studied widely. Researchers had found that for online students they are usually older, have full or part-time work, requires commuting to the campus, have family obligations and have taken online courses before. Cleveland, Dutcher & Epps (2015) explained in their study that "online students tend to be older, part or full time workers, and returning to school after being in the working world" while the students in their survey who took the face to face "tended to be the more traditional college student: younger, often directly out of high school" (p. 128). On the other hand, face-to-face students are usually freshmen and they like to seek interactions with their instructors and classmates in the physical classroom. Dendir (2016) found that "the average online student was a sophomore, whereas the typical face-to-face student was a freshman …. a closer look at the data shows that 83% of the sample in the face-to-face section were freshmen, whereas about 77% in the online sample were sophomore and above …. a majority of the online students (58%) had prior experience with online courses" (p. 62). The key to online study is the flexibility and convenience to learn at the students' own pace and when they are most productive as pointed out by Jaggers (2014) "that convenience and flexibility are key factors that entice students to enroll in online coursework" (p. 27). In terms of student characteristics, it was found that "student age, percentage female, race and grade point average (GPA)" had no differences by the mode of delivery (Parcel, Radu & Gonzales, 2018, p.4). This study, based on two courses that allowed students to choose between either online or face-to-face mode, attempts to determine which independent variables affected students' choice of learning.

Research Question

Based on the independent variables obtained for this study, would there be a significance between each independent variable compared to the mode of learning (i.e. the dependent variable) for the students who studied in BUS354 and BUS357? Would there also be interactions between these independent variables?

Chi-square Test and the Binary Logistic Regression Model

The use of the chi-square test and the binary logistic regression model as statistical tests came about from papers discussing the analysis of dependent variable in binary form. They included the studies of integrated pest management (IPM) adoption (Talukder, Sakib & Islam, 2017), drivers' reactions in car crashes (Al-Taweel, Young & Sobhani, 2016) and stillbirths in Ethiopia (Berhie & Gebresilassie, 2016). These papers analysed the binary nature of the dependent variable (see Table 1) against a range of independent variables.

Table 1: Dependent Variables in Binary Format

Dependent Variable	Category
IPM Adoption	1: Yes, 0: No
Drivers' Reactions	1: Drivers take Reactions, 0: Drivers do not take Reactions
Experienced Stillbirth	1: Yes, 0: No

Given that all the independent variables are in categorical format, the use of the chi-square test to determine the significance of the variables with the binary dependent variable made statistical sense. To further identify the levels of each independent variable such that there is significance associated with the dependent variable, these papers suggested the use of the binary logistic regression model. For example, are there significance associations between IPM adoption and different regions (Talukder et al., 2018), divers' reactions and crash type (Al-Taweel et al., 2016) and experiencing stillbirth and maternal age (Berhie & Gebresilassie, 2016). The key question for each study was to determine if there was IPM adoption, drivers take reactions or experiencing stillbirth among different levels of independent variables. From these studies, it was established that a consistent statistical approach using the chi-square test and the binary logistic regression model to determine if students' choice of learning (virtual or face-to-face) was significant against a selection of independent variables would be valid. Details about the binary logistic regression model are explained in the journals from Peng, Lee & Ingersoll (2002) and Sperandei (2013).

Interpreting Results from the Binary Logistic Regression Model

In terms of interpreting the results of the binary logistic regression model, an understanding on the use of the odds ratio (OR) is important (Strand, Cadwallader & Firth, 2011). By definition, an OR 'compares the odds of success (or failure) for a particular group to a base (reference) category for that variable' (Strand el al., 2011, p. 18). For example, if we evaluate ethnicity and higher academic results according to Table 2, we note that White British students have been selected as the reference category. Indian students are 1.58 times more likely than White British students to achieve higher academic results or they are 58% more likely to achieve higher academic results than White British students. Conversely for Black Caribbean students the OR is 0.53, so Black Caribbean students are less likely to achieve higher academic results compared to White British students. In percentage terms they are 47% less likely to achieve higher academic results. What this means is that Indian students are more likely while Black Caribbean are less likely compared to White British students on achieving higher academic results. In SPSS, OR is represented by the 'Exp(B)' ratio.

Table 2: Ethnicity and Higher Academic Results

Ethnicity	OR (for Higher Academic Results)
0 White British	Reference Category
1 Mixed Heritage	0.87
2 Indian	1.58
3 Pakistani	0.64
4 Bangladeshi	0.80
5 Black Caribbean	0.53
6 Black African	0.81
7 Others	1.21

With an understanding on interpreting the results of the binary logistic regression model, it was possible to determine which levels of the independent variables were significant and were more likely or less likely compared to the reference category with respect to students' mode of study (i.e. virtual or face-to-face).

Methodology

The status of students' mode of study (1 for virtual, 0 for face-to-face) was considered as the main variable of interest (i.e. the dependent variable). If the student had chosen to study in full online learning, then he/she was considered as a virtual student otherwise face-to-face. At the same time, a list of other demographic characteristics (also considered variables) for students was also captured. These independent variables included gender, marital status, nationality, course, school, race, qualification, programme, intake, age (now), age (joint, i.e. when joining SUSS) and cumulative grade point average (CGPA). The question of interest was to determine which of these independent variables affected students' mode of study in terms of learning in virtual or face-to-face mode and, if possible, the interactions among them. Table 3 provides a listing of the variables and its category.

Table 3: Variables Selected in Relation to Students' Mode of Study

Variable	Category
Dependent	
Study Mode	1: Virtual, 0: Face-to-face
Independent	
Gender	1:Male, 2: Female
Marital Status	1: Single, 2: Married or Divorced
Nationality	1: Singaporean, 2: Others
Race	1: Chinese, 2: Malay, 3: Indian, 4: Others
Age (Now)	1: < 30, 2: 30 to 39, 3: >= 40
Age (Joint)	1: < 30, 2: 30 to 39, 3: >= 40
Course	1: BUS354, 2: BUS357
School	1: Business, 2: Others
Programme	1: BSBZ, 2: BSMA, 3: Others
Qualification	1: Diploma, 2: A-levels, 3: Others
Intake	1: 2012/01 to 2014/07, 2: 2015/01 to 2017/07, 3: 2018/01 to 2019/01
CGPA	1: <= 2.00, 2: 2.01 to 3.00, 3: > 3.00

Statistical Analysis

To assess students' mode of learning in either virtual or face-to-face mode, a statistical analysis involving univariate, bivariate and multivariate setup were conducted. In the bivariate setup, a chi-square test was used to assess the significance between the dependent and independent variables. In the multivariate setup, the binary logistic regression model was used to determine the likelihood of study mode (virtual or face-to-face) with the above independent variables that were found to be significant from the chi-square test. The software that was used for the analysis of data is SPSS (Version 22 for Windows).

Results and Discussions

Univariate Analysis

Among the 370 students, 42% were male and 58% female. The average age of students at intake was 26 and the age groups at intake were broken into three categories: less than 30 (82.2%), 30 to 39 (11.1%) and equal or higher than 40 (6.8%). The majority was single (81.1%) with married or divorced at 18.9%. In terms of race and nationality, the majority was Chinese (79.7%) with Malay (10.5%), Indian (6.2%) and Others (3.5%) as the other races and Singaporean (97.6%) was the majority nationality with the minority being other nationalities (2.4%). More students have studied BUS357 (57.8%) compared to BUS354 (42.2%) and they mostly studied in the School of Business (87.3%) compared to other schools (12.7%). The programmes that the students studied were evenly distributed between Bachelor of Business (BSBZ) (44.5%) and other programmes (42.8%) with the remaining students taking Bachelor of Marketing (BSBM) (12.7%). Qualification-wise, the majority of these students had a Diploma (73.2%) with A-levels (8.1%) and others (18.6%) as the remaining qualifications. For semester-intakes they were broken down into three periods: January 2012 to July 2014 (10%), January 2015 to July 2017 (75.4%) and January 2018 to January 2019 (14.6%). In term of the students' Cumulative Grade Point Average (CGPA) they were based on three ranges: less than or equal to 2.00 (10%), 2.01 to 3.00 (36.5%) and higher than 3.00 (53.5%). Finally, for the dependent variable of mode of study, the majority of students had chosen to study 'face-to-face' (87.6%) with the remaining students opted for 'virtual' (12.4%). Table 4 shows a summary of these statistics.

Table 4: Summary Statistics

Variable	Frequency	Percent
Gender		
Male	155	41.9
Female	215	58.1
Age (Joint)		
<30	302	82.2
30 to 39	41	11.1
>=40	25	6.8
Marital Status		
Single	300	81.1
Married or Divorced	70	18.9
Race		
Chinese	295	79.7
Malay	39	10.5
Indian	23	6.2
Others	13	3.5
Nationality		
Singaporean	361	97.6
Others	9	2.4
Course		
BUS354	156	42.2
BUS375	214	57.8
Qualification		
Diploma	271	73.2
A-Levels	30	8.1
Others	69	18.6
School		
Business	323	87.3
Others	47	12.7
Programme		
BSBZ	165	44.6
BSBM	47	12.7
Others	158	42.7
Intake		
2012/01 to 2014/07	37	10.0
2015/01 to 2017/07	279	75.4
2018/01 to 2019/01	54	14.6

CGPA		
<= 2.00	35	10.0
2.01 to 3.00	135	36.5
> 3.00	198	53.5
Study Mode		
Virtual	46	12.4
Face-to-Face	324	87.6

Bivariate Analysis

Based on the chi-square test of independence for categorical variables, the following hypotheses were evaluated:

- Null Hypothesis (H0): the two categorical variables were independent (i.e. there was no relationship between them);

- Alternative Hypothesis (H1): the two categorical variables were not independent (i.e. there was a relationship between them and that they were significantly related).

H0 was rejected if the Pearson chi-square had p-value < 0.05 or 0.10, meaning that statistically the two variables were significant.

As shown in Table 5, the independent variables that were reportedly to be highly significant ($p < 0.05$ or 0.01) or significant ($p < 0.10$) with the dependent variable (i.e. study mode) were qualification, programme, intake, age (joint) and CGPA. The chi-square test showed that these five independent variables were correlated with the dependent variable. On students' qualification, those with A-levels (26.7%) had opted to study in 'virtual' more than those with diploma (12.2%) and other qualifications (7.2%). The marketing programme (23.4%) was more popular with 'virtual' students compared to business (11.5%) and other programmes (10.1%). Intake-wise, the latest semester-intakes of January 2018 to January 2019 had a higher proportion (27.8%) of 'virtual' students compared to the first semester-intakes (January 2012 to July 2014) (21.6%) and the second semester-intakes (January 2015 to July 2017) (8.2%). For students' age (joint), those who were '40+' had the highest percentage of virtual learners (24.0%) compared to those who were aged 'less than 30' (12.5%) and between '30 to 39' (4.9%). As for the CGPA, the proportion of 'virtual' students were higher in the 'less than or equal to 2.00' group (29.7%) compared to '2.01 to 3.00' (16.3%) and 'greater than 3.00' (6.6%). On the other hand, the other seven independent variables (gender, marital status, race, nationality, course, school and age (now)) do not have significant effect on students' mode of study given that the Pearson chi-square test was $p > 0.10$.

Table 5: Assessing Association between Study Mode and Independent Variables with P values from Chi-square Test

Independent Variable	Study Mode (n = 370) Virtual (%)	Face-to-Face (%)	P Value
Gender			0.581
Male	21 (13.5)	134 (86.5)	
Female	25 (11.6)	190 (88.4)	
Marital Status			0.905
Single	37 (12.3)	263 (87.7)	
Married or Divorced	9 (12.9)	61 (87.1)	
Race			0.891
Chinese	38 (12.9)	257 (87.1)	
Malay	5 (12.8)	34 (87.2)	
Indian	2 (8.7)	21 (91.3)	
Others	1 (7.7)	12 (92.3)	
Nationality			0.368
Singaporean	44 (12.2)	317 (87.8)	
Others	2 (22.2)	7 (77.8)	
Course			0.279
BUS354	16 (10.3)	140 (89.7)	
BUS375	30 (14.0)	184 (86.0)	
Qualification			0.026**
Diploma	33 (12.2)	238 (87.8)	
A-Levels	8 (26.7)	22 (73.3)	
Others	5 (7.2)	64 (92.8)	
School			0.941
Business	40 (12.4)	283 (87.6)	
Others	6 (12.8)	41 (87.2)	
Programme			0.047**
BSBZ	19 (11.5)	146 (88.5)	
BSBM	11 (23.4)	36 (76.6)	
Others	16 (10.1)	142 (89.9)	
Intake			0.000***
2012/01 to 2014/07	8 (21.6)	29 (78.4)	
2015/01 to 2017/07	23 (8.2)	256 (91.8)	
2018/01 to 2019/01	15 (27.8)	39 (72.2)	
Age (Now)			0.527
<30	35 (12.7)	240 (87.3)	
30 to 39	5 (8.6)	53 (91.4)	
>=40	6 (16.2)	31 (83.8)	
Age (Joint)			0.073*
<30	38 (12.5)	266 (87.5)	
30 to 39	2 (4.9)	39 (95.1)	
>=40	6 (24.0)	19 (76.0)	
CGPA			0.000***
<= 2.00	11 (29.7)	26 (70.3)	
2.01 to 3.00	22 (16.3)	113 (83.7)	
> 3.00	13 (6.6)	185 (93.4)	

***p value < 0.01, **p value < 0.05, *p value < 0.10

Binary Logistic Regression Analysis

We used the binary logistic regression model with the significant variables found in the bivariate analysis (see Table 5) to determine students' mode of study. The results are shown in Table 6. We noted that the independent variables of qualification ($p = 0.098 < 0.1$), intake ($p = 0.025 < 0.05$) and CGPA ($p = 0.007 < 0.01$) had significant effect on students' mode of study. For qualification, students with A-levels were almost twice (188%) more likely to take up virtual learning (OR = 2.875) compared to diploma holders (reference category). Students from semester-intakes of January 2015 to July 2017 were less likely (59%) to take virtual than those from the January 2012 to July 2014 (reference category) (OR = 0.407). In terms of students' CGPA, those with 'greater than 3.0' was less likely (77%) to take virtual than those from the 'less than or equal to 2.00' group (reference category) (OR = 0.228). However, programme and age (joint) were found not to have significant effect ($p > 0.1$) on students' mode of study even though it did have significant association from the bivariate analysis.

Table 6: Binary Logistic Regression Model for Students' Mode of Study (Virtual)

Dependent Variable	Independent Variable	Level	Coefficient	Odds Ratio (Exp(B))	p-value
Mode of Study (Virtual)	Qualification				0.098*
		Diploma	Reference Category		
		A-Levels	1.056	2.875	0.034**
		Other	0.030	1.030	0.961
	Programme				0.145
		BSBZ	Reference Category		
		BSBM	0.696	2.007	0.143
		Other	-0.278	0.757	0.522
	Intake				0.025**
		2012/01 to 2014/07	Reference Category		
		2015/01 to 2017/07	-0.899	0.407	0.072*
		2018/01 to 2019/01	0.160	1.174	0.772
	Age (Joint)				0.121
		< 30	Reference Category		
		30 to 39	-1.227	0.293	0.114
		>= 40	0.624	1.867	0.250
	CGPA				0.007***
		<= 2.00	Reference Category		
		2.01 to 3.00	-0.501	0.606	0.293
		> 3.00	-1.479	0.228	0.004***

***p value < 0.01, **p value < 0.05, *p value < 0.10

In terms of the interactions between the independent variables, they were analysed according to, firstly, Age (Joint) by Marital Status, and Age (Joint) by Gender, since we thought female students who were at child bearing age or who were raising a family would choose virtual learning. Secondly, other independent variables were randomly selected to obtain the interaction results and they included Age (Joint) by CGPA, Age (Joint) by Qualification, Intake by Gender and CGPA by Qualification. Except for Intake by Gender, all interactions were not significant (see Table 7).

Table 7: Interaction between Independent Variables

Independent Variable	p-value
Qualification	0.971
Programme	0.063
Intake	0.023
Age (Joint)	1.000
CGPA	0.139
Age (Joint) * Marital Status	1.000
Age (Joint) * Gender	1.000
Age (Joint) * CGPA	0.993
Age (Joint) * Qualification	1.000
Intake * Gender	0.019
CGPA * Qualification	0.976

Conclusion

The chi-square test revealed that the independent variables of qualification, programme, intake, age (joint) and CGPA were found to be significant ($p < 0.10$) and that the bivariate analysis showed students have the highest percentage of virtual learning for A-levels (26.7%), marketing (23.4%), intake between January 2018 to January 2019 (27.8%), age (joint) of '40+' (24.0%) and CGPA 'less than or equal to 2.00' (29.7%). At the same time, the binary logistic regression model was used to analyse the adjusted effect of the levels from these independent variables (see Table 6). For qualification, A-levels holders were more likely (OR = 2.875) to take virtual learning compared to students with diploma (reference category) by 188%. On the other hand, students from the 'January 2015 to July 2017' intake were less likely (OR = 0.407) to take virtual learning compared to 'January 2012 to July 2014' (reference category) by 59% and those with CGPA of 'higher than 3.00' were less likely (OR = 0.228) against the reference category of 'less than or equal to 2.00' by 77%. For programme and age (joint), together with the other seven independent variables from the chi-square test (gender, marital status, race, nationality, course, school, age (now)), they had no significant effect on students' mode of study ($p > 0.5$). In conclusion, the levels that had an effect on students' choice of virtual learning were A-level holders, those admitted between January 2012 to July 2014, and students with CGPA of 'less than or equal to 2.00' while the interaction effects were minimum. Compared to the literatures this study confirmed that older students (based on intake data) had a preference for virtual learning. In terms of the paper's usefulness to learning and teaching, for older students in virtual learning a balanced use of technology (i.e. not overwhelming) would be suitable. The limitation of this study was that they were based on two courses. Data on current work experience would also be helpful since part-time students would work either part-time or full-time. Also, students' experience of other online courses would be helpful as well. In short a data-set with these additional variables would be more helpful but for this study the variables obtained are based on those shown in Table 3. Given that these two courses were offered as both 'virtual' and 'face-to-face' formats, this study, based on the data available, determined what variables influenced students' mode of learning according to the findings from the chi-square test and the binary logistic regression.

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Degree Design Thinking: integrated design frameworks for emerging online degrees in higher education

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This paper proposes a new conceptual framework for curriculum design that incorporates the principles of both educational and service design. Traditionally efforts in designing high quality online learning have relied on learning design and not on broader principles drawn from other fields of studies such as service design. This paper presents a case study of creating a quality online course on digital learning leadership to argue for the importance of an integrated approach to educational design. This new postgraduate degree in Digital Learning Leadership was aimed at the community of professionals working in the field of digital learning. The case study presents an integrated approach that combines design thinking and a Community of Inquiry framework as a way of cultivating a sense of belonging online for a network of digital learning professionals.

Keywords: digital learning, professional practice, learning design, service design, belonging

Introduction

The so called Fourth Industrial Revolution – not just the rise of artificial intelligence but a range of advances in genetics and computing which lead to a fusion of the physical, digital and biological worlds – will continue to produce large scale disruption and change in both the world of work and higher education (Seldon 2018; Auon 2017). This has led to the increasing importance of an employability agenda within higher education and a concern with both disruptive and sustaining innovations – particularly in the areas of online learning (Al-Imarah & Shields 2019). Design thinking and associated frameworks offers one approach to this complex environment (Carvalho & Goodyear, 2018; Goodyear, 2015). In education 'instructional design' or more broadly 'teaching as a design science' has a long history (Laurillard, 2012). But this work has often focused on either the meso view of constructive alignment (Biggs & Tang, 2007) or the micro view of learning activity design. There has been little scholarship exploring large-scale design of educational programs as a whole. As Carvalho and Goodyear (2018) note such studies which could draw on emerging areas of design studies such as the move from product design to social design or service design are an important gap in both the educational and design literature.

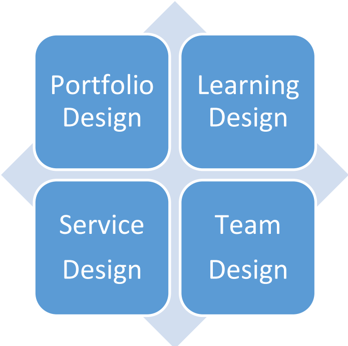
Design is a broad discipline that is increasingly being used 'beyond design' (Dorst 2019) to design solutions to 'wicked problems'. In analyzing this new type of design thinking Dorst notes that design in these large-scale complex domains must adopt a continuously iterative framework and is likely to become a multi-year "design-driven program of activities, rather than a design project." It is also increasingly multidisciplinary:

Social design requires designers to manage multiple stakeholders in the problem space as well as in the solution space, and it requires the combination and eventual integration of multiple fields of professional knowledge into what are often very complex product-service combinations (p. 119).

Through a specific case study this paper introduces an innovative, integrated approach to design work for educational programs that attempts to address some of these issues of complexity. It incorporates both existing learning design frameworks at the micro level and a new program level framework presented in this paper called 'Degree Design Thinking'. The case study outlined here is part of a larger innovation project which saw Deakin University become the first university in the world to put a suite of degrees on a global MOOC platform. There were two objectives for this program: firstly, extend the international reach of Deakin programs and secondly create a step-change process which took the design and delivery of the university's online offerings to a new level of professionalism. This paper therefore ultimately addresses the issue of new visions for digital learning through the exploration of a case study.

Frameworks for degree design

Our approach to program level design thinking evolved as part of our implementation of the Deakin Degrees @ FutureLearn initiative. The implementation of this ambitious program, from conception to enrolment, took eight months to launch seven degrees on a global MOOC platform. This was only possible through an agile design thinking framework which saw quick iterations of program elements emerge as minimum viable products that then moved to enhanced experiences across the two-and-a-half year project. What became increasingly clear across the lifecycle of the project was the necessity to connect the planning, design and delivery of a range of activities within the program. It began with a very clear focus on learning design which enacted a tailored version of Laurilard's learning activity types (Laurilard 2012) and an approach to the student experience which drew on broad notions of service design. Over the course of the project, through a series of reflective reviews, internal evaluation processes and external presentations (O'Donnell & Schulz 2018; Oliver 2018; Bearman Lambert & O'Donnell 2018), a four-part model for designing online degrees emerged. This "Degree Design Thinking" approach goes beyond traditional learning design approaches at the micro- and meso- level of learning outcomes, tasks and assessment, to address broader areas of student and staff experience at the macro level of program or degree design. Because the Degree Design Thinking framework maps a set of concerns and connections rather than a specified approach to design in each area it can easily be combined with other approaches to achieve identified outcomes. This case study describes such an integrated approach drawing on both this new model and the existing Community of Inquiry framework. (Garrison 2007)



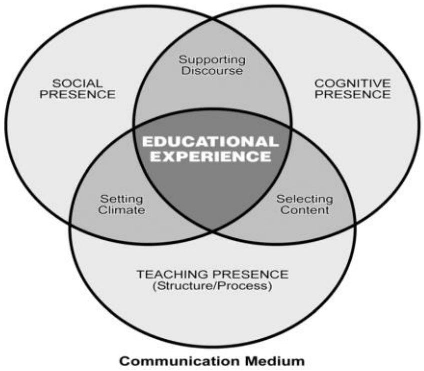


Figure 1 (left): Degree Design Framework (O'Donnell and Schultz 2018)
Figure 2 (right): Community of Inquiry framework (Garrison 2007)

Macro level design: Degree Design Thinking framework

The Degree Design Thinking framework, as described in Figure 1 above, identifies portfolio design, service design, learning design and team design as a set of interrelated processes. The framework seeks to address the challenge identified by Carvalho and Goodyear (2018) of bringing the macro, meso and micro elements of educational design together into a cohesive design process. It is a connecting framework, not a specified approach to design in each area, that enables an integrated approach to business and curriculum development, student experience and academic work practices. It can therefore be used and adapted as a planning and evaluation framework across a range of different programs.

Portfolio design focuses on designing a connected series of educational products that answer a defined educational need and work together as a set of cohesive pathways to delivering high quality digital educational experiences. This includes diversified credentialing models, the demands of local and global markets and business returns. **Learning design** operates 'at the micro level of educational activity' (Carvalho & Goodyear, 2018, p. 31) where creation of educational experience occurs, whereas **service design** ensures that the various kinds of services available to students are appropriately structured, and provided in a just-in-time manner, thus where possible eliminating barriers to the flow of student experience. As Carvalho & Goodyear (2018) note, this notion of education as a service has been ignored or challenged but is in fact critical to enhancing the holistic student experience - including seamless and simple administrative processes for enrolment and serviced problem solving or coaching during the course of study as well as coordinated academic literacies support. Finally, **team design** emphasises the need for multi-disciplinary and cross-functional teams purposefully put together. These team members include those who inhabit the 'third space' – namely, (hybrid) academics, learning designers, learning technologists, multimedia producers, graphic designers and project managers (Mitchell, Simpson, & Adachi, 2017).

Micro level design: Community of Inquiry framework

The Digital Learning Leadership suite of degrees, targeting experienced professionals, required a specific approach to cultivate a sense of belonging among professional networks and peer sharing of knowledge. Bang and Vossoughi argues that 'successful educational innovation is almost always participatory' (2016 cited in (Carvalho & Goodyear, 2018, p. 28) and this is especially true where adult professionals are the target cohort. To address these specific needs in the micro design of student experience, the project needed to go beyond the Degree Design Thinking framework to be able to creatively design specific learning activities and assessments at a micro level. Given this context, the Community of Inquiry (CoI) model was used to guide the learning design process.

The CoI framework, as outlined in Figure 2 above, presents the three components that make up educational experience: i) social presence, ii) teaching presence and iii) cognitive presence. The following explains each element of the framework (Anderson, Liam, Garrison, & Archer, 2001):

- **Social presence** – 'the ability of participants to identify with the community (eg. course of study), communicate purposefully in a trusting environment, and develop inter-personal relationships by way of projecting their individual personalities.'
- **Teaching presence** – 'the design, facilitation, and direction of cognitive and social processes for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes.'
- **Cognitive presence** – 'the extent to which learners are able to construct and confirm meaning through sustained reflection and discourse.'

Although the CoI model was chosen to guide the learning design it intersects across the degree design framework allowing moves across the complex micro-meso-macro levels of design. For example, social presence element within the CoI has implications for service design and team design in that it goes beyond the micro level design of learning activities. In the detailed description and analysis of the case study below, we illustrate how the Degree Design Thinking framework and the CoI model were enacted and applied in the process of developing the new professional degree.

Case study – Digital Learning Leadership degrees and unit

The Digital Learning Leadership suite of degrees, composing nested Graduate Certificate and Masters qualifications, is a unique mix of traditional units of study and micro-credentials and has a number of distinctive elements which necessitated rethinking the connections between the various design elements and a constant movement back and forth between the macro, meso and micro elements of design. In the next section of this paper we show how the Deakin Degree Design Thinking model and the CoI framework inform a multi-level approach to degree design.

Portfolio design

This degree suite is part of a unique approach to credentialing within the Deakin portfolio of courses. The bulk of each degree is made up of micro-credentials. These micro-credentials recognise and validate, through a standards-based reflective portfolio approach, students' already existing professional skills and knowledge in the areas relevant to their work. Each micro-credential provides half a credit point towards the degree. Given these courses are offered entirely online on FutureLearn, they attract both global and local markets and learners.

Table 1: Degree structure for the Graduate Certificate of Digital Learning Leadership

	Unit (1 credit point)	Micro-credentials (2 credit points)	Unit (1 credit point)
Units of work	Introductory unit (EEE726 – Digital Learning, Design and Assessment)	Digital learning professional expertise; Communication; Critical Thinking; Digital Literacy	Capstone unit – project based
Target cohort of learners	Part 1: Global learners in the MOOC (2-week content) Part 2: Deakin students in the closed courses (10-week content)	Global learners	Deakin students only

The table above outlines the course structure of the Graduate Certificate. The first introductory unit is broken into two parts – i) the MOOC and ii) closed, Deakin enrolled-student-only courses. The whole unit is delivered through a UK based MOOC platform, FutureLearn, and the first component of the unit is open for global exposure where we have potentially thousands of global learners, mostly adult learners interested in learning about digital learning. Therefore, learners can move through from a short two-week MOOC on digital learning, to an introductory, credit-bearing, unit of work, to micro-credentials pertaining to digital learning and finally to the postgraduate degree course on Digital Learning Leadership. The MOOC course works as a taster giving exposure of the unit and our institutional expertise on a global stage while degree courses are designed to appropriately meet the Australian Qualification Framework.

Service design and team design

As part of the project, which fundamentally challenged the ways in which our courses were traditionally offered (eg. MOOC platform and different enrolment processes for both local and global markets), a cross-functional, multidisciplinary team of people from across the University and beyond had to be involved. This team included: a senior leadership group which included the steering committee to oversee the progress and decision-making process; the university's student services area, who look after the enrolments – eg. marketing through local and global avenues; and FutureLearn HQ, who provides the platform for this degree. The ongoing communication and collaboration with student service areas across Deakin and FutureLearn were critical in ensuring that diverse learners' (learning) needs were met and supported across the whole journey.

On the micro level design and production of unit development, a teaching and production team was also carefully constructed to successfully develop the unit under time pressure. The design and development team consisted of the Unit Chair who provided subject knowledge and expertise in the area, Senior Education Developers, Videographers, Animators, Proofreaders/copyeditors, Project manager/coordinator, Graphic designers, Copyright officers. This collaboration was critical and the composition of team members from both the central learning and teaching unit as well as faculty teams was also intentionally planned. This ensured not just a diverse set of voices but also a strategic dissemination of innovation across the institution.

Learning design with the CoI framework

As noted above, in order to create a sense of belonging among a network of digital learning professionals, we drew heavily on the CoI as a conceptual framework when planning the learning design of the first taught unit within this degree suite. Below we describe some of the specific design features we employed drawing on the three elements within the CoI. Combined with the Degree Design Thinking framework and Laurillard's conversational framework (2012), a focus on these CoI elements enabled the design team to constantly move across the micro-meso-macro levels of design work.

Social presence
To facilitate social learning among global professional learners and a team of teachers, we invested heavily in the art of digital story telling that evokes and invites learners to share their own stories. We carefully crafted interview videos with digital learning experts, exploring various key concepts and prompting learners' reflection. The Unit Chair was always featured as the interviewer/story-teller, which created the sense of ongoing 'conversation' between teachers, other experts and learners.

Teaching presence
In framing the teaching presence that works asynchronously across time and place, it was important to create an illusion of teacher presence in the unit. Various videos (eg. welcome and wrap-up videos in each week, interview videos with experts) were purposefully placed at particular places within the unit to enable students to 'touch base'. We also included 'behind the scene's stories' as text-based stories throughout the unit. This was a way of bringing teaching team's personas and professional anecdotes into the discussion, wherever relevant. For example, in talking about the nature of multi-disciplinary teams in and around digital learning initiatives, 'the behind the scene's story' included an anecdote of how the teacher co-founded a national special interest group called TELedvisors who bring digital learning professionals and their discussions together. This technique worked as a way of weaving in meaningful, personal and professional networks and inviting learners to become part of these wider professional communities and dialogue.

Cognitive presence
One way of learners confirming their understanding of key ideas and achievement of their learning is through assessment. To build on the context of professional practice degrees, we designed authentic assessment tasks (both formative and summative) that modeled real-world examples of work throughout the unit. Fortnightly, learners are prompted to take part in portfolio activities scaffolded to incrementally produce work towards their summative assessment tasks. Portfolio tasks were accompanied with guiding questions relevant to key topics and learners were encouraged to share their work-in-progress as part of their portfolio and provide each other with peer feedback iteratively across the unit. This practice itself – ie. sharing their work iteratively and openly with their community and engaging with feedback process – represented the authentic nature of design work conducted by digital learning professionals. Further, the fact that these portfolio tasks were given every two weeks in smaller

chunks meant that busy professional learners could work through formative tasks effectively and achieve high quality work for their summative assessment pieces.

Conclusion

In conclusion, this case study of designing and developing new online degrees highlights the importance of comprehensive and coherent design thinking frameworks that go beyond a simple focus on the micro-level learning design. The four elements of the Degree Design Thinking framework presented here – portfolio design, service design, learning design and team design – show a new approach which works across macro-, meso-, and micro levels of degree design work. Each of these elements still require detailed design work and the case study shows how other design frameworks such as the CoI model can be used for the detailed design of student experience. The broad principles of learning design need to be combined with humanistic elements of teaching and social interactions if we are to cultivate a sense of belonging and learning community among professional learners and teachers. The CoI framework in this regard offered a useful lens in designing for a learning community at the micro level. This paper therefore contributes to the latest thinking in the broader field of learning design which brings focus on both the program and project level. Due to the limited evaluation data available on the unit/degree at this stage, its first run completed only in early 2019, further study will focus on the evaluation and effectiveness of such design frameworks and the iterative development of the program over time.

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Employing data to enhance teaching and learning in MENDAKI Tuition Scheme (MTS)

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The Malay community in Singapore has made significant social and economic progress over the years. In 2018, Singapore's Ministry of Education released figures reflecting educational achievements over a 10-year period between 2008 and 2017. Indicators such as progress in national examinations and increased representation of Malay students in post-secondary institutions over the last decade are encouraging milestones of educational mobility. The community's educational performance for key national examinations however is generally lower than that of other ethnic groups. Several researchers have highlighted the "under-attainment" of Singapore Malays. The MENDAKI Tuition Scheme (MTS), MENDAKI's flagship programme, provides highly subsidised tuition to support socioeconomically disadvantaged students in their learning. This paper reports the pilot phase of a collaboration between a university in Singapore and MENDAKI. The primary aim of the collaboration is to leverage on the use analytics to enhance the teaching and learning of disadvantaged Malay students in the MTS. Other secondary aims of the collaboration are to establish structures and to build capability of MENDAKI in the use of data for evidence-based decision making.

Keywords: Malays, MENDAKI, low performing community, analytics

Context of Project

The Malay community in Singapore has made significant social and economic progress over the years. In 2018, the education statistics from over a 10-year period between 2008 and 2017 were released (Ministry of Education, 2018). Indicators such as progress in national examinations and increased representation of Malay students in post-secondary institutions are encouraging milestones of educational mobility. The proportion of Malay primary one pupils who move on to post-secondary education has doubled from 45 per cent in 1995 to 94 per cent in 2017, whereas those who eventually obtained degrees and diplomas have increased from 15 per cent in 2010 to 21 per cent in 2015 (Toh, 2017). Only 1 per cent of its children do not complete 10 years of schooling (Channel NewsAsia, 2018). The percentage of professionals, managers, executives and technicians (PMETs) from the community has also jumped from slightly more than 7 per cent in 1980 to more than 32 per cent in 2015 (Channel NewsAsia, 2018). Figure 1 shows the percentage of Malay students who further their education and go on to post-secondary educational institutions such as Junior Colleges (JC), Polytechnics, Institutes of Technical Education (ITE) and other private institutions.

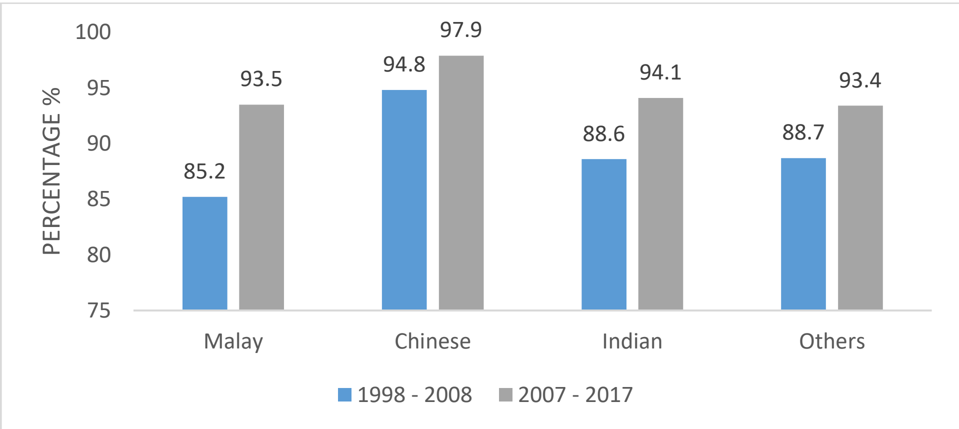

Figure 1: Percentage of P1 Cohort That Progressed To Post-Secondary Education (MOE Statistics Digest, 2018)

In relative terms however, the Malay community's educational performance for key national examinations is generally lower than that of other ethnic groups. Several researchers have highlighted the "under-attainment" of the Malay community when compared with other ethnic communities in Singapore (Tan and Ho, 2001, Zhang, 2014).

In 1982, Yayasan MENDAKI was established 'to empower the community through excellence in education' (Yayasan MENDAKI, 2017). MENDAKI programmes are designed to supplement or complement national education initiatives (Yayasan MENDAKI, 2017). The MENDAKI Tuition Scheme (MTS) provides highly-subsidised tuition to help Malay and/or Muslim students attain better results in their school and national examinations. The flagship program started off with only 880 students in 1982. Today, more than 9,000 students enrol in the programme annually. It runs over 50 centres for students from Primary 1 to Secondary 5. Students in MTS come largely from disadvantaged background. Over the years, MTS has been a valuable tool to improve Malay academic underperformance and to help Malay-Muslims acquire a higher chance of social mobility. Beyond provision of academic support, MTS empowers disadvantaged families with resources and educators with pedagogical techniques to engage students towards school success and to cultivate positive life-long learners' identity.

Along with these expansions is a rapidly growing source of student information/data to be mined for insightful knowledge. Having access to a rich data source potentially enhances the ability to effectively identify, analyse and provide interventions for low SES and/or low performing students. This paper reports the pilot phase of a collaboration between a Singapore university and MENDAKI. The pilot phase profiled of a group of 875 MTS students as well as identify determinants of their academic performance to explore the use of analytics to generate in-depth information for data-driven and evidence-based decision making.

Pilot Phase

The objective of conducting a pilot study was to examine the feasibility of a data mining approach that is intended to be used in a larger scale study. The research team explored and examined a MENDAKI data set to transform the data into a format and nature that is suitable for modelling using analytics tools. The pilot was also a knowledge discovery process that generated meaningful insights to the MTS students. This was important in shaping the research protocol of the larger study.

Sample Population

In 2015 there were 10,005 students enrolled in MTS. This comprised of 6,060 (~60%) primary school students and 3,945 (~40%) secondary school students. Primary school students may be taking Foundation or Standard subjects or a mixture of both, while Secondary level students were from Normal Technical, Normal Academic or Express stream, some may be taking subjects from a different stream. For the pilot phase, data variables of 875 Primary 6 students who sat for the Primary School Leaving Examinations (PSLE) standard subjects were analysed.

To establish a common performance indicator for benchmarking the academic performance of this pilot group of MTS students, a standardised measurement was essential for deriving fair and valid conclusion. In this dataset, academic variables were either school-based exams or PSLE results. In view of the varying standards of school-based exams, the PSLE results were used as target variable.

Methodology

This study applied K-means and Model-based Clustering methods to explore the characteristics of different groupings within this dataset. Cluster analysis is the grouping of similar objects together to form "clusters" where the objects within each have similar traits and characteristics. If the sample population converges to similar clustering rules, the "natural" groupings of the sample are established. The idea of similarity can be defined differently depending on the focus of the analysis, common measures include Euclidean distance and correlation coefficient. Unlike supervised learning methods such as regression models and decision trees where models are constructed using a target variable to make prediction, cluster analysis is unsupervised, which means the interest is solely on the input variables and interpretation of results can be rather subjective.

The algorithms of K-means and Model-based Clustering form the two major groups of clustering algorithms. K-means Clustering uses the heuristic method, which is more intuitive as it measures similarity using high-dimensional Euclidean distance between data points. Model-based Clustering is non-heuristic, as it consists of a formal statistical structure and model where each data point has a probability of belonging to each cluster. The analysis is a holistic inference of the cluster mean, variance as well as mathematical formula for prediction.

To establish a number of clusters which balances both statistical optimum and practicality, the two clustering algorithms are tested on two-cluster and three-cluster scenario to compare the results. Despite slight deviation in the distributions of variables, K-means and Model-based Clustering produce near similar results. Model-based Clustering was selected for the final analysis as it can better manage a range of different variables (nominal, ordinal etc.) through formal modelling and allows for comprehensive understanding of the cluster structures. Between the two models, the two-clusters model has more clear-cut characteristics whereas the three-clusters model produced some ambiguous or overlapping traits and one of its cluster behave more like a residual cluster rather than a meaningful group. The final model used for analysis will be a two-clusters model derived using Model-based Clustering algorithm.

Input Variables

A total of 131 variables were in the dataset. This include students' demographic, academic, socioeconomic-status (SES) as well as MTS information. Demographic variables include fundamental information of the student and his/her family composition. Academic variables include school-based and national exam results. SES variables include family income, subsidies and housing information. MTS variables include course enrolment information.

The data preparation included cleaning up the variable selection. Aside from removing irrelevant variables, new variables were derived for better representation of student population. Variables recoded into numeric values so that they can be used in data mining algorithms. The variables can be grouped into four categories:

- Academic: PSLE aggregate
- Demographic: gender, race, family role of student, marital status of main applicant, number of household members, number of other children in the household enrolled in MENDAKI, number of household members aged 65 and above and number of children in the household aged 6 and below
- Socioeconomic status: type of residence, rental block status, Per Capita Income (PCI)
- MTS: programme

The PSLE Aggregate is placed into three categories of eligible Secondary School streams. This was based on national cut-offs for Normal Technical, Normal Academic and Express stream. The cluster with the highest proportion of high performers (Express stream) was labelled as "high performing". Input variables are then compared across the clusters to define the dominating traits of students in each performance group.

For continuous variables like PCI, Analysis of Variance (ANOVA) was used for mean comparison and Kolmogorov-Smirnov test (KS test) for overall distribution comparison. For nominal variables, Chi-squared test and Exact Binomial test (for binary variable) were used to detect significant differences. For ordinal variables, rank correlation test was conducted using Goodman and Kruskal's gamma.

Findings

Significance of the Variables

Measuring variable importance in an unsupervised model like cluster analysis requires working backward, by setting the cluster assignment as the target and then construct supervised models like random forest to predict that target. Mean Decreased Gini (MDG) can then be used to quantify the importance of input variables in contributing to an accurate prediction of the target, but also help to estimate how these variables play their part in driving the formation of clusters.

Table 1 lists the top significant input variables. Socioeconomic variables dominated the list. The most is the PCI followed by Fee Wavier (a proxy of household income). Household and housing variables is the next important group, further segregating the group of students by different family composition and living environment.
With this pilot group, and generalising to the larger population of MTS students, the key variables are mainly from the differentiation in socioeconomic status of these individuals.

Table 1. Mean Decrease Gini (MDG) and relative importance of clustering variables

Variables	MDG	Relative Importance
PCI	124.76	1.000
Fee waiver	117.68	0.943
Residence	50.31	0.403
No. of household members	25.32	0.203
No. of other children in household enrolled in MENDAKI	18.63	0.149
Rental status	4.27	0.034
Marital status (of main applicant)	3.18	0.025
Programme	2.91	0.023
Family role of main applicant	2.53	0.020
No. of household members aged 6 and below	2.49	0.020

Clusters Profile

Table 2. Characteristics of each cluster

	Cluster size	***Input Variables***	***PSLE Aggregate***
Cluster 1	273 (31.1%)	- Higher proportion having married main applicant - Higher proportion having smaller household sizes - Higher proportion with lesser children in MTS - Higher income distribution and mean - Higher proportion without fee waiver - Higher proportion living in non-rental block - Higher proportion living in larger houses	Higher proportion of high performers
Cluster 2	602 (68.8%)	- Higher proportion having unmarried main applicant - Higher proportion having larger household sizes - Higher proportion with more children in MTS - Lower income distribution and mean - Higher proportion having fee waiver - Higher proportion living in rental block - Higher proportion living in smaller houses	Higher proportion of low performers

Cluster 1 comprised of ~47% of students who are eligible for the Express stream, ~8% eligible for Normal Technical stream, while Cluster 2 has ~41% of students eligible for the Express stream and ~15% eligible for Normal Technical stream. Comparing between the two clusters, the differences are statistically significant, with Cluster 1 has higher proportion of high performers while Cluster 2 has higher proportion of low performers.
Statistical tests were conducted to detect significant differences between the two clusters. In terms of family structure. Some key findings include

- Cluster 1 has significantly higher proportion of students having married main applicant (~93%), as the main applicant are most often the parents, this functions proxy for intact family.
- ~42% of Cluster 1 are households with one to three members, while for Cluster 2, ~70% of them have at least 5 household members.
- Cluster 1 has a mean PCI of S$993.78, and less than 1% of the students have fee waiver as well as Education Trust Fund (ETF) (not used as input but has a correlation coefficient of almost 1 with fee waiver). On another hand, Cluster 2 has a mean PCI of S$296.82, demonstrating greater financial challenges as ~86% of the students were receiving financial aid.
- For residence status, all students living in rental block are clustered in Cluster 2, which also has ~85% staying in 4-room houses or below. While ~66% of Cluster 1 lives in 5-room houses or larger.

The results indicated a strong association between MTS students' academic performance in school and their socioeconomic background. The inability to perform well academically is the outcome of complicated interaction between many happenings in the student's life, and not solely because he/she is academically strong. Coming from a family with stable financial status means better access to learning resources, more conducive learning environment at home, parents have more time to accompany their children and many more.

Conclusion

Completing the MENDAKI pilot study is not a guarantee of the success of the full-scale study. However the pilot provided a better understanding of the phenomenon. The pilot has shown that the set of SES variables are key moderators of education attainment among Malay Muslims in Singapore. The pilot findings are also limited by the range of variables, there is a need to expand the variables to include other proxies of teaching and learning. The SES variables interfere with various factors that correlated with optimising educational performance. Future analysis should explore the impacts of socio-economic class on individual cultural capital, values and norms, conduciveness of home environment, time use, and access to external educational resources. It is quite clear that the problem of the under attainment of the Malay community cannot be solved by targeting only the students. This is indeed a difficult issue to tackle. It is inevitable that social and income inequalities will seep into the educational arena, resulting in a divergence of educational performance between more privileged students and less privileged students. It is important to understand the circumstance behind this phenomenon and the effects it has on educational attainment. While MENDAKI develops and enhances the MTS, there is a need to encompass a wider range student support that consisted of various types of educational, social and workforce development. Based on the pilot study's findings, the larger study adopted a sequential explanatory approach with a data mining phase where predictive analytics is applied to identify factors that influence as well as predict the academic performance of students in the MTS. This is followed by a qualitative case study approach with interviews and observations to better understand the impact of the SES variables.

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"Many hats one heart": A scoping review on the professional identity of learning designers

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Learning Designers are increasingly employed in universities to support institutional digital and pedagogical transformation agendas, which are posited to better meet the diverse and changing needs of a heterogeneous student body. Despite broad commitment to investing in these roles, surprisingly little is known about what learning designers in higher education actually do in practice. This paper reports on the preliminary findings of a scoping review that thematically analysed pertinent literature, to explore what is currently espoused about the professional identity of learning designers in higher education. The review identified 40 indicators of the knowledge, skills and attributes required of learning designers in the higher education sector. This research provides valuable insights for both individuals and institutions. The findings provide universities with an evidence-informed perspective of the learning designer, including an account of the unique capabilities of learning designers as transformative change agents to student learning. For individual learning designers the findings provide a comprehensive list of indicators to benchmark role responsibilities against, and a framework through which professional identity can be comprehended.

Keywords: learning designer, instructional designer, educational technologist, professional identity

Introduction

Who are learning designers? In a thematic analysis of 37 position descriptions, Mitchell, Simpson, and Adachi (2017) found a "significant overlap and/or disconnection between [...] TEL worker roles and their expected practices" (p.4). The skills and knowledge necessary for TEL workers such as academic developers and learning designers often did not reflect their job title - that is the primary practice of a designer was not to design (Mitchell et al., 2017, p. 4). Indeed, this ambiguity is reflected in the roles of the authors, with four of the five authors identifying as a learning designer, but only one having learning designer as their job title.

Building on a Mitchell et al. (2017) study, this paper aims to provide clarity and greater definition around the professional identity of the learning designer. It also aims to identify key skills, knowledge and attributes needed by learning designers to support teaching and learning within a higher education context. An initial scoping review, explored how the role of learning designers is reported in existing literature. The term 'learning designer' has been used to represent the work, in universities across the globe, undertaken by the roles associated with the job titles detailed in Table 1.

Literature review

According to the 2019 *Horizon report*, there is an increasing demand in higher education for "digitally rich learning environments and pedagogically sound learning experiences" that can be achieved by applying learning design expertise (Alexander et al., 2019, p. 15). The recommendations note that "institutions investing in learning designers […] will be better positioned to create rigorous, high-quality programming that serves the needs of all learners" (Alexander et al., 2019, p. 15). Consequently, learning design as an area of expertise that can have a direct correlation to the success of students is a warranted assumption. This sentiment was similarly echoed in the 2016 Intentional Futures report on *Instructional Design in Higher Education*, which claimed that "instructional designers have positioned themselves as pivotal players in the design and delivery of learning experiences" (Intentional Futures, 2016, p. 2). However, what is known of learning designers - their knowledge, skills and attributes – is limited.

According to the *International Board of Standards for Training, Performance and Instruction* (IBSTPI), learning designers require 22 competencies under five broad areas: professional foundations, planning and analysis, design and development, evaluation and implementation, and management. Most of these competencies relate to what learning designers do or know. It reignites the initial question: Who are learning designers? In this scoping review, we explored the professional identities of learning designers through a knowing-doing-being framework.

Methodology

This paper takes the form of a scoping review using the Arksey and O'Malley (2005) methodological framework. A scoping review is defined as "a form of knowledge synthesis that addresses an exploratory research question aimed at mapping key concepts, types of evidence, and gaps in research related to a defined area or field by systematically searching, selecting, and synthesizing existing knowledge" (Colquhoun et al., 2014, p. 1292).

The research question and sub-questions investigated are:

RQ: What is known in the existing literature about the role of the learning designer and their professional identity within higher education institutions?

1. What knowledge do learning designers in higher education need?
2. What do learning designers do in their role?
3. What attributes, values and qualities are required of learning designers in higher education?

Table 1: Key search terms

"learning designer" OR "instructional designer" OR "learning technologist" OR "educational designer" OR "educational technologist" OR "learning consultant" OR "teaching consultant" AND "higher education" OR university NOT school OR "K-12"

A set of inclusion and exclusion criteria was devised to establish some boundaries around this research (See Table 2). Four databases - ERIC, JStor, Springerlink and Google Scholar – were selected for this review as they were identified to be the most relevant databases for educational research.

Table 2: Inclusion and Exclusion criteria

Criterion	Inclusion criteria	Exclusion criteria
Time period	2008 – 2019	Studies earlier than 2008 or later than 2019
Language	English	Non-English
Countries	All	None
Type of article	Original research, literature reviews and conference papers, published in peer reviewed journals or conference proceedings	Articles that were not peer reviewed, opinion pieces, editorials and grey literature
Study focus	Higher education or university	Educational sectors outside of university or higher education
Literature focus	Articles focusing on the role of learning designers or aspects of their work	Articles that did not relate to the role and work of learning designers
Academic discipline	All	None
Databases	ERIC, JStor, Springerlink, Google Scholar	Other databases

The four researchers were grouped into pairs, each pair searched two of the selected databases and using the key search strategy outlined in Table 1 generated a primary list of articles. This initial search returned 4957 articles, which were subsequently sorted using an 'order of relevance' filter. The pairs then scanned the title and abstract of the sorted articles. Applying the inclusion/exclusion criteria detailed in Table 2, articles were then retained or removed from the list. No further articles were reviewed once a researcher found ten consecutive articles that did not meet the inclusion criteria. This secondary search resulted in 230 potential articles being identified. In the next search phase, the research pairs discussed the 230 papers and determined which papers should be included or excluded based on a more detailed application of the inclusion and exclusion criteria detailed in Table 2. Where there was a difference of opinion on whether an article met the inclusion criteria, full articles were accessed and skimmed before arriving at a consensus regarding inclusion or exclusion. After duplicates were removed, this search phase returned 51 articles. These articles were allocated to individual researchers to read in detail and ensure they met the inclusion criteria. This final search phase resulted in 26 articles being selected for inclusion in this scoping study. A search of the reference list of all 26 articles added an additional three seminal articles, which were referenced in a number of the papers, to the final review list.

The selection of 29 articles was analysed by the researchers who 'charted the data' or coded their assigned articles in an excel spreadsheet, identifying and recording preliminary themes that emerged from the literature (Arksey & O'Malley, 2005). The next phase of our research will involve the cross-check of the data with all researchers to further validate the themes, prior to writing up the final results.

Results and Discussion

To better understand the role of learning designers, we posit the existence of an intersection between Barnett's (2009) knowing-doing-being framework and theories on professional identity construction. Based on Barnett's framework, the following definition is proposed as a lens for discussing the role of the learning designer:

- **Knowing/To Know**: This refers to the learning theories, models, pedagogies and technical knowledge that is necessary for learning designers.
- **Doing/To Do**: This refers to the methods, skills and practical application of expertise that learning designers engage with in their jobs.
- **Being/To Be**: This refers to the attitudes, beliefs, values, motives and experiences that shape the identity of learning designers. This approach is both epistemological and ontological in that it reflects on the personal values of individuals and articulates the professional identity of a learning designer.

This preliminary scoping review resulted in the analysis of 29 articles from 10 countries. The majority of the research undertaken within the articles (80.0%) was conducted in North America, followed by Asia (13.3%) and Europe (6.7%). There was a noticeable absence of articles from Africa or South America. Of these papers, 28 were from peer reviewed journals with one being a peer reviewed conference paper.

The term *Instructional Designer* was the most common label assigned to this professional role (88.5%) with *Learning Designer* being the next most common (7.7%) and *Educational Designer* third (3.8%). It was surprising that the term *Learning Technologist* did not appear in any of the articles. According to Obexer and Giardina (2016), *Learning Technologist* is a term particularly used in the UK.

There was a broad distribution of papers across 15 journals. Of these, three journals (Journal of Computing in Higher Education, Educational Technology Research and Development, and Tech Trends) each contributed five or more papers to this study. Between 2008 and 2019, the greatest number of papers in a single year to be published was in 2017 (n9). The majority of papers were qualitative research (n15), followed by mixed methods (n5) and literature reviews (n5), with quantitative research (n4) being the least frequent methodology.

This research examined what is reported in the literature relating to what learning designers in higher education institutions need to know, do and be, to fulfil their roles. The literature reported on all three dimensions of this role. Our preliminary thematic analysis revealed that the concept of Knowing appeared in a significant number of articles (n19) while the Doing aspect appeared in all articles (n29). The Being aspect of a learning designer role was the least reported dimension (n11). From the 29 articles, the researchers coded 40 indicators relating to Knowing (n9), Doing (n26) and Being (n5). In this section, we will briefly discuss how these aspects relate to the role and professional identity of learning designers.

Knowing

The literature indicates that learning designers are highly qualified professionals with the vast majority having graduate qualifications, typically master degrees and increasingly doctoral qualifications (Campbell, Schwier, & Kenny, 2009; Cox & Osguthorpe, 2003; Ritzhaupt & Kumar, 2015; Shaw, 2012; Stevens, 2013). Our analysis of the literature revealed that the top three knowledge areas needed in the learning designer role were: instructional design and models (n13), technical knowledge (n13), and knowledge through professional learning (n13). Learning theories (n11) and educational research (n9) also ranked highly in the review. Through this analysis, three knowledge areas required by learning designers were identified:

- **Threshold concepts**: These include foundation in learning theories, instructional design principles and models, and knowledge of technology.
- **Just-in-time knowledge**: As the role of the learning designer is constantly changing (Obexer & Giardina, 2016), the analysis revealed that learning designers require knowledge regarding 1) answers to technical, pedagogical and learning environment problems, 2) updates and emerging technological or pedagogical underpinnings, and 3) discipline-specific content.
- **Contribution to new knowledge**: The analysis revealed that there is significant opportunity for learning designers to contribute to new knowledge by publishing research from their work (Obexer & Giardina, 2016). Learning designers often participate in or initiate research that results in conference presentations or writing of publications, often in collaboration with academic staff (Kumar & Ritzhaupt, 2017; Shaw, 2012). However, there are significant barriers to this form of knowledge creation for learning designers due to lack of time or skills (Obexer & Giardina, 2016).

Doing

The findings of the scoping review revealed that 26 of the 40 indicators coded from the articles, or 65 percent, related to what learning designers do and the skills they possessed to perform their role. This figure is significant as it suggests that the role of the learning designer within the broader literature is determined by what they do rather than know or be. Of the 26 indicators, course and assessment design (n18), providing expert advice (n15) and relationship building (n15) ranked the highest. Project management (n12) and digital asset management (n12) were also prominent in the papers. From a synthesis of the articles and indicators, what learning designers do was categorised under five themes:

1. **Course and curriculum design**: Course and curriculum design formed the largest part of a learning designer's role, including assessment design, course development and evaluation.
2. **Project management:** Learning designers required critical thinking skills, teamwork and time management skills to be able to support and manage projects within the domain.
3. **Professional development:** Learning designers were also required to provide expert advice and professional development for academic staff.
4. **Stakeholder engagement:** Being able to build working relationships between staff and students through good communication and consensus building skills was also part of a learning designer's role.
5. **Asset production and technical support:** Learning designers were required to be involved in asset production and management, and systems administration.

Interestingly, what emerged through the analysis was the lack of discussion around *contribution to new knowledge*. While it has been suggested in other literature (IBSTPI, 2003; Slade, McGrath, & Greenway, 2018) that the role of the learning designer is partly academic - whether in the development of pedagogy or educational technology - there is a mismatch between what learning designers do and the knowledge they require.

Being

Within the professional identity framework, 'being' was least referred to with only five indicators and five articles referring to each of these indicators. The indicators included having a shared vision (n5), being an influencer/connector (n5), establishing governance (n5), having leadership (n4) and being ethical (n2). This gap in what it means *to be a learning designer* identified in the articles may be due to the evolving role of learning designers, highlighting the need for the role to be agile, to develop with emerging trends, and to be prepared for a constant re-definition of the role's scope of work and competency requirements (Halupa, 2019; Obexer & Giardina, 2016; Ritzhaupt & Kumar, 2015). As Hokanson, Miller, and Hooper (2008, p. 38) have argued, "being a designer and acting as a designer, therefore, becomes more important than understanding what tasks a designer does". Hence, beyond exemplifying leadership through practices such as modelling the way, inspiring a shared vision, challenging the process, enabling others to act, and encouraging the heart (Kouzes & Posner, 2011), learning designers need to develop designer resiliency, which is not defined by the complexity of the role but by the ongoing challenges that come with the role in an ever-changing field (Stefaniak, Baaki, Hoard, & Stapleton, 2018). Based on the analysis, urgent research is necessary to validate the findings and inform the professional identity of learning designers, as the values, attributes and ontological perspectives of learning designers are implied or rarely articulated within the papers.

Conclusion

Learning designers are critical to the success of higher education institutions, especially in implementing and achieving digital learning and teaching reform agendas that have an impact on student success. Our preliminary findings highlight that globally there is a paucity of research being conducted into the critical role of learning designers within higher education institutions. Whilst much is known about what learning designers know and do as seen from the findings of this study, little is known about the professional identity of learning designers. As Ewing and Smith (2001, p. 16) assert, "[It is] impossible for us to separate out who we are from what we do: we bring our beliefs and our already acquired knowing and understanding to our practice. Being is embedded in our practice of doing and, through the doing, as practitioners we continue to become who we are." Therefore, if we are to move this profession forward, further research that seeks to establish higher education benchmarks for the entry to knowledge, skills and personal values, attributes and ontological perspectives required of learning designers working within the higher education sector is needed.

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Piloting Mobile Mixed Reality to Enhance Building Information Modelling Delivery in Construction Education

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With new building information modelling (BIM) workflows becoming required within the architecture, engineering and construction industry, more research is required to understand the best pedagogical delivery methods of this new spatial technology workflow. Mixed reality (MR) and mobile visualisation methods are identified as important technology drivers for rethinking higher education, practice driving learner engagement and spatial information delivery. This paper outlines qualitative results derived through thematic analysis of learner observation and reflections from a technology-enhanced lecture, and hands-on workshop focused on MR-BIM innovation within the construction industry. Forty-five (45) participants from a postgraduate construction course at an Australian University participated in answering the research question: “How do learners perceive the interactive visualisation mode of a presentation delivered through MR-BIM and mobile pedagogy?”. The results of the analysis identified two general themes (learning and technology) and five sub-themes (learning engagement, learning experience, technology experience, technology readiness and technology future). Students felt engaged during the session with observation supporting the reflective analysis evidenced by learners asking questions, commenting on technology possibilities and sharing of their experiences between peers, lecturers and social networks. More work is required on the delivery method, with only one-third of the reflections discussing the learning.

Keywords: virtual reality, augmented reality, mixed reality, mobile learning, BIM, AEC education

Background

Architecture, Engineering and Construction (AEC) projects are growing in scale and becoming highly complex; thus, the massive information and data in a project can be overwhelming if not managed properly. Compounding this are the governance requirements within the AEC industry for compliant buildings and optimised process and communication workflows requiring new and innovative technologies (Chan, Ma, Yi, Zhou & Xiong, 2018). With ever-increasing problem complexity and governance requirements within AEC, a disruptive technology, Building Information Modelling (BIM) has been identified as a tool to improve the efficiency of the management process, promote coordination, and collaboration among project participants enhancing project interoperability. BIM is an information and communication technology (ICT) that integrates multidisciplinary collaboration throughout the project lifecycle with many countries implementing measures to implement BIM into their public projects. Given this, there has been a rapid shift in the AEC education practice to integrate BIM into course content, which has led to difficulties in integration (Puolitaival & Forsythe, 2016).

This challenge is compounded with the learner’s expectation that they be engaged by their environment, with participatory, interactive, sensory-rich, experimental activities (either physical or virtual) (Jones, Ramanau, Cross & Healing, 2010) and higher expectations for input opportunities with individualised resources for productive and effective student outcomes (Sadler-Smith & Smith, 2004). Learners are characterised as more oriented to visual media than previous generations preferring to learn visually by doing rather than by listening or reading. This has resulted in a shift away from traditional face-to-face, didactic lectures and tutorials to self-direction, collaborative peer learning and technology-enhanced teaching and learning through multiple delivery modes and coding methods (Clark & Mayer, 2016). The 2019 Educause Higher Education Horizon Report (Alexander et al., 2019) captures this as a *Wicked* challenge impeding higher education, requiring a rethinking of the practice of teaching.

New mixed reality (MR) and mobile technologies are identified as important technologies and drivers for rethinking higher education practice and learner engagement (Cochrane, Smart & Narayan, 2018). Specifically, new mobile MR (MMR) visualisation is being explored within AEC design workflows (Birt & Cowling, 2018; Birt, Manyuru & Nelson, 2017) with positive usability results. However, currently, there is limited research into the effect that MMR workflows have within BIM education and how this can enhance and optimise the AEC industry. More detailed research is required in the design methods, simulation and communication, especially as it relates to BIM in construction education and integration for learners (Puolitaival & Forsythe, 2016).

This paper outlines the qualitative results of a pilot project to integrate MR-BIM and mobile delivery into a postgraduate construction subject using thematic analysis of the learner's reflective comments and observation on the technology-enhanced delivery method answering the research question: "How do learners perceive the interactive visualisation mode of presentation delivered through mixed reality building information modelling and mobile pedagogy?". Specifically, the learners where given a lecture on innovation within the construction industry focusing on the applied use of virtual reality (VR), augmented reality (AR) and artificial intelligence (AI) delivered using innovative MR technology and BIM models and then split into small learning groups for hands-on experiential learning with mobile VR and AR technology.

Methodology

The specific lesson was run in the first trimester of 2019 at an Australian University and involved 45 postgraduate participants from the construction course SDCM73-100 Professional Portfolio. The subject uses situated learning and encourages students to develop their professional skills in a real-world environment by combing self-analysis and reflective learning skills with professional methodologies, to expand analytic and strategic thinking capabilities as it relates to the construction profession. The students were given a 60-minute lecture (see Figure 1) on the impact of AI, VR and AR technology within the construction industry with a demonstration of HTC VIVE and HoloLens technology as it applies to the construction industry and BIM visualisation. Students were then asked to complete two hands-on learning tasks using mobile AR (see Figure 2) and mobile VR (see Figure 3) by exploring BIM models and real-world locations enhanced with the technology.

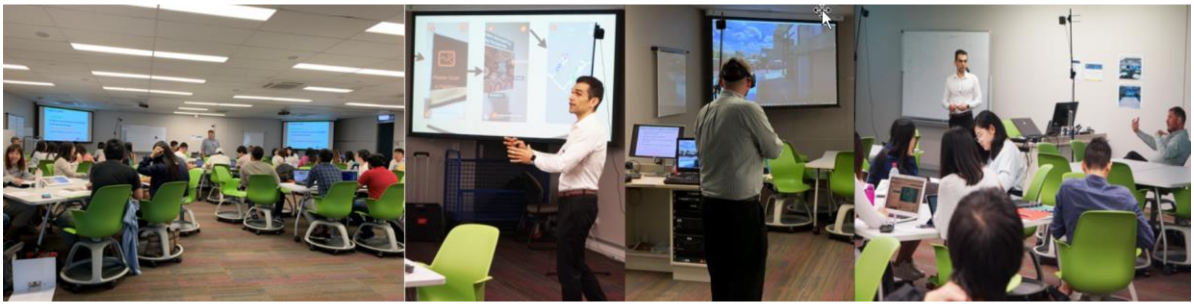

Figure 1: Future of work and impact of AI/VR/AR technology within the construction industry lecture

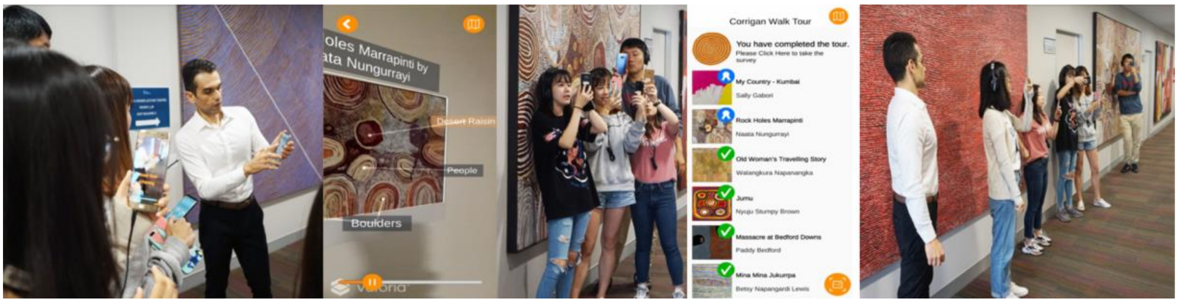

Figure 2: Augmenting the built environment place hands-on with mobile AR technology

Figure 3: Communicating the virtual built environment hands-on with mobile VR technology

For the mobile AR technology hands-on, we used an in-development, mobile app called *Corrigan Walk Tour* (Vasilevski & Birt, 2019). The app was built as an AR guide for the indigenous artworks collection at the learner's institution. This app was used as an example AR application for the students to understand the applied nature of AR within a built environment place. The students started the app with 5 minutes of onboarding, including detailed explanations on navigation, app objectives, and how to optimally use the app. We did not talk anything about the artworks or the indigenous culture, hence enabling the students to discover and learn this information by themselves individually through the app. The students were provided with Android Samsung Galaxy devices to minimise variation and headphones to prevent sound pollution and interference with any activities at the place. The tour was conducted to enhance the learners understanding beyond only the specifics of BIM construction data management to include factors around coordination, communication, design methods and simulation.

For the VR technology hands-on session learners were required to experiment with two mobile VR simulated experiences of a fictitious BIM built pavilion environment constructed in Autodesk REVIT. Students were provided with Samsung S8 mobile phones and Samsung Gear VR virtual reality headsets and 5 minutes of onboarding related to the task and hardware use. The first experience saw learners experiencing the virtual BIM pavilion as a single user where they could navigate the environment, and watch the simulated transition of the real time lighting across 24 hours. In the second experience, the learners were placed in the same BIM environment only this time it had multiuser connectivity and voice chat enabled. The users could watch their self avatars and those of their fellow students in the environment. The learners had the same navigation and lighting system in place. This allowed for enhanced communication between the learners and the affordances associated with multiuser environments such as agency, perception and peer learning.

Learners were given 20 minutes for the AR session and 10 minutes each for the single-user and multi-user VR, respectively. When students completed their hands-on tasks, they could also experiment with the HTC VIVE and HoloLens technology. Students were then asked to complete a reflective essay on the experience linking it to the construction industry, which was completed two weeks after the session.

We used a qualitative research methodology involving two methods for conducting this research study. We used thematic analysis (Braun and Clarke, 2006) to examine the written reflections of the students. We classified the student's ideas to closely define categories based on our research question "How do learners perceive the interactive visualisation mode of a presentation delivered through mixed reality building information modelling and mobile pedagogy?" and concurrently categorised the emerging themes and sub-themes. We also used participant-observation (Jorgensen, 1989) to collect data during the lecture and two hands-on sessions about the interaction with the software as well as the visible responses of that interaction. We also noted if any of the students required additional help or guidance to complete the tasks.

Results and Discussion

The results of the analysis identified two general themes (learning and technology) and five sub-themes (learning engagement, learning experience, technology experience, technology readiness and technology future). Only one-third of the reflections discussed the learning, and almost all of them focused on technology which will require more onboarding about reflective practice in the follow-up sessions.

Data shows that students felt engaged during the session. They wrote about being involved with the activity and receiving feedback while conducting it, "in terms of the educational application, this extraordinary tutorial is a perfect example of its use in teaching as it gives us a more direct feeling of the design as an end-user." "Interestingly, we can "walk" in this VR environment by moving our feet in reality, and when the audio function turned on, I could hear someone talking in the "white house". Another example of engagement is a student stating: "Moreover, I could press the button in the equipment to "go" to the place I was looking at, while I could see other users at the same time in the application in the multi-user mode, and even communicate with each other via the …headphones." All this is in line with Jones, Ramanau, Cross & Healing (2010) learner's expectation of participatory, interactive, sensory-rich engagement by their environment. Furthermore, all of the students enjoyed the session and had unique experiences: "It was wonderful experience… It was like dreaming and imagination.", "This week we had an amazing experience with …, regarding the topic of how VR/AR can be used in the construction industry and the future.", "AR and VR technologies can alter our senses of reality." Clearly the students enjoyed the shift away from traditional delivery to self-direction, collaborative peer learning and technology-enhanced learning (Clark & Mayer, 2016).

For many of the students this was their first encounter with this kind of technology: “That was my first time to experience the AR/VR glasses”, “Since I am a tech-oriented people and have heard a lot about virtual reality, I was so glad to have the chance to use this new construction technology in the class.” “This activity introduced to me my first AR experience which I did not know the concept before, while this activity showed me that how the AR technology applied in daily life with a mobile phone instead of any high-tech equipment such as Google glasses, meaning it is easy to access and understand this technology.”, wrote one of the students, stating the affordability and accessibility of the technology. Sadler-Smith & Smith’s (2004) higher expectations for various inputs and individualisation were at met to a high degree, which in turn affords for productive learning outcomes that are effective at the same time.

Students showed a positive attitude towards the technology, even though most of them felt that it is not ready for widespread use, stating that “…this new kind of technology is not fully developed and still need time to be applied widely in the construction industry…”, “Both AR and VR are still in the developing stage.” and that “it is still not “perfect” enough.”. “I am convinced that although the details of the AR/VR software are still not perfect, this advanced technology will be improved and finally can benefit the construction industry and make the process more convenient and efficient.”, said one of the students, predicting the usefulness of the future improvements of these technologies. Many students also believed in changes that this technology will bring in the future, such as “I believe that it is a trend of development and it will have a profound effect on the whole society…”. “I believe that VR/AR will become an essential technology in the future, and I would like to follow this technology and learn more about this technology.” This aligns with views of Alexander et al. (2019) and Cochrane, Smart & Narayan (2018) that illustrate MR importance in higher education practice.

The students also appreciated the many possibilities of useful applications of these technologies: “this advanced technology will be improved and finally can benefit the construction industry and make the process more convenient and efficient.”, “the future job opportunities in the construction industry would be changed by this technology. It is likely to require more IT stuff in the construction industry, as more things are involved in using VR or AR.” and “augmented reality and mixed reality, VR is set to become an integral part of the construction process from the architect’s office to the job site... AR/VR are one of the best technological advancements to happen in the construction industry because it streamlines every process involved in the project.”

Observation data supports the results from the analysis of the reflections. The students were engaged to a high degree within the activities, which is evidenced by them asking questions and giving various comments about the use and the possibilities of the technologies. The students were not afraid to express their enjoyment and excitement during and after the use of both technologies and share their experiences between their peers, with the lecturers and even the social networks. However, learners had many pre conceptions before the session that was reiterated by the course convener’s observation that stated, “Before the sessions most students believed that they already possessed some understanding of AI/VR/AR and their applications, but after using the technology most realised they didn’t have an understanding prior to the session”. Following the sessions, most students advised that their understanding of AI/VR/AR technologies and their applications had been significantly adjusted and improved. With students expressing that their preconceptions (particularly about the practical use of the equipment) were inaccurate prior to the session. It was also noted by the convenor that, “The authentic experience provided in the demonstration sessions was reflected in good knowledge retention compared to some other components of the subject.”

For the lecture the course convenor noted that “the enthusiasm and provocative presentation engendered strong engagement but for some of the [English second language] learners the amount of unfamiliar content and volume of information was difficult to process, leading to some engagement issues such as mobile phone use”. Some adjustment to the presentation sessions before the next offering will improve learning outcomes. During the VR hands-on, the observation showed that the learners were highly engaged and excited to use the technology. The single user experience ran smoothly with all learners completing the built environment navigation without assistance. The multiuser experience required several interventions with regards to the headphones and communication with the learners having to be prompted several times to communicate with each other. The focus which could be observed from a PC observer visualised in (Figure 3) projected on the screen noted that learners spent most of their time watching the avatars of the users and the movements rather than trying to communicate with each other. When communication took place it was more in relation to where the user was in the scene and the location to group together to see each other rather than specifics about the built environment. This will need to be adjusted in future iterations and supports the idea of very specific lesson scaffolding in VR environments.
For the duration of the mobile AR hands-on, observation showed that the behaviour of most of the students conveyed the impression that they were in the flow state and had an intense focus on the activity in hand. The students were completing the objectives of the mobile AR app in one take, without stopping or pause until the end

of the activity. Many students were going back and re-scanning the artworks looking for the hidden features. After the completion of the activity, meaningful discussions emerged between the students and also with the lecturer. These discussions were on the subject of the use of AR/BIM in construction and future applications.

Conclusions

The use of mobile MR and BIM in learning offers a supportive environment that compliments the learning outcomes by engaging the students and providing unique experiences throughout the learning process. The improvements in the learning aspect, improved attention, unique interactions, reducing the cognitive load and increased enjoyment are the core features of these techniques. Based on the results, we recommend further integration of these techniques in the courses offerings and delivery that will enable all these features for the learners in, and not limited to architecture, engineering and construction industry. The techniques should be adopted within the curriculum that will lead to enhanced learning environments and subsequently lead to better learning outcomes. For more conclusive results and more in-depth understanding of the benefits and optimization of the use of technologies to enhance learning, future works should also include longitudinal studies with larger sample size and comparison to a traditional delivery control group. That will investigate how the students' knowledge evolves in time influenced by using these techniques.

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One system to examine them all: Defining the complexities of implementing an institution wide online exam model

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A significant majority of universities have engaged in piloting or implementing technology enabled forms of examination (online exams) in response to increasing pressures on space, resources and the demands of scale. Informed by analysis drawn from a series of consultative workshops and interviews with over 120 participants including academics, support and professional services staff and senior management at the University of Sydney, this paper will explore the tensions and challenges arising from the institutional demand to determine the requirements for the procurement of a single online exam system to replace the current spread of disparate pilots across the faculties. Using pain points, alleviations and mitigations that are felt within the existing exam system, we will identify two tensions that increase in importance the further any system moves away from the dominant models of exam facilitation and marking using technology.

Keywords: online exams, assessment, institutional adoption of technology, technology enabled assessment

Introduction

Over the last decade, there has a been a significant interest by Universities in implementing online facilitation and conduct of examinations (Hillier & Lyon, 2018), which has been aligned with a strategic and pedagogical embracing of the wider suite of tools related to electronic management of assessment (Mayhew, 2018; Walker, Voce, & Jenkins, 2016). Considering the advancing technological landscape, opportunities for adopting technology in the implementation of assessment have become extensive and widely available through vendors (e.g. Cerimagic & Hasan, 2019; Wadley, Weaver, Curry, & Carthon, 2014). With the significant increase in student numbers experienced by many institutions creating issues of scale and sustainability for existing assessment practices, there is an increasing pressure to extend pedagogical processes and assessment to use technology and the devices students own themselves (Boitshwarelo, Reedy, & Billany, 2017; A. E. Fluck, 2019; Newland & Martin, 2016). Drawing on the insights gained from an extensive consultation exercise with academic and professional services staff conducted at the University of Sydney in 2019 (as part of the University approach to determining the feasibility of acquiring an online exam platform), this paper will interrogate some of the critical issues and challenges that emerge as institutions consider, pilot and evaluate the efficacy of moving whole or part of the exam process to an online environment, as an alternative assessment modality to the traditional pen and paper-based exam.

Contested definitions of online exams

Exams are a contested and increasingly ‘controversial’ mode of assessment in higher education, with an increased focused on considerations such as authenticity of assessment and the use of more progressive, iterative assessment models (see e.g. Williams & Wong, 2009). There is also considerable debate in the pedagogical literature about the future of ‘traditional’ exams in an authentic assessment environment (e.g. Rojas Serrano, 2017; Wren, Sparrow, Northcote, & Sharp, 2009). However, for many institutions and discipline contexts they remain the dominant form of assessment, that some authors assert are critical to ensuring academic integrity and honesty and offer a fair measure of student understanding and performance (e.g. McCabe, Treviño, & Butterfield, 2001; P. Singh, Thambusamy, & Druckman, 2016). In the context of this study, we did not evaluate the efficacy of continuing to use exams in our faculties, although authenticity of assessment and academic integrity are critical centerpieces of the University education strategy. If those issues came out during the workshops then that would form part of our findings.

Regarding online exams, the facilitation and conduct of exams using technology is not a recent concept, with some examples of the uses of computer mediated assessment dating back almost 100 years with references to and exhortations about the benefits and dangers of computer or electronic mediated forms of examination (McLuhan, 1970; Osler, 1913; Suppes, 1966, for example). In the modern era, there has been two narrative themes running parallel in the literature. The first takes a holistic or broad approach to defining technology enabled examinations broadly, whilst the second narrative defines specific constraints and boundaries to delimit their analysis to specific practices and approaches. *Table 1* summarises these two narratives through some of the critical studies in the area on online exams.

Table 1: Definitions on technology enabled examinations in the literature

Broad	**Specific**
'use of computers for testing' (Nardi & Ranieri, 2019, p. 1496).	*'a timed, supervised, summative assessment conducted using each candidate's own computer running a standardised operating system'* (A. Fluck & Hillier, 2017; A. E. Fluck, 2019; Hillier & Lyon, 2018).
'application of computers to assessment processes' (Davies, 2010, p. 56)	*'the use of any technological device to create, deliver, store and/or report students' assessment marks and feedback'* (Appiah & Van Tonder, 2018, p. 1454).
'the use of information technology in conducting assessment' (U. G. Singh & de Villiers, 2017, p. 164).	*'Electronic examination (e-examination) is intended to serve as summative (final) assessment - e-exam - in order to define the evaluation - grade - for a course' (Kuikka, Kitola, & Laakso, 2014, p. 2).*
'E-assessment (based on JISC, 2007) is defined as the use of information and communication technology to mediate any part of the assessment process' (Tomas, Borg, & McNeil, 2015, p. 589).	

As the purpose of our study was primarily organisational in that we were seeking to define the requirements of a technology enabled exam solution, the specificity of the types of device, the software or cloud solution or even the degree to which technology intervened in the process (owned by the University of the student) was not of critical importance. We focused on identifying the issues arising from how the current exam system was coping with significantly increased student numbers and a substantially more complex timetabling challenge resulting from student flexibility and unit choice, especially at an undergraduate level.

Context and methodology

In response to a growing slate of pilot projects testing various aspects of online exams using various commercial platforms across the University of Sydney, four faculties came together with the central Information and Communications Technology division and the Office of the Deputy Vice Chancellor Education to undertake a consultation process with academics, senior leadership and professional services. The aim of the consultation process was to identify staff pain points with the current exam system that might be alleviated by using technology to deliver exams, as well as identifying any potential benefits arising from the benefits offered by technology that could not be leveraged from pen and paper exams.

In early 2019, we ran a series of structured consultative workshops with the Faculty of Medicine and Health, The University of Sydney Business School, the Faculty of Health Sciences, and the Faculty of Science; each of which comprised of self-selected and nominated staff who had an interest or expertise in the conduct of exams. In total, 124 staff attended these four workshops which ran over three months. These workshops identified significant experiential and predictive insights into the conduct of exams at the University, all of which were recorded and then coded on the fly as part of a guided discussion and further analysed after the workshop. We used three broad categories (pain points that were alleviated through technology, pain points that were mitigated through technology and affordances that were created through technology) to help bring together the results of the consultation and provide a frame for better defining the problem that we were trying to solve by implementing online exams at the University. Each workshop allowed participants the opportunities to consider (through group and collective discussions) the issues with the current processes and procedures for exam-based assessment (both pen and paper, and online). As these workshops were based in faculties, the perspective of the people in the University that supported students in their learning was critical. We conducted one-to-one interviews with central services staff such as Disability Services, Counselling and Psychological Services and Indigenous Support Services to identify how practices such as reasonable adjustment for physical disability, the impacts of the digital divide and the capacity for technology to impact on mental wellbeing could be managed through the implementation of online exams.

The data from this project was collected primarily to inform the decision-making process at the University. This paper will use the aggregated and collective insights that arose from the coding of this data as the research question discussed here was not central to the consultation process explicitly (however tacitly important it became).

Moving away from central tendency – two tensions arising from differing schemas of online exams

As stated earlier, the purpose of this project was to interrogate the feasibility of procuring an institutional wide online exam system. We had hoped that these workshops would provide critical information to kick-off the procurement process with a business case outlining the benefits and costs of online exams. What emerged were more fundamental pedagogical and technological tensions that were centred on the absence of an agreed or shared understanding of what constituted an exam at the University. There was a lack of an agreed frame of reference or common rubric or typology influencing how the participants evaluated the effectiveness of exams in their disciplinary or functional contexts. As we commenced each workshop, we realised that our own understanding and definition of online exams was substantially different from those of the participants within and between groups. Each participant approached their engagement with the consultation with very clear experiences through which they defined online exams (either as the solution or the problem). Despite clear instructions at the start, vendor names and platforms were frequently mentioned by participants, sometimes conflating the functionality and benefits of online exams with those of a specific platform. Over the course of each workshop, participants narratives and stories weaved discontinuously between different pedagogical, operational and policy contexts, with participants within workshops often disagreeing that something was a pain point or even that it was part of the process of conducting exams. It was clear from the workshops that, like pen and paper exams, there are multiple modes of delivery embedded within the broad conceptual definition of online exams, much of which emerged from their lived experiences with specific platform or software or with a type or mode of exam (such as fully invigilated on campus, multiple choice tests, take home exams, open book exams, viva or oral exams). There was however, a dominant mental schema present in many of the workshops, represented by the traditional large-scale conduct of a ‘final’ exam, organised and ran by a central exams support unit, invigilated by people, with all students undertaking the exam at the same time under examination conditions.

When we pressed the participants on different modes of online exams; the further the discussion moved away from the modes of online exams that replicated their mental schema of a final exam, the more diverse and disparate their understanding and perceptions became. In some ways, the participants were anchored by their central perceptual tendency, where if pushed into concepts or frames they were unfamiliar with, they reverted back to interpreting or modelling their understanding through their own experiential schema or through the common attributes of the schema they shared with others (an example is the way academic integrity could be used to explain the entire exam process from design to marking and feedback). In the context of the challenges outlined earlier, the identification of a single institutional system in this context is problematic at best.

The consultation process exposed some of the tensions and complexities arising from how an institution might determine and evaluate the requirements and benefits that can come from implementing a single institutional system for online exams. The first of these tensions was that participants focused on the lowest common dominators of exam conduct as a way of finding common ground between their divergent experiences and knowledge. The only way the participants could imagine how a single institutional solution for online exams would work, was to evaluate the requirements of any potential system through the lens of these common but generic requirements that would need to present in any online exam systems (such as proctoring and invigilation, marking and feedback and the notion of typing exams instead of writing). This meant that participants found it difficult to imagine or predict the innovation, enhancement or transformation of exams using technology

The second tension was explicitly raised by the staff who supported students to participate in exams. The further discussion moved past the use of fixed computers in synchronous delivery modes to conduct exams, they believed that their capacity to support students requiring reasonable adjustment for disability (such as extra time for the exam, writing support for those with difficulty using their hands or assistance for those with visual impairment, for example) became increasingly compromised. Similarly, when BYOD was raised as a mode of online exam, they noted that students from low socio-economic backgrounds or indigenous students may have financial difficulties in purchasing devices which operate at standards equal to the market leading devices. This digital divide was also evident in the increasing technological complexity and expertise required to engage with vendor owned platforms, install bespoke software or engage security or integrity protocols such as locked down browsers at a student or institutional level.

Conclusions

Two critical factors for how institutional systems are evaluated in higher education are how well it integrates with the other University systems and how effective is it for its designed purpose across all the complex ecosystem of faculties, disciplines and student profiles. As Martin Weller pointed out in 2007 discussing the Virtual Learning Environment, institutions are faced with two choices '…The first is to develop a system
that is broad enough to meet the needs of all students, and the second is to develop a range of tools that meet the needs of specific audiences' (Weller, 2007, p. 9). This project was initiated because the University identified between six and ten separate online exams projects running in small contexts across the faculties. None of them were centrally funded or supported, there was little practice sharing between projects and no explicit consideration of scale or transferability. The default position in other learning technology systems such as the VLE and the lecture recording system is do as Weller suggests and find a single system, whereas the practice on the ground defaulted to the second option he proposes. The challenges of identifying an institutional wide online exam at the University of Sydney were manifestly clear in our data..

Where we were unable to elicit an explicit exposure of the mental schema used by respondents to evaluate the relevance and criticality of the pain points with the current exam systems (either pen and paper and/or technology pilots) there remained the possibility that these images were sticking points for any potential institutional solution. They would represent evaluation hurdles that may be very difficult to define and challenging to expose to any procurement process, with any solution having to be a perfect fit for the unexposed mental images of online exams. Another complexity that arises from these schemas is that they may limit the ambition of what is possible through the deployment of an online exam solution. By that we mean that any system might be considered through the lens of how it provides replacement opportunities for students and staff (replacing handwriting with typed scripts), or enhancement opportunities (such as affording more authentic use of multimedia, images or sounds for example) or truly game-changing opportunities where the whole notion of exam based assessment is challenged and transformed through the use of technology (the use of AI, machine learning or gamification for example). The one size fits all mantra of both procurement and the single vendor solution can struggle to provide for all of those opportunities simultaneously, once again leading the determination of operational requirements to be defined at the level of the lowest common denominators rather than in the framework of aspiration and transformation.

The tensions between delivering a system that can be realistically implemented within the ICT infrastructure, delivering within budget and with a reliability and security expected of critical University systems and the pedagogical requirements of a diverse, multi-disciplinary university are demonstrable and real. The compromises that need to be made between pedagogical and educational ambition and the realities of the one system to examine them all significantly impact on the ambition and benefits that can be realised from transitioning between the existing pen and paper system and online exams. These tensions may also open up new and challenging issues around contract cheating, the integrity of the degrees we award and how we best support widening participation and student achievement and retention in our programs. In the forest of vendor solutions, feature promises and collegiate testimonials, can we as an institution identify what we actually want from an online exam solution, identify what we are going to want in five years' time and whether any solution presents a roadmap to get there?

It will be a critical challenge for the next phase of research (expanding the interviews to other institutions and to students) to be able to better identify the explicit assumptions and mental schemas residing in the perceptions of key decision makers in institutions. One important missing voice in this first stage was that of the students. It will be a key question to address going forward to identify what benefits and affordances emerge for students as universities move to online exams. There is potential for the same tensions to emerge, but perhaps not necessarily around the conduct of online exams but in their own lived experiences with the tools and technologies that facilitate online exams (experiences of laptop batteries running out, Wi-Fi connectedness difficulties or privacy and security concerns, for example) and their own self-efficacy in terms their confidence with the use of technologies to facilitate exams.

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Engaging students in a wide-scale educational technology implementation: Investigating student attitudes

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University-wide implementations of various technology teaching tools have been occurring for many years. Often staff are trained in using the tool and students are thus required to use it in various ways in their courses and for assessment purposes. This paper outlines the implementation of a university-wide ePortfolio platform, PebblePad, and investigates student attitudes one year after its introduction. Although students are still getting used to the platform, they are learning to accept the tool and are using it in various ways in their courses to support their learning. Results also show numerous ways students can get support to use the platform and the types of assistance provided. It is hoped students will accept PebblePad in the future, learn to be less critical and that deep learning can continue to be supported. In conclusion, PebblePad is a wide ranging ePortfolio system that can, when used well, support student learning in a large variety of ways.

Keywords: ePortfolio; attitudes; technology implementation; adoption; feedback; PebblePad

Introduction

In the past ten years it has not been uncommon for universities to implement an ePortfolio system across the institution (Hains-Wesson, Wakeling, & Aldred, 2014; Lambert & Corrin, 2007; Slade, Murfin, & Trahar, 2017). It is also noted that Faculty and program adoption is also common (Parange, 2017; Perlman, Ross, Christner, & Lypson, 2011) as a different approach. Griffith University is a large Queensland university with 47,260 students across five campuses (Griffith University, 2017) with an implementation that involved students and staff in courses and programs from all four Academic Groups across the university. The implementation, using the software platform PebblePad, has been reported previously (Blair, Campbell & Duffy, 2017; Campbell, Bourke, Trahar & Nisova, 2017; Campbell, 2019) and involved using a multi-pronged implementation approach through an Innovators Program (Blair, Campbell & Duffy, 2017) that involved academics implementing the ePortfolio system into their courses and potentially across programs. Over 100 academic innovators participated in the first year of implementation which suggests the program was successful as it was the largest implementation of its type at the university. In its second year, training through a variety of ways, such as central workshops as well as more specific workshops for groups of academics, continued to encourag staff to use PebblePad in meaningful ways in their teaching to promote active learning (Campbell, 2019).

This paper thus reports on the student attitudes in using PebblePad during the second year of implementation, which means many students were exposed to it in the first year of implementation and were also using it in a variety of ways in the second year. PebblePad is a unique platform that is more than just an ePortfolio system as it that allows students to gain deeper and more authentic learning than previously with other online tools. The tool can be applied to a wide range of learning contexts and it can support both individual learning activities and group learning activities. It also has capability to support assessment through the submission of work using a system called ATLAS (Pebble Learning, 2018). The overall implementation was very much tied to employability and evidencing student successes while at university (Author., 2017).

Literature Review

In universities today it is becoming increasingly important to provide students with rich, hands on and authentic learning experiences because students "learn by experiences, doing and creating, demonstrating newly acquired skills in more concrete and creative ways" (Adams Becker, Cummins, Davis, Freeman, Hall Giesinger, & Ananthanarayanan, 2017). It is also recognised that students are increasingly active contributors to their learning (Adams Becker et al., 2017) and as such platforms such as PebblePad are increasingly important in contributing to the student learning experience. Studies suggest that students who are exposed to active learning report greater retention of course material for both the topics presented as well as the whole course material (Bennett, Agostinho, & Lockyer, 2017; Miller, McNear, & Metz, 2013; Smith & Cardaciotto, 2011). Research suggests that in order for teachers to use new technologies in their teaching it is more likely to occur if the tools can be connected in some way to their existing practice (Bennett et al., 2017).

Fostering student learning

One definition of ePortfolios is that it is a digitised collection of artefacts that can include various items such as demonstrations, resources, and accomplishments that represent either an individual, or a group, or even an institution (Lorenzo & Ittelson, 2005). This can be beneficial for student assessment tasks that require various types of artefacts. One study based at Griffith University with accounting students suggests students showed positive attitudes towards ePortfolios with regards to being able to critically reflect and engage in their learning (Bodle, Malin, & Wynhoven, 2017).

By using ePortfolios, such as PebblePad, students are able critically reflect "on one's learning and for compiling and demonstrating evidence of learning and skill development" (Krause, 2006, p. 1). This also allows students to make connections through their learning experiences which can then enable the transfer of knowledge and skills to other contexts (Penny Light, Chen, & Ittelson, 2012) in the future. Thus, in this instance students are able to better able to apply their knowledge to their learning situations in the future. The tool also allows students to go back to think about what they have learnt, thus helping with their memory as well. One study to assist with critical reflection using ePortfolios reported positive results when using various classroom strategies to help students (Jenson, 2011). This included innovative use of in-class questioning to allow students to reflect on why they were learning this and how this will assist their studies.

From the literature review the following research questions ware developed:

1. In what ways are students using PebblePad in their courses?
2. What are student attitudes when using PebblePad in their courses?

Methodology

After gaining ethics approval for the project via a university-wide process, all students using PebblePad were emailed an invitation to complete a survey with 12,634 students being emailed towards the end of Trimester 1, 2018. With a six percent participation rate, 747 students participated in the survey. It is important to note that not all students completed every question and as such the response rate for individual questions varied. It is also worth noting that with such a low response rate it may be that students who completed the survey felt strongly in either the positive or negative and completed the survey in order to strongly voice their opinion and it may not be the opinion of the majority of students. Students who completed the survey were predominately female with a 68.8% response rate with a small number of students who identified as 'other' 1.2% (n=9). The rest of the respondents were male with 30% (n=211). There were 45% (n=320) students who completed the survey who were less than 20 years old with 24% (n=168) who were 21-24. Less than 10% of students were in each of the older age categories with 5.25% (n=37) who were 50+ completing the survey.

Survey questions included demographic data including which courses PebblePad was used in as well as Likert scales on beliefs about using this platform in their learning. Importantly, the students were asked for the ways they used it plus who they asked for assistance in using it. Students were asked questions about self-reflection and employability as well as open ended questions such as what they found worked well and how it could be improved. The two open ended questions were coded for emerging themes using coding software with 450 responses with positive and valid comments. For the final question, onwhat could have been improved, there were 406 responses that were valid improvement comments.

Results

Students were asked in what course(s) they were using PebblePad. Students across all four academic groups (n=709) report using PebblePad, which shows the implementation is widespread. Usage includes most of the Schools in the academic groups and across many of the programs across the university, so the data is not just from isolated courses or disciplines. In June 2018, there were 20,145 unique active users and as such it is well embedded across the university which has 47,260 students (Griffith University, 2017) and almost 5,000 staff.

Students were asked how they used PebblePad and were given a large checklist which they could check as little or as many items as they wished. Many students (n=442) used it to submit a 'shared' assessment, complete a required template (n=265) or reflect on their learning (n=257). Other students used it as a learning journal (n=144) and to receive feedback from teaching staff (n=138). Some identified uses were not used much by students at all, including sharing work with potential employers (n=7). Figure 1 gives a breakdown of identified uses.

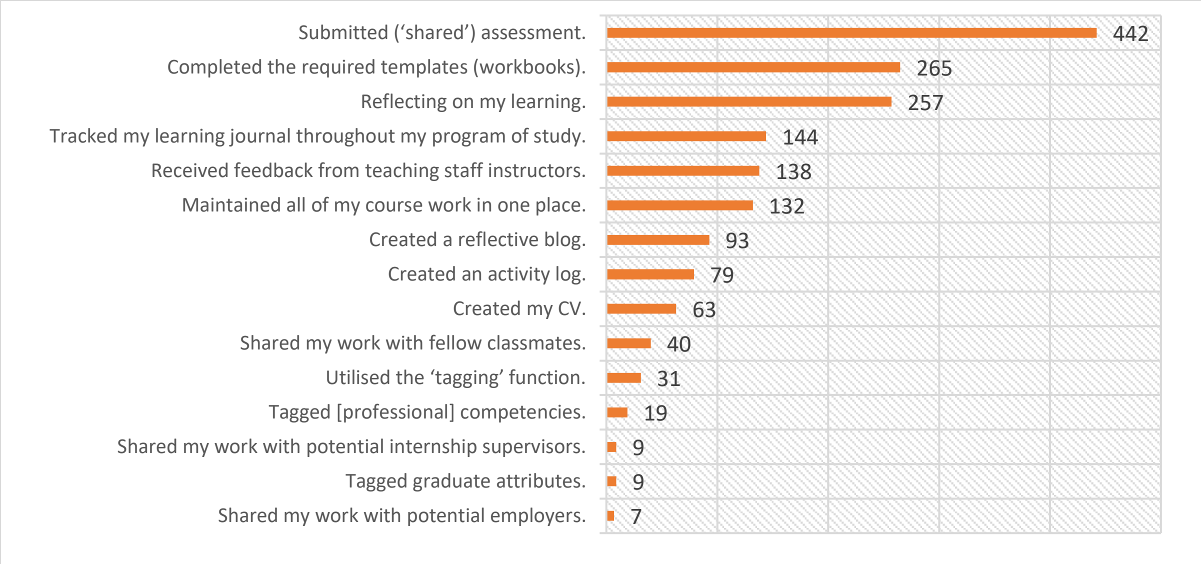

Figure 1: Ways of using PebblePad (students were able to check more than one use)

Results show that the majority of student use of the platform links directly to their course activities. There were also a small number of students who used this platform to engage with opportunities for their career development, professional networking and promotion, outside of the learning requirements including tagging of graduate attributes and professional competencies as well as sharing with potential supervisors and employers. This indicates that students' attitudes towards the platform was that it was useful beyond their course requirements.

To get familiar with the tool, students report predominately working it out themselves (n=279), as well as utilizing the self-help materials provided online from the university in their Blackboard course site (n=245), while other students report asking their peers (n=169). Figure 2 shows the ways students report gaining assistance in using PebblePad with 647 students completing the question, with some selecting more than one as there are 1364 responses. Feedback from the survey also indicated that some tutors or instructors provided time to learn the tool in class and responded to queries via email. Few students indicated that they took advantage of the central IT and Library support teams.

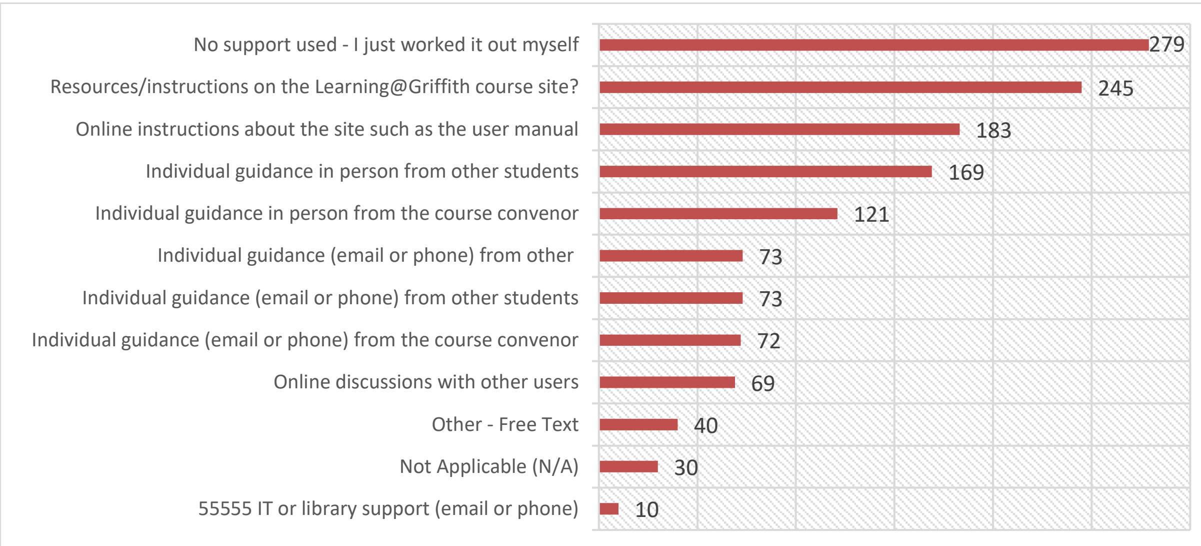

Figure 2: Ways of gaining support when learning to use PebblePad (could select multiple responses).

Students were given an opportunity to comment on what they found worked well with PebblePad in their courses with there being 450 comments overall. With regards to 'assessment' there were 70 comments. One student commented that using PebblePad as a tool *"making a foundation of my knowledge to help in assignments"* was beneficial, while another reported *"I found using PebblePad helped to connect lectures with tutorials and then remind myself of the learning for assessments*". Another student commented on the technical advantages of using PebblePad by stating *"The fact that you could submit something for assessment but still work on it and it would get updated on the other end so it saved the fact of having to submit a file into a submission folder taking up time and avoiding technical troubles"*. There were 207 positive comments on 'ease of use'. With so many positive comments it suggests that some students' attitudes were quite positive about using the platform. While some students commented on their ePortfolio specifically about the layout and ease of using it visually with one student suggesting *"I think being able to customise the layout of your PebblePad and being able to easily include pictures and videos and links to support what I was saying made PebblePad a very useful tool for learning and presenting"*.

Another student commented on the functionality of the ePortfolio in a positive way *"I like being able to easily switch between workbooks, being able to preview my work and reminders to save every 10-20 mins"*. There were 31 comments about the 'templates' with one student commenting *"Was useful in completing the workbooks and having everything together in one place. Can look back on work and find old resources"*. Comments such as these suggest that students were engaging with the platform to make the most of the available features. Student comments about investing their time in making PebblePad work also provided valuable feedback to the system admin and vendor via their comments.

However, not all students report liking using the platform in their courses with some students commenting on what could have been improved. These include areas such as editing functions with 116 comments, navigation (n=110 comments), the look and feel and the structure (n=91 comments), training and support (n=61 comments), learning design (n=34 comments) and submission (n=19 comments) amongst others. One student commented on the navigation when s/he said *"I found some things slightly confusing in terms of accessing different functions, however I think that might just been because I was using it in a hurry and for the first time too. So, when I went back to it, I found it very accessible and functional"*, while another student suggested simplifying menus into *"Workbooks and Portfolios without all the clutter of every single document you have added. Having the marking rubric imbedded into each workbook page. Make things like finding feedback on assignments on the actual workbook page"*. Some suggested areas of improvement are around functionality and editing including this comment *"The text boxes glitch and make it impossible to click into a paragraph you have already written without overwriting your work"*. Although there were some negative comments, as reported above, not all students reported negatively about their experiences and some students found it very useful to complete their work in PebblePad.

Discussion and Conclusion

Although PebblePad is used as an ePortfolio system and more across the university in all Academic Groups and most Schools, the students do not always appear to like the platform, with some being critical of it in its first years of implementation. As the platform developers are continuing to work to improve the functionality of PebblePad, and through continued use it is hoped that students will accept PebblePad, much like Blackboard and other learning management systems that students are required to use. Based on the comments from students, they need a clear purpose when using a platform like PebblePad as it has so many various uses and features. Continuing to promote the benefits of an ePortfolio platform such as PebblePad will hopefully allow students to discover its benefits throughout their programs and beyond. This may help to change and improve student attitudes to using PebblePad in the future.

Results also suggest students need clear guidance on how, when and why to use PebblePad to give them confidence in using the tool for their course and/or tasks. Contextual orientation or introduction sessions, written instructions and instructional videos were noted as positive. It is recommended academic staff continue to use these support materials, both created and supplied. It may also be effective if the students are provided opportunities and structure to support each other in their use of PebblePad. As they are likely to 'figure it out themselves' or with their peers, it would be beneficial to tap into this as an opportunity for them to develop skills and confidence.

Teaching staff can perhaps assist students further by structuring the workbooks and activities in PebblePad so that they are well thought out and provide relevant support material easily accessible to students. Based on the negative comments in the results, it may not have been the platform per se that was the negative experience, but large

convoluted workbooks or lack of instructions and purpose that frustrated the students when using PebblePad in their courses.
As shown above a large number of students across the university use PebblePad to enhance their learning. Students also use PebblePad in a large variety of ways to support their learning such as submitted assessment tasks, completing scaffolded work via templates, and reflecting on learning. It is hoped to continue this research in the future to gain further insights into student attitudes of the platform and how they are changing.

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Enhancing Learning of System Modelling through 360^0 Virtual Reality Video and 3D Printing

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New technologies like 360^0 virtual reality videos and 3D printing are creating philosophical shifts in approaches to teaching and learning in the classroom. However, most studies isolate new technology rather than study the benefits of using them in combination. Multiple representations support a variety of learning activities especially when students are learning new concepts or complex ideas. This study explores the blending of a 360^0 video-case study with 3D-printed haptic manipulations to enhance learning of ICT systems analysis and design. We hypothesize that the blending of both the virtual and physical can lead to improved learning motivation, engagement and enhance learning outcomes. The study follows a design-based research (DBR) methodology with this paper representing the second loop of the DBR approach focusing on both the usability and learning outcomes from a sample of 24 participants from an Australian University. The results of the study show positive impact on the measure of navigability and communication when compared to a traditional lesson leading to improved engagement and motivation among the learners.

Keywords: system modelling, ICT education, 360^0 video, 3D printing, design-based research.

Background

Innovative new technologies such as virtual reality (VR) and 3D printing are not just altering the field of education for students, they are shaking up the role of educators and creating philosophical shifts in approaches to teaching and learning (Becker et al., 2018). There is growing interest in 3D immersion and VR applications, especially 360^0 VR videos where students can dive themselves into an immersive playback experience (Hosseini & Swaminathan, 2016). The use of visualization such as VR has provided an opportunity to present essential learning content for students using multiple visual representations. For example, when a written narrative fails to communicate a concept or a given problem, a visual representation can potentially remedy the problem and facilitate understanding (Sankey, Birch, & Gardiner, 2012).

Likewise, there is an increased growth in the use of 3D printing within education afforded by the accessibility of printers and the benefits such as creativity and manipulation (Buehler, Kane, & Hurst, 2014). 3D printing has been utilized to support learning in a range of educational and training contexts. The human sense of touch is a dynamic, informative, and convenient perceptual system to connect and construct meaningful understanding (Lederman, Klatzky, Morgan, & Hamilton, 2002). Interactive and hands-on learning environments are considered as promising strategies for providing instructional content that allows the learner to engage actively in the learning process (Jones, Minogue, Tretter, Negishi, & Taylor, 2006). However, most studies explore each of these innovative technologies in isolation. Multiple representations support a variety of learning activities and unique benefits when students are learning new concepts or complex ideas (Ainsworth, 2006).

For example, studies involving multiple mixed media visualizations have been used by paramedics to train lifesaving skills (Birt, Moore & Cowling, 2017) and within architectural design-based education to assist with spatial learning (Birt & Cowling, 2018). The use of technology and haptic representations can provide an array of visual information and feedback. In addition, the importance of using a framework as a sequence of learning activities has a significant role in ICT system modelling (Muñoz-Carpio, Cowling, & Birt, 2018). Visual literacy skills are important elements in education and their development is one of the main goals of technology education (Verner & Merksamer, 2015). An essential question that arises from this study is how 360^0 visualization and 3D-printed tools can be used as a connecting part to improve learning motivation, engagement and advance students' learning outcomes.

Methodology

The aim of this research is to investigate the learning engagement and motivation using a 360^0 video and enhanced learning modelling when adding 3D-printed components in a System Analysis and Design (SAD) context. The research intervention adopts the design-based research (DBR) hybrid approach proposed by (Muñoz-Carpio, Cowling, & Birt, 2018) when investigating learning performance and engagement in SAD. This methodology, '4C' (derived in the first DBR loop), that show an iterative process (see Figure 1), proposes a set of connected activities established with the purpose to enable requirements understanding, solutions and incremental modelling development. This method guides students with pathway support to build a model by following four steps (Conceptualization, Connection, Construction and Consolidation)

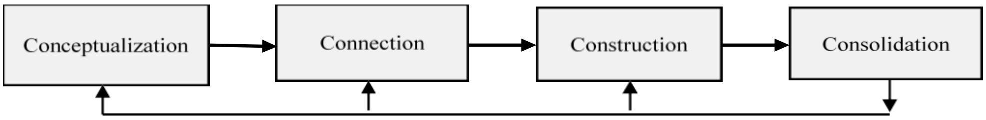

Figure 1: 4C Framework adapted from (Muñoz-Carpio, Cowling, & Birt, 2018

In the second loop, twenty-four, *(n=24)* first-year student participants currently enrolled in an information technology program were recruited as volunteers from an Australian University who enrolled in a SAD unit. Ethics clearance was granted for this study before running the experiment. All participants received a short lecture PowerPoint slide highlighting the 4C framework that provided a visual overview of the process to model their system as shown in Figure 2. A demonstration of the experiment with the tools and a usability assessment survey was also outlined.

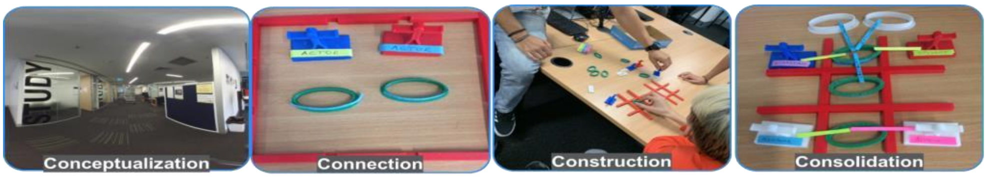

Figure 2: Visual overview of modelling mapped to 4C framework

Learning Intervention

The second loop of the DBR experiment represents virtual and tactile elements to enhance students learning of system modelling. This follows loop one usability testing, that provided feedback for evaluation and solution implementation following the DBR methodology. All participants were imparted system modelling theory highlighting the process of constructing a system model. The students participating have a technological line competency in using unified modelling language (UML) before starting the experiment. All participants were assigned a code to be used in the test for results traceability and informed of the experiment in line with ethics. Prior to the intervention, students were administered a pre-test exam to determine level of knowledge about use cases and UML syntax to define a baseline competency.

The participants were assigned to one of the two conditions (experimental and control). Twelve participants, *(n=12)* were randomly allocated to work under a control group condition (CG) and twelve, *(n=12)* under the experimental group condition (EG). All students were provided their assignment stimulus with a scenario involving library management and booking systems, but the method of delivery was different for each group.

The CG participants were given a standard printed case study, paper and pen to create a 'use case' model. Learners in this group were assigned with the same case study as the EG but as a narrative written case. CG students were required to identify users and use cases to make connections and construct a present a system model. On the other hand, the EG was given a box containing 3D-printed components (syntax), a set of instructions and a Google cardboard type with a smart phone ready to be used for the 360^0 video to be watched. The use of a virtual scenario provides an ocular explanation of a system environment in a real-world setting and the addition of tactile 3D-printed syntax address opportunities to represent a system that can be manipulated and visualized.

The conceptualization step in the EG, allowed students to immerse themselves into a virtual case study ‘library management and booking system’ to experience the scenario and conceptualize the elements of the problem domain. The aim of virtual immersion is for learners to extract symbolic information from the real-world scenario rather than reading a narrative and to promote analysis motivation and visual engagement. In the second step - connection students identified actors and activities in a checklist fashion using 3D components that represent actors and activities that presents the syntax for system modelling UML. This activity can be presented as puzzle-like pieces as part of the preparation of the intervention. In the third step - construction, the initial construction of the structure of the models is represented using UML for modelling using puzzle pieces that do and do not join. This phase provides a conceptual understanding of connection and process of construction meaningful understanding reflected in a system model. Connections have made between actors and use cases form the basis of the entire system’s use case model. The final phase - consolidation follows the construction phase where students have connections made between actors and use cases representing an entire and informative system. This phase assisted the learner with model abstraction from the real-world scenario and support learning with a visual and tactile learning method.

Results

We investigated the impact of presenting a case study using a 360^0 video, supported by using physical 3D- printed tools to assemble a system model. A paired *t-test* was run to determine whether there were statistically significant usability aspects. These results help determine what are the most important pedagogical advantages of using visual enabled multimodal learning for system modelling, specifically focused on learning use case modelling. The authors understand the low power of the sample size, but this is in keeping with early stage usability testing. Table 1 presents the results of paired sample *t-test* for the two conditions performed for the CG and EG of the usability measure. Each measure was ranked on a Likert scale from 0 to 5 with 0 representing not relevant and 5 representing very relevant. Results of the usability test were analysed using SPSS v25. Table 1 display the results of the paired statistics.

Table 1: Usability Test - Paired Samples Statistics CG vs EG

Assessment measure	Mean	Std Dev	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	t	p- value	
Accessibility	0.867	0.834	0.215	0.405	1.328	4.026	0.001#	
Learnability	0.467	1.246	0.322	-0.223	1.157	1.451	0.169	
Efficiency	0.267	1.486	0.384	-0.557	1.090	0.695	0.499	
Satisfaction	0.267	1.100	0.284	-0.342	0.876	0.939	0.364	
Memorability	0.600	1.298	0.335	-0.119	1.319	1.790	0.095	significance at 0.05 =*
Error Free	0.933	1.280	0.330	0.225	1.642	2.824	0.014*	
Manipulability	1.000	1.512	0.390	0.163	1.837	2.562	0.023*	
Navigability	1.200	1.373	0.355	0.440	1.960	3.384	0.004*	
Visibility	1.000	1.363	0.352	0.245	1.755	2.842	0.013*	significance at 0.01=#
Real-world	0.733	1.534	0.396	-0.116	1.583	1.852	0.085	
Communication	0.600	0.910	0.235	0.096	1.104	2.553	0.023*	
Creativity	0.933	1.163	0.300	0.289	1.577	3.108	0.008*	
Engaging	0.867	1.187	0.307	0.209	1.524	2.827	0.013*	
Motivating	0.867	1.457	0.376	0.060	1.674	2.303	0.037*	

The paired sample is used to determine whether the mean difference between two sets of observations is zero and measure the performance of the students’ sample before and after completing the intervention. Two competing hypotheses are measured under the paired *t-test* sample, the null hypotheses (H_0 = the intervention has no positive effect on the assessment measure) and the alternative hypotheses (H_1 = the intervention has a positive effect on the assessment measure). The null hypothesis (H_0) assumes that the mean difference is equal to zero and therefore confirming the hypothesis. Alternative hypothesis assumes that the mean difference between the paired samples is not equal to zero. In our case results are not zero, confirming H_1 hypothesis. Significance of the results is determined by the p-values.

Table 1 shows the usability measures outcomes of the significant and non-significant results of the user-centered interaction. The results of the use of a 360^0 video as an educational tool fundamentally helps increasing students' motivation and engagement. This preliminary result of the usability test as hypothesized show that the intervention has a positive effect on engagement and motivation. These results suggest that the use of a spherical 360^0 video is also significant for the intervention on accessibility, error-free, manipulability, navigability, viability and communication as it provides an added layer of facilitated interaction for individuals and between students. These results show statistically significant on the <0.050 alpha. Positive results on the accessibility (significant on the <0.010 alpha) can be associated to the ocular 360^0 interaction and consequently students' navigability and visibility that leads to engagement to the task and motivation providing a foundation for learnability when incorporating 3D printed components.

Table 2 presents the results of the plot from eight questions related to SAD domain asked to the participants. The table display the median, quartiles (Q1=lower and Q2=upper) of a data set results showing the values. Questions asked referred to use cases standards, notations and concepts. In the pre-test, the comparative groups, under the experimental conditions, the results have slightly different distributions of the results in the mean, 2.91 and 3.88 respectively. In the post-test, under EG, the results are higher (mean = 6.33) compared to the CG (mean=5.166).

Table 2: Pre and Post testing performed on two groups showing outliers

Data Summary									
Groups		N	Min	Q1	Median	Q2	Max	Mean	SD
Pre- Test	CG	12	1	2.75	3	3	5	2.9167	0.9962
	EG	12	2	3	4	5	5	3.8333	1.1934
Post- Test	CG	12	3	4.75	5	6	7	5.1667	1.1934
	EG	12	4	5.75	7	7	8	6.3333	1.1547

Table 3 presents the data results after removing atypical data value(s) that are notably different from the rest of the data (outliers) to reduce the impact of variance of the results (max 8 points). One student has been removed from the CG and two from the EG condition. The results of the pretest under both conditions shows a median value of 3 and median results of the post-test 5 and 6.5 for the CG and EG respectively. The comparative results indicate that learning in the post-test has increased compared to the pretest.

Table 3: Pre and Post testing performed on two groups with outliers removed

Data Summary									
Groups		N	Min	Q1	Median	Q2	Max	Mean	SD
Pre- Test	CG	11	0	2	3	3	4	2.5	1.0871
	EG	10	0	2	3	4.25	5	3	1.7581
Post- Test	CG	11	0	4	5	5.25	7	4.6667	1.8749
	EG	10	0	4.75	6.5	7	8	5.3333	2.708

Discussion

In this intervention we outlined the use of a VR 360^0 video case study demonstrating an alternative approach providing an educational learning experience when modelling systems. Table 1 presents the results of the paired samples *t-test* of the usability test measures (Control vs Experimental). As hypothesized, the results of alternative hypothesis H_1 confirms that the intervention has a positive effect on the assessment measure. The statistical significance is determined from the p-value, demonstrating that engagement (0.013) and motivation (0.037) are statistically significant on the <0.050 alpha. Usability results were also significant for the intervention on accessibility, error free, manipulability, navigability, visibility, communication, creativity. The nature of using haptic 3D syntax has helped students with learning outcomes in the experimental conditions post-test as indicated in Table 2 of the learning outcomes results.

The role of physical manipulation reinforces accessibility when solving problems, active collaboration and interaction which encourages communication and creativity. The nature of using 360^0 video using google cardboard with a smart phone assists students with the manipulability, memorability, navigability and communication as it provides an added layer of facilitated interaction between teams. Positive results on the accessibility and real-world measures can be associated to the visual 360^0 interaction and consequently students' satisfaction that encourages engagement and motivation and provides a groundwork for learnability.

The use of 3D-printed syntax in the learning activity can provide a haptic ability to connect the classified data elements and characterise them to the visual information captured from the 360^0 video as part of the learning activities. Table 2 presents pre-test and post-test outcomes using box and whisker results performed on two groups showing outliers. Three students have been outlaid from the total sample n=24 as they shown a high variance. Table 3 shows the results of the testing performed on two groups with outliers removed to reduce abnormal distance from the other data results in the experimental condition. As hypothesized, the incorporation of 3D-printed objects in the experimental condition enhances and reinforces learning outcomes. This result indicates that students reinforce learnability in the experimental condition. Students undertaking the experimental method score slightly higher (mean = 3) than those undertaking the traditional teaching method (mean =2.5) in the pre-test. However, the variance is minimal and can be due to the variability of students' learning competences. The findings suggest the importance of integrated interactive instructional 360^0 video into the learning activities combined with 3D-printed syntax can enhance manipulability, navigability, visibility and communication to improve motivation and learning engagement. The experimental condition is best for the consolidation stage, motivation and engagement. A limitation of the intervention is limited by the sample size (n = 24) in which the experiment was performed but compatible for usability testing. The use of a sample of students with foundational knowledge of system modelling is preferred rather than having a large number of students with no foundational knowledge. The effects of quantitative data shows quality results for discussion that can be significant when applying the intervention across a range of different areas of study.

Conclusion and future work

The use of 360^0 video enhanced by 3D-printed syntax can be used in ICT system analysis and design to enhance motivation, engagement and learning. 3D-printed components can assist students to manipulate, navigate and communicate their system models. These characteristics in partnership can boost integration and participation of learning system modelling. This level of engagement can suppress fear of failure and create learning accessibility and create positive association with learning. We are currently working on adaptive use of the 360^0 video including the use of Oculus go and Oculus quest to extend sphere towards a higher representation of the case study using simultaneous users.

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MENTOR – Intelligent Mobile Online Peer Tutoring Application for Face-to-Face and Remote Peer Tutoring

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E-learning platforms have been increasingly adopted by universities to extend and enhance learning. However, the literature review has shown that limited research has been conducted on the effects of electronic peer tutoring on student learning. Correspondingly, there is a lack of a suite of technological affordances to facilitate online peer tutoring sessions and appointments remotely. This paper describes the development of a novel smartphone app – Mobile Education Networked Tutoring On Request (MENTOR) – to facilitate face-to-face and remote peer tutoring. The MENTOR app aims to predict the tutoring needs of students using tutor-tutee matching, provides coordination of face-to-face tutoring sessions via the use of smartphones' location data and online operation of remote tutoring sessions.

Keywords: Peer tutoring, predictive, prescriptive analytics, remote tutoring

Introduction

Recent studies have reported that peer tutoring is a cost-effective intervention that yields gains in academic and communication skills of the students (Song et al., 2018). Peer tutoring has the potential to provide pedagogical benefits to both tutor and tutee (Leung, 2015). According to Rosen (2011), face-to-face learning is increasingly complemented and partially supplanted by online or e-learning which appeals to the iGeneration. Harnessing iGeneration's aptitude towards electronic communication and learning would be advantageous towards students' learning, particularly peer-to-peer learning. Research has shown that peer tutoring at the university level could improve performance and enhance students' conceptual knowledge by reapplication of concepts (Colvin et al., 2010), raise motivation and learning (Simon et al., 2012), increase self-determination and learner autonomy (Carpenter et al., 1999) and improve student tutees' academic performance (Thomas, 2000). However, studies conducted on online peer tutoring within a dedicated online educational environment have received relatively little attention. One of the few studies is the on-campus/off-campus Peer Tutoring Electronic Network (OPTEN) model was developed by Jegede (2002) which utilized an online asynchronous text-based conference communication system for electronic peer tutoring. One of the major drawbacks of OPTEN is the arbitrary switching of tutor and tutee roles on a weekly basis without consideration of students' competency levels in the peer tutoring activities. Evans et al. (2013) attempted to address the issue of tutor-tutee mismatched by developing Online Peer-Assisted Learning (OPAL) web-based tutoring system that provides the tracking of statistical information about tutoring history called "tutoring tickets". These tutoring tickets listed the topics or problems the tutors had tutored previously as well as the timing and duration of past tutoring interactions. One of the weaknesses in OPAL tutoring process is that it relied on communication methods like email, Skype and Google Docs and OPAL's tutoring tickets did not indicate tutee feedback on tutors' teaching, which would be useful for optimizing the tutor-tutee matching.

Informed by the literature, we propose a new smartphone app with inbuilt predictive and prescriptive analytics called Mobile Education Networked Tutoring on Request (MENTOR) which analyses students' academic profile and questionnaire responses to predict tutoring needs and prescribe suitable peer tutors. This paper describes the role of MENTOR in tutor-tutee matching and how tutees can be individually paired with tutors by the optimization rules and ranking algorithms via a web-based scheduling program. Tutor-tutee matching can be efficiently accomplished via the MENTOR app by granting tutees the choice of tutors based on student profile, subject topics, gender, tutor ratings and reviews received from past tutees. This development and research project emphasises the importance of online peer tutoring and aims to examine the learning processes of tutees via face-to-face and remote peer tutoring sessions offered by MENTOR. This project also aims to investigate the efficacy of location-based tutoring versus the traditional scheduled tutoring sessions. This project will also examine tutees' perceptions of the tutor-tutee matching offered by MENTOR versus the current scheduling approach. This paper presents the front-end needs analysis of MENTOR that helped identify some potentially useful features of the application.

Methods

We conducted the needs analysis and User Experience (UX) research with the current undergraduate student tutors and student tutees from various schools (Engineering, Education, Science, Business, Humanities, and Social Sciences) to align the student understanding and needs of the features for the proposed peer-to-peer smartphone app. UX research deals with the study, design, and evaluation of the experience the user has through the use of a system. According to Bargas-Avila et al. (2011), UX is used to describe and understand user's experience with interactive application which ranges from qualitative research of experiences with in-depth interviews to quantitative data from questionnaires. The use of UX paves the way in helping us to understand the background of the respondents, search for methods and correlates among ratings of technology perceptions to develop an innovative solution for peer tutoring. Specifically, MENTOR UX design incorporated the following to understand peer tutoring needs, user goals, user behaviors, and user experiences.

- **Service Blueprint** - Focuses on the user journey map, user steps and user journeys for peer tutoring.
- **Minimum Viable Product (MVP)** - MVP is used to design, develop and test MENTOR app to gain feedback for future iterations
- **Affinity Mapping** - Affinity Mapping is designed to cluster ideas and opinions in organizing information into groupings based on relations between small units.
- **User Personas** - Creation of User Personas to determine the goals, characteristics and represent the needs of a larger group of users (e.g. Tutors, Tutees, and Tutor Manager).

In this study, selected student tutors and tutees were interviewed to gain detailed insights into issues they faced as a tutor or tutee during traditional face-to-face sessions and their attitudes toward the use of a mobile app that electronically host peer tutoring sessions.

Results

Needs Analysis

Surveys were carried out using questionnaires collected from students studying in higher education to understand the needs of peer tutoring with tutors and tutees. The findings of the survey are shown in Figure 1 to 4. The needs analysis was carried out with 616 students (314 male, 302 female) comprising undergraduate and postgraduate peer tutors and past tutees to study (i) the effectiveness of peer tutoring (Figure 1), (ii) challenges faced by student related to their study (Figure 2), (iii) the preferred features in regard to peer tutoring app (Figure 3) and (iv) attributes of a good tutor (Figure 4). The findings of the survey data in Figure 1 show that the majority of the students are receptive to peer tutoring. This suggests that peer tutoring application as a user-friendly and intuitive method in helping to facilitate student learning. Figure 2 shows a large number of students who have experienced peer tutoring reported that they required help in tutorials (29.9%) and foundational knowledge (23.71%) in their studies. The results also revealed that students sought for examination tips (15.46%), quick crash course (11.34%) and around 10% of the respondents sought advice on their coursework. The findings in Figure 3 reveal the type of features the students prefer. As observed from Figure 4, good knowledge and communication skills (approachable), patient, responsive, respectful and the ability to identify learners' needs are the attributes found to be a good tutor. These attributes are useful for the prescriptive analytics in identifying tutors who have general skills required for the job of peer-tutoring.

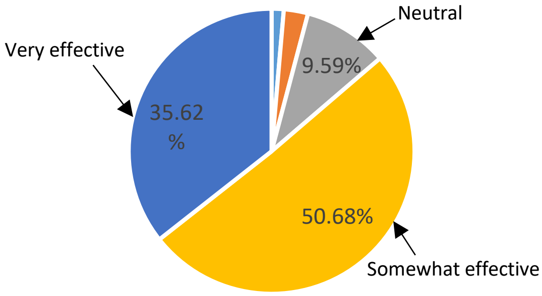

Figure 1: How effective do you think the peer tutoring program was in helping students?

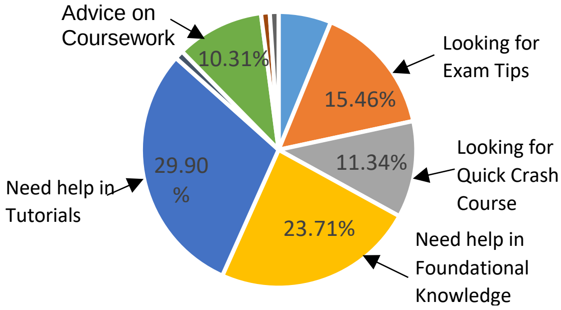

Figure 2: What influenced you to go for the peer tutoring program?

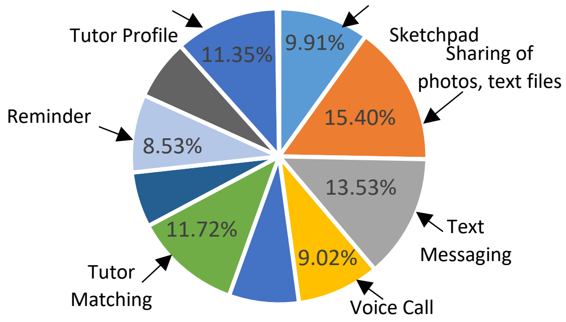

Figure 3: What features would you like to see in this mobile app?

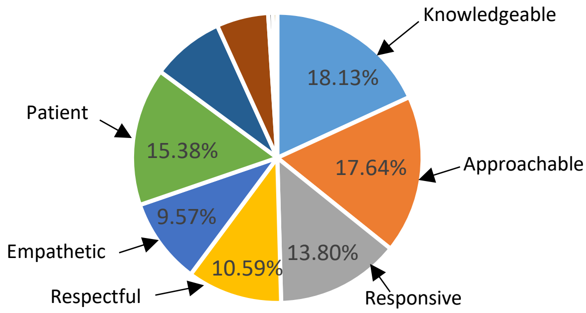

Figure 4: What are the attributes you would look for in a good tutor?

MENTOR Prototype

The proposed MENTOR application incorporates face-to-face (location-based) peer tutoring and remote peer tutoring (refer Figure 5 for a schematic of the MENTOR peer tutoring process). MENTOR app offers:

- **Face-to-face (location-based) peer tutoring** - Coordination of face-to-face tutoring sessions via location data of tutees and tutors is available when a tutee requires it. Tutees are able to link up to any proximal tutor to carry out face-to-face consultations.
- **Remote tutoring (online peer tutoring)** - Tutees can choose to have remote tutoring sessions via MENTOR's real-time, interactive screen sharing capability equipped with a digital sketchpad interface and accompanied by voice calls or instant messaging for tutor-tutee conversations.

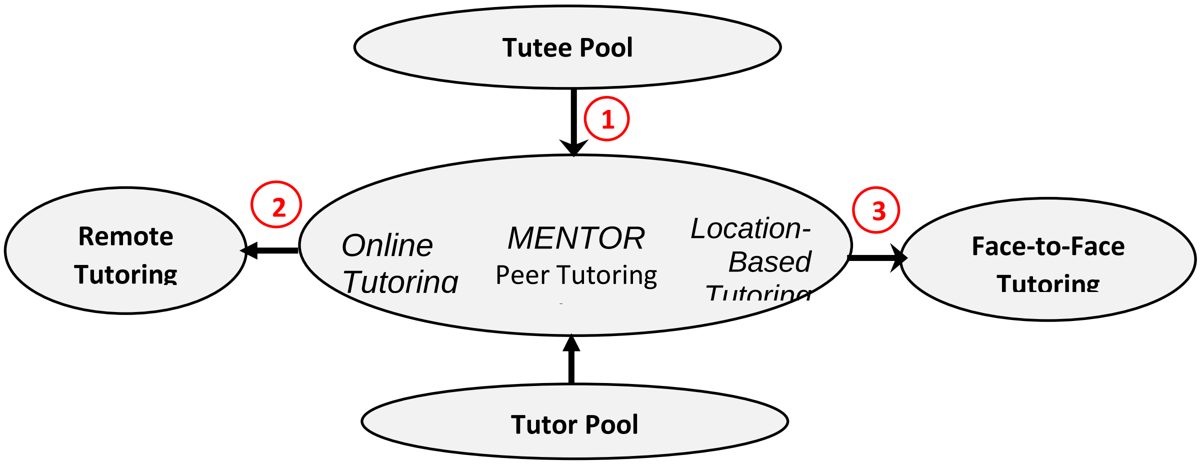

Figure 5: Schematic of the MENTOR peer tutoring process

- **MENTOR app**: Before tutees select remote tutoring or face-to-face tutoring, tutees answer an onboarding questionnaire which will help MENTOR predicts tutoring needs and prescribes relevant tutors according to the topic, gender, tutoring experience, and tutor ratings.
- **Remote Tutoring** is conducted via an interactive screen sharing feature in real-time on a digital sketchpad interface. Content can be uploaded to the sketchpad and viewed by tutor and tutee simultaneously.
- **Face-to-face tutoring**: Tutee seeking help can filter a list of tutor by a geo-tagging location-based map. Tutees can link up to any proximal tutor to have face-to-face tutoring sessions. Notifications are sent to the tutee, tutor and tutor manager once the peer tutoring session is confirmed.

Tutor-tutee Matching

The tutor-tutee matching provides the pairing of tutees' requests for a specific subject with respective tutors who have relevant expertise in terms of coursework and discipline. Matched and selected tutee-tutor pairs can arrange to meet at a convenient spot (within the campus) face-to-face based on the recommendations given by MENTOR app. Otherwise, tutees may choose to request for remote tutoring session at any time and place via MENTOR virtual platform. The optimization rules and ranking for predictive analytics (Figure 6) are derived from the scoring values of different input parameters extracted from student profile (e.g. year of study, school, programme, courses enrolled), topic, preferred gender, tutoring experience, and tutor ratings. The scoring value will be modeled with online questionnaire responses focusing on students' professed knowledge shortfalls and finally matched with mutual tutor-tutee availabilities to prescribe the right recommendation of tutors available.

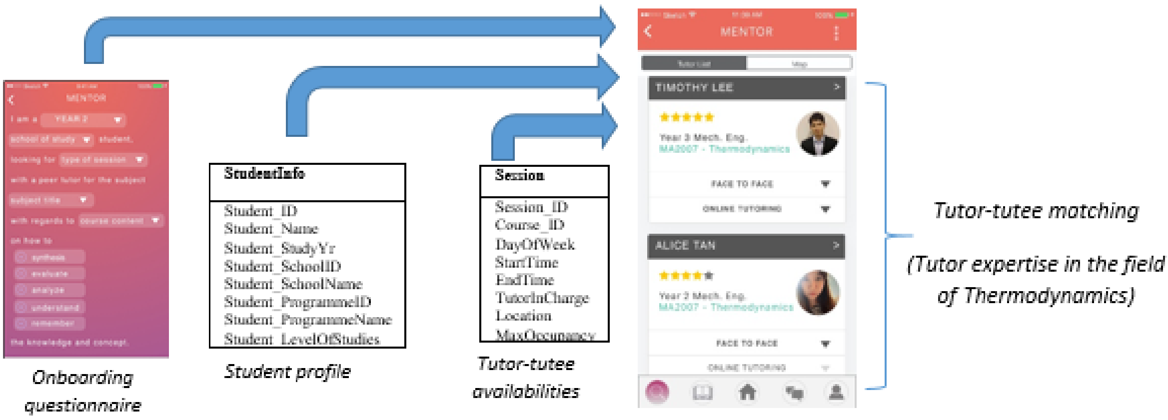

Figure 6: Tutor-tutee matching based on (i) *questionnaire* (ii) *student profile* (iii) *tutor-tutee availabilities*

Location-based Peer Tutoring (Face to Face)

The use of location-based tutoring is coordinated by a geo-tagging location-based map of both tutors and tutees. In the MENTOR app, geo-tagging enables proximity search and shows the proximal location of the most relevant and available tutors. Tutees can link up to any proximal tutor to have face-to-face tutoring sessions based on proximal locations of the three nearby tutors (Figure 7) thus accelerates the process of finding and receiving face-to-face tutor help as shown on MENTOR's location-based informative map.

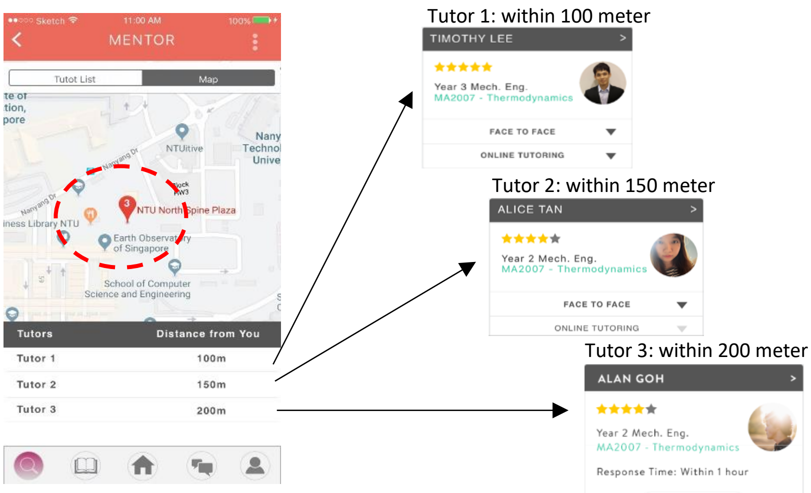

Figure 7: MENTOR's view of three tutors using geolocation proximity

Remote Tutoring

Remote tutoring is conducted via an interactive screen sharing feature in real-time communication on a digital sketchpad or whiteboard interface (Figure 8). Students can choose to have a remote tutoring session via MENTOR's real-time interactive screen sharing capability equipped with a digital sketchpad interface with the available tutor. The remote tutoring allows educational content to be uploaded and viewed by both tutor and tutee in real-time, accompanied by voice calls and instant messaging for tutor-tutee conversations. For example

- Tutor and tutee communicate using voice calls in the tutoring session to seek help for a particular problem.
- Tutor and tutee clarify their doubts using instant messaging, sketch mathematical formulas or equations and draw geometrical shapes in real-time. Comments and annotations by the tutor and tutee can be viewed by both parties simultaneously.

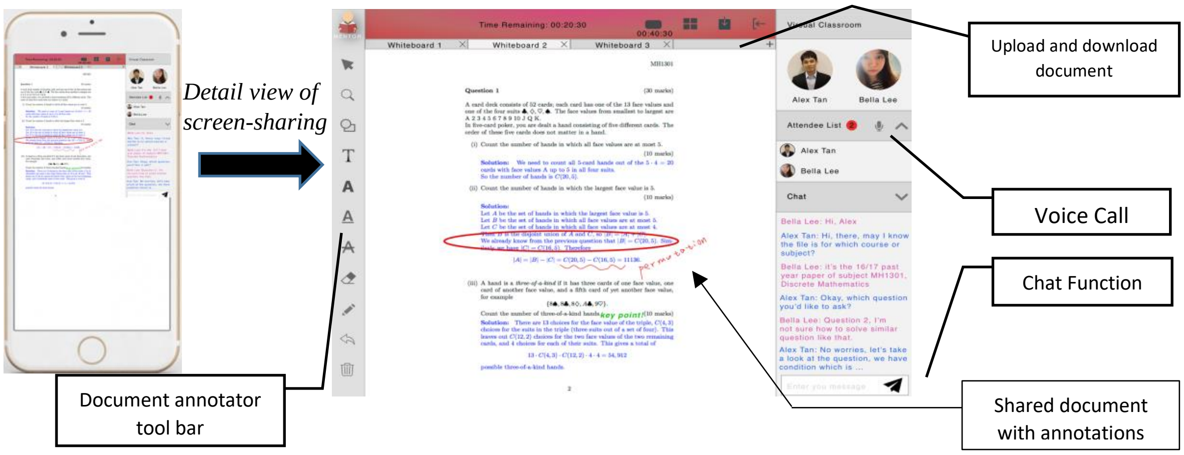

Figure 8: MENTOR's remote peer tutoring

Discussion and Future Work

In our initial study, it is hypothesized that facilitating peer tutoring online and offline via a smartphone may reap the combined benefits of e-learning and peer tutoring. The MENTOR app is a unique smartphone mobile application which can be customized and integrated with pre-existing school databases and learning management system (e.g. Blackboard Learn) as an app fully dedicated to education. In this study, the MENTOR peer tutoring model aims to integrate 'on-the-go' session booking based on student's location and remote peer tutoring using a smartphone (iOS and Android OS platform), making peer tutoring convenient, flexible in timing and location. This research provides an informative snapshot of the use of tutor-tutee matching, location-based information and real-time communication using remote tutoring. MENTOR has the potential as an intelligent peer tutoring model to generate knowledge and outcomes using predictive and prescriptive analytics. The findings of the needs analysis underlie the settings of the peer tutoring app and provide a structure in which the learning environment promotes the use of analytics for tutor-tutee matching to support and enhance learning. MENTOR application can be scalable to other higher education contexts to facilitate peer tutoring; maximizing the efficiency and efficacy of peer tutoring using expertise matching, expert locations, and automated coordination of peer tutoring sessions to achieve a closer match between students' perceptions of peer tutoring provided. MENTOR app can be extended to various educational institutions to facilitate peer tutoring, from primary, secondary schools, to tertiary institutions and universities.

Acknowledgement

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Developing A Mobile Immersive Reality Framework For Enhanced Simulation Training: MESH360

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This paper reports on the second iteration prototype design stage of an immersive reality (XR) enhanced simulation project in critical healthcare higher education. While there is no doubt of the positive impact on the development of a variety of clinical skills through the use of XR in health education, a literature review indicates that the level of engagement with learning theory and the wider literature to inform the design of these learning environments is limited. The authors propose that XR can be employed within the learning environment to introduce critical elements of patient and practitioner risk and stress through environmental and socio-cultural influences without putting either students, educators, practitioners or patients at real risk, but create a safe learning environment that more authentically simulates these risk elements. The MESH360 project involves a collaborative transdisciplinary team of educational researchers, designers, practitioners, and working professionals in the design of mobile XR to enhance student and professional paramedic training to prepare practitioners for the environmental stressors and critical care decisions involved in high risk situations. Using Design Based Research (DBR), the project explores the impact of mobile XR enhanced simulation for novice and professional paramedics.

Keywords: Immersive Reality, Biometrics, Design-Based-Research, Critical Care Health Education.

Introduction

Critical healthcare first responders deal with the everyday carnage of the road toll, as well as unforeseen events ranging from natural disasters to mass murders. Higher education providers need to critically explore how to best prepare first responder professionals for these high risk, unforeseen events that require critical awareness, diagnostic and problem solving capabilities beyond their training and expertise in controlled medical treatment procedures. Simulation is a widely adopted and proven technique for clinical training and critical care response education (Kaufman, 2010). However, there is little evidence of engagement with newer pedagogies or learning theories that can inform the development of student critical thinking and critical diagnostic capabilities within health disciplines, beyond on the job experience such as clinical placements (Stretton, Cochrane, & Narayan, 2018). Zepke et al., (2010) identified “enabling students to work autonomously, enjoy learning relationships with others, and feel they are competent to achieve their own objectives” (2010, p. 3) as ways to enhance student engagement in tertiary education in general. Within the context of healthcare higher education, scenario-based analysis and critique are widely used, but can be made more authentic through the integration of well-designed immersive reality (XR) learning experiences. Recent critiques of the literature surrounding XR in healthcare higher education indicates that XR is predominantly utilised in healthcare education for clinical simulation exercises, with a focus upon skill development rather than higher level diagnosis or higher order clinical reasoning (Stretton et al., 2018). Consequently, there is little evidence of engagement with learning theory in the design of XR for higher health education, and a subsequent reliance upon behavioural learning design (Cochrane, Smart, & Narayan, 2018). While there is no doubt of the positive impact on the development of a variety of clinical skills through the use of XR in health education, the level of engagement with learning theory and the wider literature to inform the design of these learning environments is limited (Stretton et al., 2018). Authentic learning experiences in health education add elements of patient and practitioner risk and stress through environmental and socio-cultural influences. This is where XR can be employed within the learning environment to introduce these critical elements without putting either students, educators, practitioners or patients at real risk, but create a safe learning environment that more authentically simulates these risk elements.

There is much recent hype and rhetoric surrounding how virtual reality is transforming education, however the literature evidences that it is predominantly being used to deliver interactive content – effectively enhanced textbooks - rather than enable student determined learning that explicitly develop problem solving and navigation of the unknown or focus upon critical threshold concepts (Peter & Harlow, 2014). Ideally, the integration of technology into education environments should be driven first and foremost by sound pedagogical design principles based upon the key graduate profile capabilities that are critical to a specific professional context. To make this pedagogy-first approach explicit explorations of technology enhanced learning environments can be embedded within a Design-Based Research (DBR) methodology (Cochrane et al., 2017; McKenney & Reeves, 2012) informed by the scholarship of technology enhanced learning (SOTEL) (Cochrane & Farley, 2017; Haynes, 2016). Several contexts have been identified as being highly relevant to immersive learning environments, including; clinical and critical care health, automation, high-risk environments, environments that are prohibitively costly to reproduce, and educational environments that utilise simulation. These can be directly mapped to mixed or immersive reality learning environments.

The MESH360 project builds upon these key findings applied to the context of critical care health practice in high risk learning environments, simulated via the design of immersive reality learning environments, utilising the principles of heutagogy (student-determined learning) as a guide for the design of the learning environment (Blaschke & Hase, 2015). Building upon an initial 2017 prototype that explored critical scene awareness (Cochrane, Cook, et al., 2018), the project uses mixed methods to triangulate qualitative data and quantitative data over several iterative prototype designs. Specifically the project utilises biometric triangulation of subjective qualitative participant responses and feedback. The 2018 iteration of the MESH360 Paramedicine project explored the following research questions:

- How effective is immersive reality for authentically preparing tertiary paramedic students and upskilling workplace paramedic professionals to develop the critical decision making capabilities they need to best respond to unfamiliar high risk critical care incidents?
- What are the key elements of an implementation framework that can guide the scalable development of accessible immersive reality learning environments that enhance critical care simulation training for authentic real world high risk first responder scenarios?

Methodology

To advance the potential impact of XR in critical care health education curriculum design can be more explicitly informed by the Scholarship Of Technology Enhanced Learning (SOTEL) (Cochrane & Farley, 2017). The academic advisors bring this critical lens to the project team, and act as mentors to the paramedic lecturers in the team as they critically explore their teaching practice through the lens of SOTEL. SOTEL explores critical practitioner reflection on the design and implementation of technology enhanced learning environments founded upon learning theory. The MESH360 project uses a DBR methodology. DBR and SOTEL are particularly relevant to move technology enhanced health education beyond the predominant mode of individual comparative trial-based case studies, towards transferable design principles that can be applied to a variety of health education contexts for wider impact (Cochrane & Farley, 2017). DBR provides a structured, four-phase iterative framework (McKenney & Reeves, 2012) for designing XR learning environments for health education (Cochrane et al., 2017). The four phases of our project are:

Phase 1: Analysis and exploration - Identification of the critical pedagogical issues surrounding the design of XR learning environments and exploration of supporting literature to identify initial design principles to address these issues (Cochrane et al., 2017).

Phase 2: Design and construction - Prototyping of the design of an XR learning environment and pedagogical intervention informed by the identified design principles (Cochrane, Cook, et al., 2018).

Phase 3: Evaluation and reflection - Evaluation of the prototype XR learning environment design through user feedback, and refinement of the design principles (Initial prototype evaluation 2018).

Phase 2-3 Loop: Iterative redesign and re-evaluation of the prototype XR learning environment (2018-2019).

Phase 4: Theory building - Development of transferable design principles and dissemination of findings (2019).

The 2018 iteration of the MESH360 project focused upon Phase 3 and the first Phase2-3 loop leading to the development of a second higher fidelity enhanced simulation environment and an implementation framework. The MESH360 project partnership participants (outlined in the project team details Table 1) comprise a collaborative transdisciplinary team of researchers, development team leaders, practitioners, students and professionals. The team members have collaborated on the initial conceptual and prototyping development of the MESH360 project over the past 2-3 years (Aguayo et al., 2018; Cochrane, Cook, et al., 2018; Cochrane et al., 2017; Cochrane, Cook, Aiello, Harrison, & Aguayo, 2016). Simulation participants included AUT paramedic students and professional paramedic ambulance crew members.

Table 1. Transdisciplinary Design-Based Research project team

Team Members	Role in project
Academic Advisors	Principal investigator and educational technologist
App development team	Co-Principal Investigator and immersive reality application development team
Paramedicine Lecturers	Paramedic lecturers and core members of the MESH360 enhanced simulation project development, development of simulation environment
Embodied Reports, Santiago, Chile	Biometric data researchers and tracking software development
Paramedic students and practitioners	Simulation participants: 30 student volunteers from year1-3, 5 invited professional paramedics

The 2018 Phase 2-3 loop was informed by the evaluation of the 2017 prototype that recommended: redesign of the embodied biometric instruments; redesign of the enhanced simulation environment through a). development of multiple authentic scenarios that are linked through the VR experience, b). addition of new forms of user interaction, c). exploring higher definition Head Mounted Displays (HMD). We attempted to address these issues in the design of the 2018 VR scenario that moved from a static 360 scenario viewed via a Google Cardboard compatible HMD to the development of a virtual ambulance callout via an Oculus Go HMD.

Data collection and analysis methods:

The project uses mixed methods to triangulate qualitative data and quantitative data over several iterative prototype designs, initially across two years of iterations of the project. Building upon prototype XR learning environment design (Cochrane, Cook, et al., 2018), we use biometric triangulation of subjective qualitative participant responses and feedback (Pre and post participant surveys, and post focus group for each iteration of prototyping and implementation of the immersive simulation) (Aguayo et al., 2018). Participants wear a smart watch during the XR simulation that measures participant stress by recording heart rate (HR) and skin conductivity data (Galvanic Skin Resistance or GSR) facilitated by the development of a custom application. The first prototype trial in 2017 indicated the alignment between cognitive and emotional impact of the XR learning experiences on learner outcomes within an enhanced simulation (Cochrane, Cook, et al., 2018). In 2018 we wanted to correlate the difference of the impact of enhanced simulation from novice students to professional practitioners. Post enhanced simulation participant interviews were conducted and recorded to explore the subjective impact of the enhanced simulation upon participant learning, comparing their analysis of an enhanced critical care scenario simulation. Data collected from both novice (trainee students) Paramedics and expert Paramedic practitioners provided comparative impact of the project at different user experience levels. The analysis of the alignment between the subjective participant feedback with the immersive environment hot spot and participant eye mapping, triangulated by time-aligned biometric participant data provides a rich basis for answering the research question regarding the impact upon participant learning, and the subsequent 2019 iterative redesign of the project will enable the development of transferable design principles. A summary of the implementation framework for the MESH360 project is provided in Table 2.

Table 2. Mobile XR enhanced critical care simulation implementation framework

Data Collection Activities	Implications for enhancing critical care clinical simulation
Recruitment of volunteer participants	Participants invited via Facebook, Instagram and announcement on the LMS to respond via email to a project email account. Respondents were then emailed a simulation booking, instructions, consent form, information sheet – in accordance with the MESH360 ethics approval from the university ethics committee
Pre survey to gather participant demographic and prior experience data	Anonymously coding participants to map the impact of the VR enhanced Simulation
Biometric Sensors worn on wrist by participants	Measure participant stress levels via GSR and HR
Pre-VR experience - HMD	Define baseline levels of stress
VR experience – HMD with eye tracking, hot spot activation, user navigation of scenario, wirelessly mirrored to monitor for observation	Creating an authentic simulation within a real context that approximates real world stress and risk elements and participant diagnostic skills via multi-sensory VR experience
Post VR initial diagnosis	Participant initial diagnosis based upon VR simulation
Traditional clinical simulation treatment of high fidelity mannequin	Participant treatment of mannequin based upon VR scenario
Post clinical simulation diagnosis	Participant final diagnosis of VR + clinical simulation
Post simulation participant interview - videoed	Brief subjective participant feedback on the impact of the VR experience
Post simulation participant survey	Purposive sampling of subjective participant feedback on the impact of the VR experience

The 2018 VR experience consisted of a 4 minutes long 'Ambulance Ride' VR experience, which was divided as follows:

a). Presentation of 'calm' scenario, a nature scene, to smoothly introduce participants to the VR experience (15 seconds),
b).Transition to static 360 Panorama of the back of the ambulance (45 seconds) to gain baseline data,
c). Transition to 360 video of the back of the ambulance ride including ambient sound (1 minute),
d). Presentation of job description by radio call first, then by text box providing more details, followed by a job update increasing complexity of job (radio first, then text box),
e). Arrival at accident scene in a garage with patient for participants to explore,
f). Close up scene of patient with emergency care equipment laid out exactly as in the physical high fidelity mannequin simulation suite.

The participant VR experience was wirelessly mirrored to a monitor for the research team to follow their progress and exploration of the VR scenario. Following the VR simulation experience participants were asked to provide a preliminary diagnosis of the patient, and were then ushered into the adjacent physical simulation suite with a high fidelity mannequin and equipment to demonstrate treatment procedures while observed through a one-way window.

Summary of results

Space limits detailed analysis of the project results, hence we present a brief summary of results, and a full analysis will be the subject of a following journal article.

- Participant post simulation survey: Very positive feedback, with suggestions on improving fidelity.
- Participant post simulation feedback video playlist: all participants agreed that the VR experience enhanced the traditional simulation and helped inform their patient diagnosis.
- VR environment eye-tracking heatmap: participants spent significant time exploring the 360 scene with the virtual patient discovering clues for diagnosis and treatment procedures.
- Biometric triangulation: Stress levels were highest in first year students, and all student stress levels significantly increased when the job call came through in the VR scenario. Conversely practicing paramedic stress levels were highest pre simulation, and their stress levels decreased as the VR scenario progressed.

Initial thematic analysis revealed that the most positive participant feedback was from the second year students and the professional paramedics – both groups were the most enthusiastic about the value added by the VR enhanced simulation to their learning. This indicated that there was a ‘sweet spot’ for the impact of the VR enhanced simulation between non-experienced novices and third year students who are highly experienced with traditional clinical simulation techniques. Practicing paramedics believed the VR provided a more authentic training experience than their prior educational experiences. Next Stages: The 2019 iteration of the project aims to better integrate the flow of the learning experience between the VR pre simulation and the actual clinical mannequin-based simulation. The third iteration the MESH360 project in 2019 will refine the design principles established in the first two iterations of the DBR project.

Conclusions

This paper outlines the research methodology design and second iteration prototyping of the DBR project that explores the development of an immersive reality framework for enhancing critical care simulations for educating first responders for the real world stressors involved in critically analysing environmental factors and patient diagnosis and treatment in authentic learning environments. We identified significant differences in the impact of the immersive environment between novice and expert practitioners. The next stages of the research will iteratively evaluate and refine prototype immersive reality learning environments, comparing the impact upon both novice and expert paramedics. This will inform the development of transferable design principles.

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Using team-based learning in a problem-based learning medical course to improve transition from a pre-clinical to clinical learning environment

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Many medical schools choose between using either a problem-based learning (PBL) or a team-based learning (TBL) approach to curriculum to teach pre-clinical students the foundational sciences needed to understand disease processes. This study explores whether it is possible to combine the strengths of both approaches to better prepare medical students for the transition from a pre-clinical to a clinical learning environment. While PBL allows students to identify gaps in learning and then apply new knowledge to an established problem, TBL gives students the opportunity to apply their learning to multiple new clinical problems thus providing opportunities for knowledge transfer. We used the Learning Activity Management System (LAMS) to run modified TBL sessions that were designed to fit within the normal lecture program. Iterative development of the intervention over five years based on staff and student feedback has delivered positive educational outcomes.

Keywords: Team based learning, knowledge transfer, medical curriculum

Introduction

At Western Sydney University (WSU), the five-year undergraduate medical degree implements a problem-based learning (PBL) curriculum across the first two pre-clinical years. PBL has been rolled out in many medical programs since its' inception at McMaster University Medical School 50 years ago (Servant-Miklos, 2019). It is favoured in medical degrees as a student-centered approach to stimulate learning of basic sciences and clinical knowledge around a problem scenario (Hmelo-Silver, 2004). The pedagogical advantages of PBL stem from students initially identifying gaps in their knowledge and using these gaps to generate topics for self-study. Students then return to their small groups and apply their new knowledge to solve the pre-set problem (Dolmans, 2014). This process of investigation, explanation and resolution of the problem is important for improving student self-directed learning skills and learning the cognitive skills needed for problem solving and collaboration. Thus PBL is explicitly designed to prepare students for clinical learning where every new clinical scenario is an opportunity to identify knowledge deficits and seek out resources to continue their learning experience (Taylor & Miflin, 2008).

Increasingly, however, medical schools have been turning away from PBL and starting to use a different instructional approach called team-based learning (TBL). The reasons for this range from avoidance of the more resource intensive and thus costly PBL (Burgess, Ayton & Mellis, 2016) to disenchantment with the PBL process itself at achieving its educational goals (Miflin, 2004). TBL lessons are comprised of pre-session individual preparation in the form of readings or lectures, an individual readiness assurance test (iRA), a team readiness assurance test (tRA) comprised of the same questions as the iRA, and application exercises (McMahon, 2010). TBL does share some pedagogical features with PBL. The learning theories are both centered around problem solving in small teams and applying the new learning to that problem. TBL differs in other ways, for example, in TBL multiple small groups are run simultaneously in a large room, rather than each group working in a small room with their facilitator. Also, in TBL, students are given pre-class work, whereas in PBL students develop their own understanding of what learning they need through initial classroom discussion. Finally, in TBL students are given immediate feedback on their answers and reasoning through content expert facilitation, whereas in PBL there are no specified questions and the facilitator is encouraged not to provide academic content, but to rather guide the self-study process.

Dolmans and colleagues (Dolmons, Michaelsen, van Merriënboer & van der Vleuten, 2015) have asked if there could be 'benefits to be gained from combining these approaches' unique strengths?' and if so, 'how can the two approaches be combined?' At WSU, we have been exploring similar issues, and through five years of iterations of our teaching strategies, we have found there is a definite place for TBL in a PBL-centered course, particularly when it comes to helping students transition from a pre-clinical to clinical stage of their course.

A 2016 systematic review (River et al., 2016) concluded that blending technology with TBL, ranging from video-conferencing, online quizzes and social media did not necessarily correlate with positive student perceptions or outcomes. However, their study did not examine the currently available purpose-built software platforms that are used to run TBL in large courses. To date there is limited research comparing these technologies (e.g. OpenTBL, InterDash and LAMS) but the following paper shows how the use of technology has greatly facilitated the introduction of TBL to this course to minimize the impact on staff and students, and will be explained further below.

Case study: Infectious Diseases Clinical Classrooms

Context

As part of an initiative to improve student transition from pre-clinical to clinical learning in our medical program, we looked at ways that we could engage the students in more opportunities to apply their knowledge to clinical scenarios. Therefore, we sought ways to assess if students could transfer their knowledge outside of the PBL problem that they had participated in, to new cases that may not immediately present the same way as they had initially learned, but which shared an underlying scientific reasoning. The Infectious Diseases block, which occurs near the end of the second year of the medical degree (at the end of the pre-clinical section) was deemed an ideal place to attempt this intervention. A TBL approach was chosen as it provides multiple points for testing student foundational knowledge (through individual and group readiness assessment) and application of knowledge through team discussion and feedback in the more complex application exercises. These clinical classroom modules brought together clinicians, research scientists, educational designers and most importantly students to work together to develop, design, share and evaluate the content.

Modification of the TBL process

As our resources are currently centered around a PBL curriculum, this teaching intervention needed to be equivalent in resource use to our normal lecture program. For example, the same number of staff and hours would go towards the session and the time impact on students would be positive not onerous. To do this, the original TBL model was modified so as to maximise the time that the students spent with the content experts in the TBL session (which we named “Clinical Classrooms”). To accommodate this change, the original lecture content was shortened to videos of core concepts to free up space in the curriculum. The Clinical Classrooms sessions were 1 - 2h in duration, with one session held each week. Following the introduction of the main disease area in PBL where students identified their own gaps in knowledge and formed learning objectives, the students were introduced to supplementary online Clinical Classroom modules delivered through an online software system capable of implementing PBL and TBL (the Learning Activity Management System - LAMS). After several years of iterative development of our approach, our current modified TBL format consists of:

1. Assigned pre-work lecture content
2. Pre-Clinical Classroom individual readiness assurance test (iRA) with marks via LAMS
3. Start of Clinical Classroom face-to-face session of 60 students
4. Team formation of 3 to 4 students and leader selection through LAMS leader tool
5. Team readiness assurance test (tRA) using immediate feedback through LAMS
6. Application exercises in the form of four to five case studies. Teams complete questions in the form of short answers or ‘scratch card’ MCQs delivered through LAMS.
7. Content experts in the form of a clinician and a scientist answer student questions as they progress through the session

Iterative development of the Clinical Classroom process

An educational design research approach as originally outlined and then refined by McKenny & Reeves (2018) was applied to the development of this intervention. The steps taken to refine and develop the intervention were: (1) analysis of the problem (insufficient transfer of knowledge between clinical problems); (2) design of the intervention (modified TBL); (3) evaluation and reflection (a collaboration between students, researchers and lecturers), (4) repeat cycle.

The first phase of the intervention occurred in 2014 and involved pre-recording the lectures, creating iRA and application exercise questions and developing the structure and delivery of the components. The first iteration of the course used a different software platform from that outlined above, which was a combination of Blackboard for delivery of video content and NearPod for delivery of tRA and application exercises. In addition to this, the session had to be delivered in a lecture theatre. Ethics clearance was obtained, and feedback was sought from all stakeholders and involved both student surveys and staff interviews at the end of each session initially and then once a year as the modules matured. In addition, learning analytics tracking data revealed the student rate of progress, usage of the resources and scores on assessment tools both before and during the Clinical Classroom.

The survey instrument had eleven questions and used a 5-point Likert scale covering: pre-session video delivery, motivation to prepare, Clinical Classroom engagement, problem solving and an open-ended question about improvements. Feedback from both staff and students led to iterative development and modification of the Clinical Classroom to the final modified version as outlined above. In particular, the lecture theatre was deemed not suitable for small group work and the sessions were split across two sessions, each with a smaller number of students, so that we could make use of our technology-enabled teaching labs for group work. This allowed maximal beneficial interaction between students and content experts with respect to working through solutions while being able to answer tricky questions on the go. In addition, NearPod was found to be not suitable for self-paced group work as the lecturer is charge of the pacing of the content which led to student dissatisfaction, e.g.,

> Please give us more time to answer questions or give us warning when the questions are being taken down as sometimes we are in the middle of discussions when the questions are taken down.
> [Hepatitis Clinical Classroom using NearPod software, 2014]

We then chose to work with the open source LAMS software which had recently been adapted specifically to deliver a TBL style curriculum. We needed the technology to be flexible enough to deliver our modified TBL Clinical Classrooms and this software stood out from other purpose-built software options for this reason as LAMS is designed to run multiple different learning designs. From 2015 to 2019 we have evaluated and modified the modules to a point that student and staff satisfaction rates are good to very good. Key changes to the Learning Design of the Clinical Classroom have included changing the learning space to assist grouping and interactive ability, group size to maximise individual interactions within a group, placement of iRA as a pre-work task to allow students to assess their level of knowledge prior to entering the group work session, and importantly, improving alignment of expert content and questions. We have also brought a research student into the project team who originally participated in the Clinical Classrooms as a second-year medical student in 2016 and who has provided valuable insights into student motivations to learn and content for the project.

In the two examples below of the survey responses (Figures 1 and 2) it can be seen that the iterative development and improvement in the modules has led to improved student satisfaction in the use of online lectures (with iRA) and satisfaction in students perception that they can apply and transfer knowledge to new clinical scenarios.

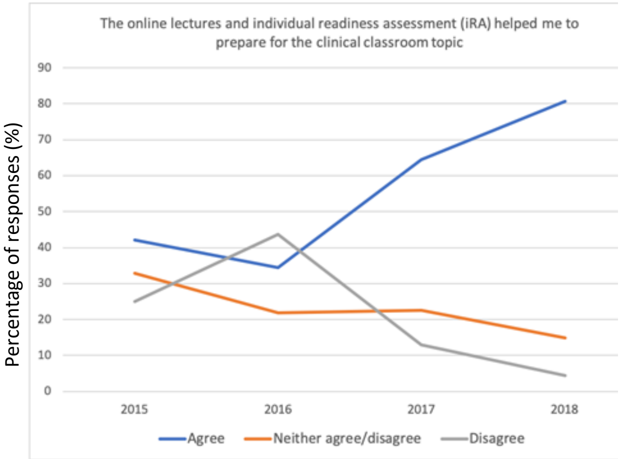

Figure 1: Student responses to having lectures online with iRA

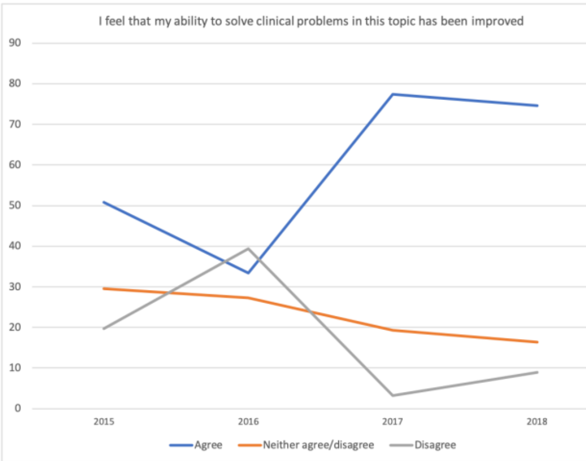

Figure 2: Student response to transfer of knowledge to new clinical scenarios

There were also improvements with motivation to prepare for class, engagement with the content and team discussion and a request for more Clinical Classrooms in the future

Table 1: Student response expressed as agree or strongly agree for Clinical Classroom feedback

Survey question	2015 (n = 61)	2018 (n = 67)
Online lectures and individual readiness assessment (iRA) motivated me to prepare for class	44% agree or strongly agree	81% agree or strongly agree
Team discussion activities in the Clinical Classroom helped me engage more with the content than in a normal lecture	40% agree or strongly agree	88% agree or strongly agree
I would like more Clinical Classrooms in the future	33% agree or strongly agree	81% agree or strongly agree

Positive student feedback included: “The group discussion with tutors coming around to help us was very effective and helped with my understanding (student feedback, 2017)” and “very good way to learn ID, could probably even work for other blocks like neuro (student feedback, 2018)”. Based on the Clinical Classrooms being well received it was decided to roll out a new Clinical Classroom for the Oncology block in 2018 – this has subsequently been positively received by students “i wish u've done this every week in onco. make it a little bit shorter though like id ccs” and “Overall really good for consolidating learning” (student feedback Oncology Clinical Classroom, 2018).

Conclusions and next steps

Our design research approach has been valuable for iteratively designing a practical way to include TBL in our PBL oriented course. This has allowed us to combine the exploration of ideas and promotion of self-directed learning components of PBL with the application of learning to alternate scenarios and challenging of students assumed level of learning aspects of TBL. Use of the LAMS software has made the intervention possible with a relatively small team as there is no need to hand out scratch card, there is automated selection of leaders and groups and student progress through the session can be monitored in real-time to quickly catch struggling students. The software has also been integrated into our LMS to allow for single sign on for students.

While PBL allows students to apply new learning to an already established problem, TBL allows students to transfer and apply their knowledge to multiple professionally relevant, clinical problems. We see this as very desirable in identifying gaps in deeper understanding on topics and as a way of developing thinking and reasoning skills. The scientific understanding of the underlying mechanisms (pathological changes to structure and function) provides the basis for understanding disease process, no matter what the condition. This allows us to highlight the important linking concepts between conditions, rather than just the presentation of the conditions themselves.

Future directions include a roll out of the modified TBL Clinical Classrooms into other parts of the course including in Year 1. Our program is undergoing significant change to adapt to a new partnership with a rural medical school and ongoing feedback from students to move away from face-to-face lectures and to flexible online delivery. Advancing the use of TBL in our course is a positive way to address these diverse issues. Our research contributes to a gap in the literature showing how PBL and TBL can be delivered in the same medical course and in the process, we have adopted an innovative approach to improve transition from a pre-clinical to clinical learning environment.

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Declaration: The first author in this paper is related by marriage to the creator of the Learning Activity Management System software used in this study.

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Designing with Constraints: Are we designing for creativity or compliance?

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Presented is a concept that forms the basis of a larger research project aiming to understand the university lecturers design practices around bureaucratic constraints and, as a result, if they were still able to be creative. This idea was developed from the research findings of one of the author's PhD dissertation (Dave, 2017) wherein the lecturers expressed their design practice impacted by the various constraints which are explained in this paper. The authors argue that like other professional designers (engineers, architects), lecturers should be able to be creative despite the constraints. Also raised are the higher-level issue of learning and training in the area of higher education which makes people more responsive to creativity.

Keywords: Educational design, university teaching and learning, creativity, how students learn

Introduction

Educational design is a hybrid practice. For some people, it is a professional practice with roots in systematic approaches to instructional design (Gagné, 1974). For others, it is just a part of what they do as lecturers – often 'taken for granted' and not seen as needing special skills, concepts, methods or training (Bennett, Agostinho, & Lockyer, 2016; Goodyear, 2015). A key concern of professional educational designers is to ensure rigor. This is where the use of structured methods and appropriate learning theory in designing and/or selecting learning materials and tasks is critical to learning outcomes (O'Reilly, 2004). In contrast, few higher education lecturers have specific training in design methods or learning theory, or with little experience in using explicit methods and theory to guide the 'designerly' aspects of their work. How then do university lecturers design learning tasks for their students? Despite the practical importance of *good* task design for students' learning outcomes, there is still limited research on how university lecturers actually engage in task design, or on how they explain what they expect students to do when tackling tasks that they have designed.

Background study

The research proposed in this paper is based on the results of a PhD study conducted by one of the authors Dave (2017). It is relevant to present the study briefly. The project explored university teachers design practice by conducting a series of case studies which included semi-structured interviews along with the other data provided by the teachers. Total of nine courses from a range of disciplines (mathematics education, social work, pharmacy, accounting, psychology, human resource management, Australian sports culture) participated. Out of the nine courses, four courses were undergraduate, four courses were postgraduate, and one course was combined degree. Almost all the data gathered was qualitative in nature such as verbal audio recordings,
transcripts, written documents. Some quantitative data was produced – mainly the numbers of students in each course and some demographic data about them. The study was conducted in three phases.

The first phase was semi-structured interviews with the teachers from different disciplines. In the first interview, the teachers nominated a task which they talked about. Teachers explained how they designed the task and what was the rationale for the task and why did they think the task was the best choice to achieve the learning outcome. Therefore, phase one provided teachers' intention for the choice of the design.

The second phase was the students' focus groups from each teachers' class. The students were asked: "what do you think your teacher is trying to achieve here?", "how the task was communicated to you?" "was the rationale for the task explained to them?" and so on. This phase was divided into two stages. The first stage was the written individual responses from the students on the above questions. In the second stage, the students discussed the same questions in the focus group.

The third phase then was to take the results of phase two (what students think of the task and task rationale- design intention) and ask teachers feedback on students' interpretation of the design. This was the opportunity for the teachers to reflect on their choice and get feedback from the students on their design through the researcher. At this stage, the alignment/misalignment of teachers design intentions to students' interpretation was prepared and discussed. In the cases where the misalignments between intention and interpretation were emerged, one of the reasons teachers provided was bureaucratic constraints that limited their creativity. The results showed that design practice is constrained by policy-related factors. As a result, lecturers are more focused on compliance with those policies and not on the curiosity that the task needs to generate among the students. The following section outlines those constrains and discusses the idea of designing with constraint and its impact on student engagement.

Designing with constraint

When academics design an activity or assessment tasks for students, one of the challenges that they are dealing with is bureaucratic or regulatory constraints. For instance, one can only give student so many assessment tasks, it could be worth so many points and it could only take so many hours to do. Lecturers also have to map the assessment tasks to the unit/subject and curriculum outcomes, graduate attributes, learning outcomes and so on (Prosser & Trigwell, 1999; Ramsden, 2003). There are a lot of constraints to deal with. It contrasts with how people used to set the assessment task in the past. Academics setting up the activity (particularly assessment tasks) are much more conscious of the regulatory constraints than they are of educational purposes and what suffers is the opportunity for students to make personal meaning of the assessment task through their own creative input.

To contrast lecturers' role as a designer with the serious designers from the other disciplines such as architecture, product design or mechanical engineering, we need to take the analogy, let's think about the architecture designer – an architect. The constraints that an architect deal with are much more complicated and much more numerous than lecturers in higher education have to typically deal with (Alexander, 1977). The architects have constraints of space, context, material, approvals related regulations, and so on. If one is a trained professional designer such as an architect, one has to deal with numerous constraints and yet able to make the activities creative. It could be argued that in taking this constraint seriously, one becomes more creative (Alexander, Ishikawa, & Silverstein, 1977). This leads to how the academic task sets in context, where academics have to be conscious of the constraint, and yet manage that creativity. Expanding on this analogy further, we want more than the creativity or a creative piece of work from academics, who are designing the task, but also want to be open for the user of that designed task (students in this case) to be able to adapt creatively in the same way architects want their users to take ownership of the building and personalise for their own use (Dave, 2017). Design professionals nowadays often manage to work with multiple constraints and still come out with creative tasks. This raises an important question as to how academics in universities can be assisted to manage this complexity.

Freedom to interpret

Fig. 1 below illustrates the conceptual distinction between the task and the activity in which students actually immerse themselves. A point of contention can arise when what students do is different from what the teachers want them to do. One clear message stemming from the distinction between the aim of the task (design intention) and the activity carried out (interpretation of the design by the students) is that teachers need to design tasks allowing flexibility for students - with adaptive properties, to allow for students' interests, needs and capabilities. For example, a teacher's design *ideally* might set some requirements for a project and let students relate the task to their views or work situation. Also, students have to judge for themselves how much time and effort they need to dedicate to an activity given other competing for academic and non-academic demands on their time and energy.

Mann (2005) suggests that the students are alienating their labour in the sense that they cease to see the intrinsic value of the task and they trade their labour for marks in the way that people at work trade their labour for wages. If the students being in the mode in their higher education where that is how they typically make sense of the task, then it is very hard to get them to undertake tasks other than fairly simple trade of their time and marks. Mann (2005) refers to this as an issue with communication without referring to the design. This does not mean that once alienated, always alienated or alienated a bit means alienated a lot. Never-the-less, even in situations in which students often adapt that alienated position, it is still possible from time to time to set up a task that they will interpret in a different kind of way (Goodyear, 1997).

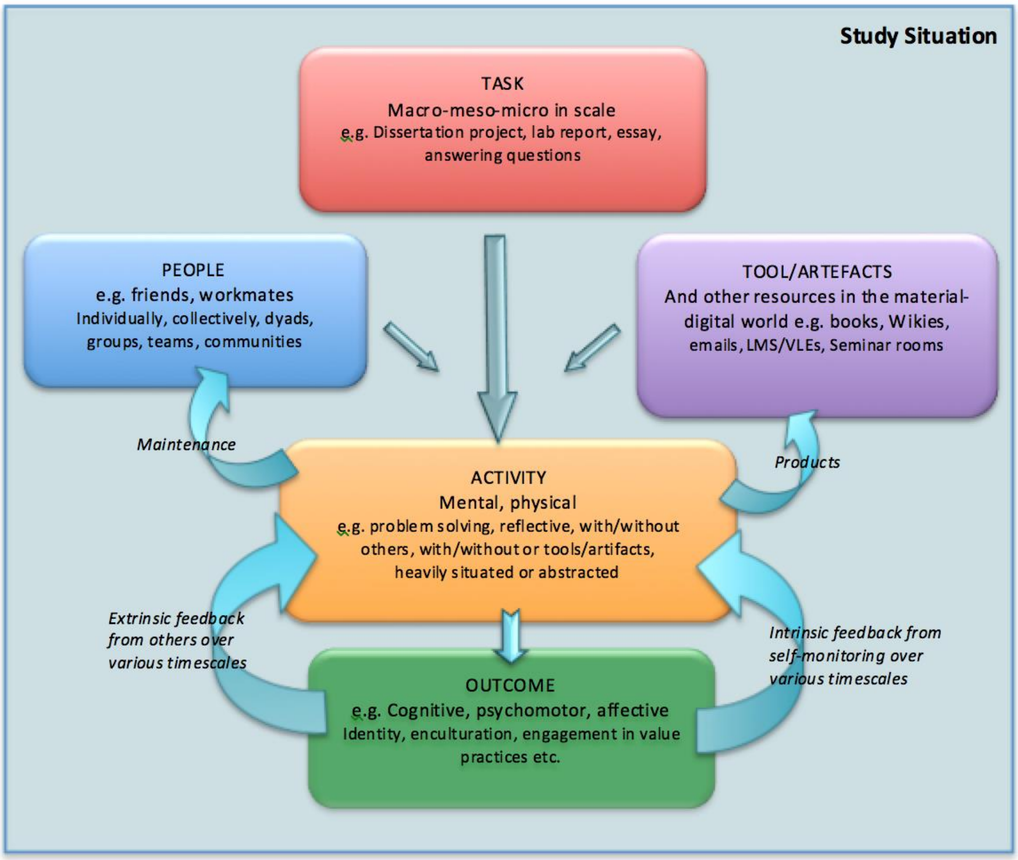

Figure 1: Conceptualising the problem space of educational design: adapted from (Goodyear & Retalis, 2010)

Students, when they are faced with a new task, are often prepared to be open to the ideas such as 'this could be something interesting', 'this could be different' or 'this could be something I want to do'. A good design must encourage their enthusiasm and creative responses. However, it is a matter for another wider research on how the task design should support students and sustain their interest in the activities that they do.

Addressing bigger issues in higher education

The issue of *good* design is partly about the bigger issues, such as quality of teaching, the way university education is conducted (design, delivery, mode and so on), how students engage and if something needs to be done to improve those aspects (Agostinho, Lockyer, & Bennett, 2018). But even if we did not have that alienating relationship, we still have a problem about how we design *good* tasks (Goodyear, 1997). The issue is about having a right mixture of structure and creativity, structure and openness. Curriculum and assessment design does not seem to be working for many students. Going back to the architectural analogy, what architects produce is multiple representations of, and multiple documents about, the building. Some of the documents would be in response to the planning requirements and that would be very different from the architecture drawing or an artist rendering of the completed building which is what one needs in order to excite the clients. Applying this to the higher education context, the design team can map the task to the certain quality assurance framework (addressing bureaucratic constraint) but the design team also can say that here is the part of a task that engages students' intellect and imagination. For instance, Dave (2017) provides an example of a task when the students of the Bachelor of Teaching degree participated in the task in mathematics education. The task was designed to meet the requirement of the NSW Teacher Education Standards (compliance with policies), but there were also other components such as working in team (graduate attributes), assessing a child on his mathematical ability (excitement) and use the tool prescribed by the Department of Education (required intelligence) and figuring out how to move forward in the testing depending on the answer given by the child (component of imagination).

There is a lot to be done in higher education and more generally in the area of learning and training to help people respond creatively to challenges. Technology can play a major role in helping teachers to design creatively. This brings to the bigger issue of how university teachers can be supported for design work (Sue Bennett, Agostinho, & Lockyer, 2017).

Way Forward

As per Dave (2017), the university teachers perceive the creative design process is limited by various constraints. This project is designed to understand university lecturers' design practices when they design with constraints and get a first-hand account of what are the constraints that they face while designing tasks and how those constraints limit their ability to be creative. The research also aims to find out if creativity is something that the lecturers consider while designing the tasks and if they do, how they maintain the creativity while complying to the constraints and, if they don't, what can be done to support university teachers to be more creative in designing their tasks.

This project is broken into two stages. Stage 1, the pilot of the project, aims to begin with participants from one university. The data would be gathered through triangulation of the data collection methods – a survey and then interview. Firstly, an initial survey would be sent out to ascertain demographics and gather data from open-ended and closed survey questions from the lecturers. The participants would be invited to participate via email from the researchers to participate in a 30-40 minute follow-up interview. The semi-structured interviews will focus on the constraints that teachers face while designing the tasks and how they [try] to overcome it to add creativity. Stage 2 the project would be extended to a further institution, asking the same interview questions. The results of this data will be published in a further publication.

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Students' self-regulated learning skills and attitudes in online scientific inquiry tasks

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Teaching students to think and act as scientists through inquiry is at the core of recent science education. Although self-regulated learning (SRL) is acknowledged as crucial to performing scientific inquiry, much is yet to be understood about the specifics of students' interactions with the scientific process. In the current study, we conducted an exploratory investigation of the role of students' SRL and related attitudes when completing an online scientific inquiry-based task. A task with a Predict-Observe-Explain learning design was used to examine the role of students' SRL and attitudes within specific phases of the scientific inquiry process. Participants were 233 students from an online undergraduate course. Four groups were identified with differing levels of SRL skills, challenge and confidence. We found that students with low SRL skills who also perceived a learning situation as challenging and had low confidence in their ability to learn, had difficulties designing effective experiments and correctly interpreting data. Implications and future studies are discussed.

Keywords: self-regulated learning, scientific inquiry process, digital learning environment.

Introduction

Changes in science curricula in higher education over the past decades towards a more performative conceptualisation have refocused attention on the teaching and learning of the scientific inquiry process. The scientific inquiry process can be conceived of as a series of methods and practices that professional scientists engage with while discovering new knowledge (Pedaste et al., 2015). Learning through inquiry requires self-regulation, that is, "planning, monitoring, and reflecting, which includes being able to plan a research project, monitor your progress, and think about how you could do better next time" (White et al., 2009, p. 176). Although there is compelling evidence to suggest that self-regulated learning (SRL) underpins a number of parts of the scientific inquiry process, much is still to be understood about the specifics of this relationship, particularly in digital environments (Roll et al., 2018). Therefore, the aim of this paper is to examine the role of students' SRL and related attitudes when completing an online scientific inquiry task.

The scientific inquiry process broadly involves formulating a hypothesis, conducting experiments or observations to test that hypothesis, interpreting obtained results and communicating findings to the academic and broader community (Pedaste et al., 2015). Some success in teaching the scientific inquiry process has been found in the use of Predict-Observe-Explain (POE) tasks (White & Gunstone, 1992). A POE task has three parts: (1) students make a prediction based on previous knowledge and known assumptions in the form of a hypothesis, (2) they explore an environment, usually a simulation if the learning environment is digital, where they conduct experiments and observe their outcomes, and (3) they interpret their findings in light of their initial prediction, providing an explanation of the observed phenomenon.

Throughout the scientific inquiry process, particularly when completing POE tasks, students can be viewed as active agents who regulate their cognition, affect/motivation, behavior and context. Broadly speaking, SRL involves three phases: (1) planning, during which students set goals and define strategies to use; (2) monitoring, when students check their progress towards their goals; and (3) regulating, when students make changes to their learning approach, if necessary, to guarantee goal attainment (Pintrich, 2000). Students' attitudes towards learning have been found to impact their ability to self-regulate their learning; particularly, challenge and confidence. Challenge is related to how difficult students perceive a task to be, and confidence (or self-efficacy) is related to how able they feel about learning new content. Perceiving a task as challenging can be motivating to certain students, but not if combined with low confidence. In this case, students' ability to successfully regulate their learning can be compromised.

In the current paper, we present an exploratory study investigating the role of students' SRL (namely, monitoring, regulating) and attitudes (challenge and confidence) when completing a scientific inquiry-based task in a digital learning environment. A task with a POE learning design was chosen to provide a framework in which we could examine the interactions between students' SRL with specific parts of the scientific inquiry process.

Method

Participants were 233 students from a large US-based university enrolled in an introductory Astrobiology online course in foundational concepts in biology, physics and chemistry – called Habitable Worlds – as part of their undergraduate study (Horodyskvj et al., 2018). Habitable Worlds is built on Smart Sparrow, a digital learning platform that affords automatised personalised feedback and captures students' interactions with the system as audit logs. The current study focused on one of the 67 lessons in Habitable Worlds – Brightness. In the Brightness lesson, students learn about the concepts of luminosity, brightness and distance in astronomy, interacting with different tasks across 32 screens. Within this lesson, there is a POE task where students investigate the relationship between brightness and distance.

The POE task has four main screens: Predict, Observe, Analysis and Evaluate. On the Predict screen, students are asked to select a hypothesis about the relationship between distance and brightness. They have five options, with three of these being plausible predictions based on relevant knowledge that students had access to at the outset of this lesson. After the Predict screen, students have the opportunity to check whether their assumptions are plausible. If they select two of the five hypothesis that are not plausible, they are returned to the Predict screen to select a new hypothesis. This cycle continues until the student selects one of the three plausible screens. Therefore, a high number of attempts in the Predict screen can be interpreted as students struggling to identify their assumptions when selecting a hypothesis.

On the Observe screen (Figure 1), students are asked to conduct an experiment to investigate the relationship between brightness and distance. They have access to a simulation where they can position a probe at different distances from the sun (drag and drop) and make an observation, which records on a graph the probe's brightness at that particular distance. Students also mark two checkboxes to indicate they have followed the prescribed methodology. Prior to this screen, students view two tutorial screens with instructions on how to use the simulation. Students are expected to make a sufficient number of observations with a varying range of distances. In case they fail to do so, the system provides students with automated feedback. The available automated feedback options on this screen are: correct, no checklist (students failed to check off the checkboxes), not enough observations (they failed to make the number of observations stipulated earlier in the lesson as the ideal number to be able to make meaningful observations), same observation (they did not make any new observations from the previous tutorial screens, or from previous attempts), and skewed data (they did not have a good range of observations; either too far or too close to the sun). A high number of attempts on this screen can be broadly interpreted as students having difficulty designing and conducting this experiment. The degree of difficulty can be further clarified by examining the type of feedback triggered in the system.

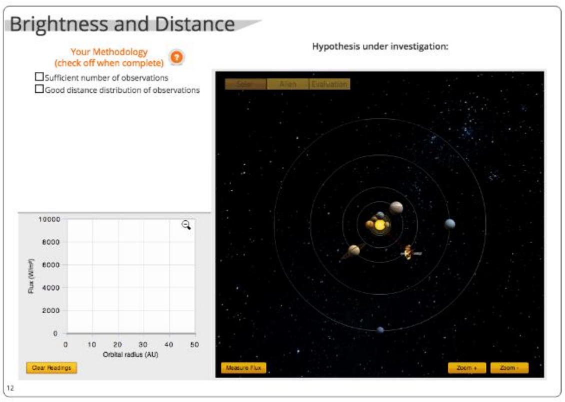


Figure 1: Observe screen in the R*2 Brightness lesson

Both the Analysis and Evaluate screens are related to the Explain phase of the POE task (Figure 2). On the Analysis screen, students are asked to interpret whether their observations match their initial prediction. Students then receive personalised feedback based on whether they made an incorrect match (answering that their observations matched their prediction, when it didn't; or vice-versa) or had difficulty using the graph to interpret their results ("no points visible" option). In both cases, students stay on the current screen for further attempts based on the feedback received. A high number of attempts on the Analysis screen can be interpreted as either students' having difficulty interpreting their observations (incorrect match) or having difficulty manipulating the graph (no points visible).

On the Evaluate screen students are asked to either accept or reject their initial hypothesis. On this screen, they are asked to interpret their observations in a formal manner as usually stated in scientific reports: accept or reject a hypothesis. Students stay on the current screen for further attempts if they have rejected a correct hypothesis or accepted an incorrect hypothesis. Conversely, they move to the next screens once they have either accepted a correct hypothesis or rejected an incorrect one. A high number of attempts on the Evaluate screen can be interpreted as students having difficulty interpreting their results and evaluating their initial hypothesis.

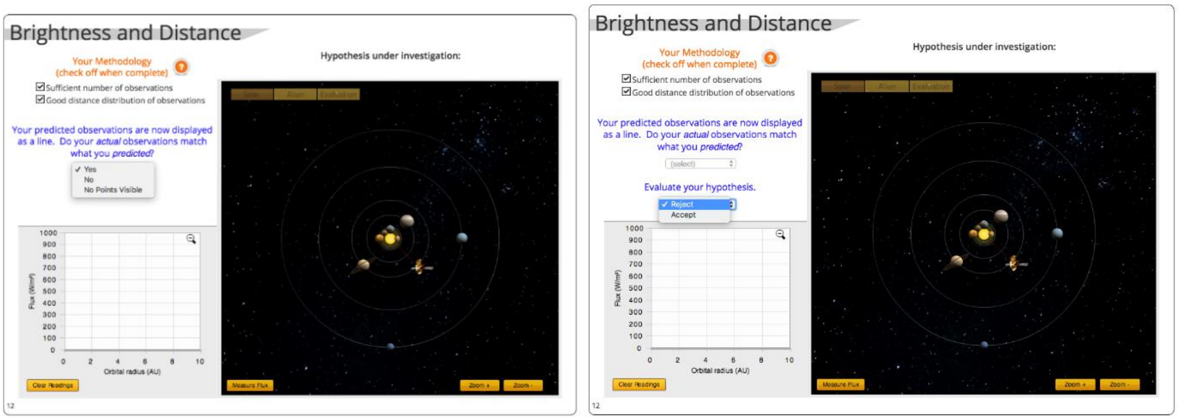


Figure 2: Analysis (left) and Evaluate (right) screens in the R*2 Brightness lesson

After completing the POE tasks in the Brightness lesson, students were invited to complete a questionnaire to report their level of SRL related to monitoring ("While completing this task, I asked myself questions to make sure I understood the material.") and regulating skills ("While completing this task, I tried to change my approach to the task depending on the feedback received."), and their attitude towards task difficulty ("Overall, how challenging was the material in the preceding task?"), and confidence completing the task ("Overall, how confident are you that you understood the material in the preceding task?"). All items were adapted from previous research (see de Barba, Kennedy & Trezise, 2017). Single-item measures were used to minimally disturb students during course activities (de Barba, Kennedy & Ainley, 2016). A 7-point Likert scale was used (1 strongly disagree to 7 strongly agree).

Audit logs collected throughout the Brightness lesson were used to investigate students' interactions with the content. These included time, number of attempts on a screen, students' response and feedback provided (automatically triggered based on students' responses and interaction with screen elements, such as the simulation). Students could attempt a lesson several times, but for the current study we focused on their first lesson attempt to examine their initial interaction with the content.

Results

In order to examine the association between students' SRL and related attitudes with their interactions when completing an online scientific inquiry-based task, we first clustered students based on their reported score for monitoring, regulating, challenge and confidence. A Two-Step clustering method was used. Two clusters were suggested, but three and four cluster solutions were also considered. The two and three cluster solutions had unequal group sizes and did not discriminate among all clustered variables. The four-cluster solution, on the other hand, produced clusters with similar sizes and was able to provide a richer combination of students' SRL measures. Table 1 presents the four student groups that resulted from this analysis.

The four clusters varied on two levels of monitoring and regulating (high or low), two levels of challenge (high or low) and three levels of confidence (high, medium and low). We labeled the two levels of monitoring and regulating as "SRL", the combination of high challenge with low or medium confidence as "Confused" , and the combination of low challenge with high confidence as "Confident". Clusters 1 and 2 reported lower monitoring and regulating values than clusters 3 and 4. The difference between Clusters 1 and 2 was that Cluster 1 reported high challenge and low confidence, while Cluster 2 reported low challenge and high confidence. Similarly, the difference between Clusters 3 and 4 was that Cluster 3 reported high challenge and medium confidence, while Cluster 4 reported low challenge and high confidence.

Table 1: The four SRL groups

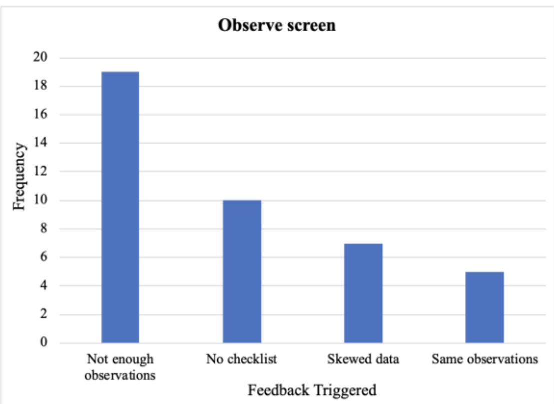
	Cluster label	Monitoring	Regulating	Challenge	Confidence
Cluster 1 (n=57)	*Low SRL Confused*	3.47 (1.28) [a]	3.77 (1.18) [a]	4.14 (1.17) [a]	2.96 (1.36) [a]
Cluster 2 (n=32)	*Low SRL Confident*	3.16 (1.32) [a]	3.63 (1.41) [a]	2.31 (0.97) [b]	5.78 (0.42) [b]
Cluster 3 (n=89)	*High SRL Confused*	4.84 (0.89) [b]	5.34 (0.69) [b]	4.51 (0.77) [a]	4.84 (0.89) [c]
Cluster 4 (n=55)	*High SRL Confident*	5.11 (0.71) [b]	5.31 (0.69) [b]	2.27 (0.73) [b]	5.33 (0.70) [b]

Notes. Different superscripts indicate significant differences across rows.

Group difference analyses were then conducted to identify cluster differences on students' audit logs from their interaction with the POE-related screens. One MANOVA was conducted for total time spent on each of the screens, and another MANOVA was conducted for number of attempts students made on each of the screens. There was a significant difference between clusters for the number of attempts students made on each screen ($F(12, 579) = 2.30$, $p = .007$; Wilk's Lambda = 0.884, partial eta squared = .04), but not on the total time spent on each of these screens ($F(12, 579) = 0.90$, $p = .552$; Wilk's Lambda = 0.953, partial eta squared = .02). Specifically, we found differences among groups in the number of attempts on the Observe and Analysis screens. On the Observe screen, students in Cluster 1 (Low SRL, Confused) had more attempts than those in Cluster 4 (High SRL, Confident). On the Analysis screen, students in Cluster 1 (Low SRL, Confused) had more attempts than those in Cluster 2 (Low SRL, Confident).

A Chi-square was conducted to examine students' responses (Correct/Incorrect/Missing) for the Observe, Analysis and Evaluate screens. A significant result was only recorded for the Observe screen, X2 (6, N = 233) = 18.68, $p = .005$. This showed that students in Cluster 1 (Low SRL, Confused) were more likely to select an incorrect response and less likely to select a correct response.

Considering the results so far indicating that Cluster 1 students (Low SRL, Confused) were finding it difficult to progress in the POE task, we further examined the type of incorrect feedback triggered on their first attempt on the Observe and Analysis screens (Figure 3). On the Observe screen, two types of feedback were triggered related to designing an experiment ("Not enough observation" and "Skewed data"), with "Not enough observations" being the most frequent; while the other two types of feedback were related to not completing the task correctly ("No checklist" and "Same observations"). On the Analysis screen, most of the feedback triggered was related to students accepting an incorrect initial hypothesis.



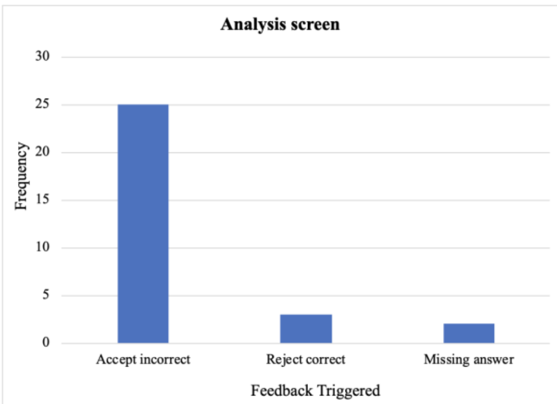


Figure 3: Frequency of feedback types triggered on the Observe (left) and Analysis (right) screens for Cluster 1 students

[5] Reports of high challenge and low confidence have been associated with the state of confusion in learning situations (de Barba, Kennedy & Trezise, 2017).

Discussion and Conclusion

Taken together, findings from the current study suggest that students' SRL together with their attitudes toward learning impact how they completed an online scientific inquiry task. This was reflected in behavioral differences between the groups with different self-reported levels of SRL and attitudes in the POE task. Particularly, we found that students with low self-reported SRL skills and confusion (high challenge and low confidence) presented behaviors related to known difficulties that students face when applying the scientific inquiry process: designing inconclusive experiments and misinterpretation of data.

Designing inconclusive experiments occurs when individuals "do not always behave as logical thinkers and do not perform the actions that would be most effective for testing a hypothesis" (De Jong & Van Joolingen, 1998, p. 185). This difficulty was evident on the Observe screen, where students were asked to conduct an experiment to investigate the relationship between brightness and distance. Students with low self-reported SRL skills and confusion (Cluster 1) made more attempts and obtained more incorrect responses than confident students with high SRL skills (Cluster 4). Further analysis showed that Cluster 1 students' additional attempts and incorrect responses were related to creating too few observations in the simulation. From these findings, we can infer that problems students from Cluster 1 faced in this task were related to their knowledge about the scientific inquiry process (i.e., how many observations would be effective to create an experiment to test the relationship between two variables) rather than the content being learnt (i.e., concepts of brightness and distance). However, due to students in Clusters 1 and 4 differing on both SRL (monitoring and regulating) and attitudes (challenge and confidence), we cannot relate difficulty with designing experiments to any one of these constructs separately.

Misinterpretation of data is when students do not interpret their observations correctly. This is considered a type of confirmation bias, where students' initial hypothesis guides the interpretation of their observations (De Jong & Van Joolingen, 1998). This difficulty was evident on the Analysis screen, where students were asked if their observations matched their initial prediction. Students with low self-reported SRL skills and confusion (Cluster 1) had more attempts than confident students with low SRL skills (Cluster 2). These additional attempts were related to Cluster 1 students accepting their initial incorrect prediction. Considering these groups had similar SRL skills, students' difficulty interpreting data was most likely associated with their perception of task difficulty and confidence. However, it is difficult to determine whether the misinterpretation of data was related to their knowledge of the scientific inquiry process (i.e., being unable to interpret data from graphs in general) or to the content being learnt (e.g., not understanding the relationship between brightness and distance).

In sum, this preliminary study begins to unpack the relationship between specific aspects of SRL and phases of the scientific inquiry process. As the main implication of this type of study is to inform personalised interventions, it is crucial for future studies to (1) better understand the interplay between aspects of SRL and their impact on scientific inquiry learning (i.e., focus on controlling for phases of SRL in relation to students' perceptions of task difficulty and confidence), and (2) carefully consider task design so as to capture distinct learning analytics for learning markers of the scientific inquiry process and of the content knowledge.

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"Okay, but what does it look like?" Building staff capacity in online learning design through role modelling

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Designing for online learning requires staff to rethink their approach to teaching and learning. A key challenge in this reconceptualisation is envisaging what this new teaching context might 'look like'. In this paper, we describe the development of a self-paced online staff capacity building resource, which modelled good-practice online learning design principles and assisted staff to reconceptualise teaching through experiencing premium online learning.

Keywords: curriculum innovation, online learning, professional development, capacity building

Teaching and learning in higher education are changing significantly due, in part, to the influence of digital technologies. Responding to this digital disruption often means teaching staff need to rethink the way in which they have taught, and the way they understand how students learn. Yet for many, envisaging what this new online teaching context may 'look like' is difficult, as teaching is strongly influenced by an educator's own learning experiences (Richardson, 1990, 1996) which are likely to have been predominantly face-to-face and teacher-centric (Goodyear, 2015). This paper describes how we* designed a self-paced online staff capacity building resource that modelled the online learning design that we were asking staff to adopt. The resource put the teacher in the position of the learner to provide an experience of premium online learning and help teachers reconceptualise what higher education teaching could 'look like'.

Background to the program

The capacity building resource was developed as part of a major curriculum innovation project that aimed to re-design the online learning experience for both on-campus and online students. The project involved academic staff teaching in three courses across two faculties working together with a team of learning designers and digital resource developers to co-create online learning experiences complemented by active and collaborative face-to-face learning activities where relevant. Eight units from each course were selected for redevelopment over the course of three consecutive teaching periods. For each unit, a learning designer worked with the academic in charge of the unit, and the wider teaching team as appropriate, to redevelop learning materials, ensure constructive alignment and provide ideas and suggestions on how to structure learning in the online environment. Students utilised these materials either wholly online, or in a flipped-classroom model depending on their study mode. In taking a multidisciplinary team approach, the learning designer also liaised with the digital resource developers and other university staff, including liaison librarians and digital accessibility experts, as required.

The learning design approach drew heavily on Diana Laurillard's (2012) Conversational Framework which utilises technology to create activities that build knowledge and skills in an iterative way while creating opportunities for teacher-student and student-student interactions. The approach was underpinned by our institutional policy around premium learning and teaching. To assist staff in the design and development process, we clustered these principles into five learning design themes briefly described below:

- **Learning is scaffolded**
  A clear narrative sequence communicates the relationship between activities, tasks and learning outcomes. This alignment creates a consistent and integrated learning pathway that fosters deep learner engagement.
- **Learning is activity-focused**
  The learning materials include clear 'calls to action' and a mix of learning activities that lead to defined summative assessment tasks. Learners use active investigation to develop skills and knowledge and explore key concepts in authentic professional contexts.
- **Learning is feedback-focused**
  There are multiple opportunities for formative feedback from staff and peers, through activities and assessments, so students can improve as required. Students have opportunities to evaluate their own and others' work in order to develop evaluative judgement. Student learning progress and achievement is monitored and acted upon to maximise success and improve curriculum design.

- **Learning is supported**
  Inclusive learning experiences and environments are designed to accommodate student diversity, and create equivalent opportunities for academic success for all learners in rich online and located learning activities and spaces. **Learning is supported** by student services which enable participation and success, academic support services to develop underpinning knowledge and skills, and high production-value learning resources.
- **Learning is social**
  Students are welcomed into a respectful, vibrant learning community with multiple opportunities for dialogue and interaction with teaching staff and fellow learners. Learning resources and activity sequences are designed to highlight that the teacher guides and facilitates student learning that is both self-directed and collaborative with peers.

Challenges in implementing curriculum redesign

Laurillard (2012) conceptualised learning as a dialogue between student and teacher, deepened by conversations between the student and their peers. Conversations with peers allow students to clarify, explore, contextualise and extend knowledge while the teacher's communications guide the learning journey by showing students how the teacher understands and acts on knowledge, and designing opportunities for students to test and clarify their own understanding against that of the teacher (Laurillard, 2012). A key aim of the project was to design for learning using these principles in order to transform the online unit site into a space for interaction and engagement between student, teacher and peers, rather than a simple repository of information. This concept of the unit site as an active space for interaction was often difficult for academic staff to visualise as they found it hard to imagine something *other* than what already existed in the online space. Anecdotally, co-creating this shared understanding, rather than working towards a pre-defined end goal was one of the biggest challenges in the design process.

Implementing the learning design principles described above required academic staff to reconceptualise their approach to teaching and learning, often moving away from the 'traditional' (e.g., face-to-face, teacher-centred, synchronous) approaches they likely experienced as students themselves . Despite a substantial body of literature showing that a student-centred, active approach is more effective for learning (Ramsden, 2003), reconceptualising and changing teaching practice is difficult (Richardson, 1990). A teacher's approach to teaching is heavily influenced by their own learning experiences, discipline and previous teaching practice (Richardson, 1996; Singh & Hardaker, 2014) and reconceptualising their practice requires more than the development of new pedagogical knowledge. To reconceptualise their approach, teachers need to be able to observe, experience and test a new approach, with support from peers and experienced others (McLoughlin, 2000; Osika, 2006).

The curriculum redesign also required other changes in the way the teachers worked. For example, timelines were different, with learning materials needing to be prepared well in advance of teaching. Most of the academic staff had not worked with a learning designer before – although this co-design approach is an important part of supporting academics to meld their subject matter expertise with pedagogical knowledge to effectively support student learning (Osika, 2006), it can at times be uncomfortable as role boundaries are negotiated in this so-called 'third-space' (Whitchurch & Law, 2010). The flexibility of the learning design and the need for this to be contextualised to the discipline meant that the final unit design was variable and uncertain, creating a further challenge in envisaging what the new unit site might 'look like'.

Developing an online resource to build staff capability

To address these challenges, we created a unit site that modelled the learning design to assist staff to visualise this end goal. The resource was designed to role-model the learning design principles in action and provide teaching staff with insights into what their unit site and learning design might look like, while communicating that this was only one way to undertake the design process, as it was important that the design principles were contextualised to both the discipline and unit context. Thus, the resource needed to articulate a clear vision and goals, while being flexible enough to accommodate different disciplines and levels of expertise and experience. In addition, we were conscious that staff outside of the innovation project were keen to apply the learning design as part of their own curriculum renewal processes, therefore we needed to create a capacity building resource for multiple audiences. By designing and hosting this resource on the University learning management system that teachers and students use for their own teaching and learning respectively, we hoped to allow teachers to more easily envision how these principles could be applied to their units and learning materials. The resource also provided examples of how academic staff involved in the project had already enacted the learning design in their units.

Beginning with identifying the learning objectives, we then employed a number of strategies to bring the learning design principles to life and model for staff what these might look like. These strategies are discussed below, in relation to each principle.

Learning is scaffolded

The resource was structured into a sequence of modules with the following themes:
- Start here: an opportunity to introduce the project team and provide context to the innovation project strategy delivered by the Deputy Vice-Chancellor (Education)
- Topic 1: a general introduction to the innovation project
- Topic 2: the learning design process and how technology could be leveraged in the learning design
- Topic 3: explained and modelled each of the learning design principles in detail
- Topic 4: new ways of working together and what this approach might mean for teaching teams
- References of evidence underpinning the project and further readings.

The first module included a short video in which the DVCE articulated the vision and goals of the project, placed the project in context of curriculum renewal processes, and provided reasons why and how we were taking this approach to online curriculum design. This communication of a clear overall strategy, vision and goal, by leaders, is considered essential for successful eLearning innovations (e.g., Singh & Hardaker, 2014).

The resource utilised an animated pedagogical agent - the ‘Cloud Coach’ - to personalise and enhance the learning process (Clark & Mayer, 2016). The Cloud Coach explicitly identified and explained how the learning design was enacted, to help staff identify different ways in which the learning design principles might be applied in their own teaching (See Figure 1). A conversational tone for the Cloud Coach’s text (i.e. voice), and human-like movements (blinking and ‘thumbs-up’) were used as preliminary research suggests that a conversational tone and human-like behaviours in pedagogical agents are effective for learning, encouraging learners to see the computer as a conversational partner rather than simply receiving information on the screen (Clark & Mayer, 2016).

You can see the narrative in this course expressed through the bold 'key topic statement' at the top of the page and the sub-headings used within the page. These are written in our 'voice' which not only builds social presence but this personal narrative recognises that learning is holistic and has a human dimension (Millar & Bester, 2008). The sequence of activities across this course also broadly align to the sequence described above.

Figure 1: Sample ‘Cloud Coach’ explanation of the enactment of ‘Learning is scaffolded’

Each step (a ‘step’ is a single html page) also included a list of additional resources to help staff learn more about the topic and tailor their reading to their particular area of interest. A brief (1 – 2 sentence) summary of each additional resource was provided to put each reading in context and help staff readily personalise their learning journey by choosing the resources of most use to them.

Learning is activity-focused

To demonstrate how the online unit site could be a space for activity, rather than an information repository, each step of the resource included a task, or ‘call to action’ to encourage learners to actively engage with the content. We used these tasks to prompt staff to reflect on how they might apply the principles to their own teaching. For example, staff might be asked to identify one area of their unit in which they might apply one of the principles, or one strategy that they might be able to implement in the next teaching period. Some tasks were linked across steps to make larger, more meaningful learning activities so that by the end of the module staff had created a draft learning design map which could then be used as a starting point for unit re-development.

Learning is feedback-focused

Teachers often do not have opportunities to discuss their teaching, and their approach to teaching and learning, with others (McLoughlin, 2000) – feedback is often limited to student evaluations. Yet these discussions enable teachers to observe, test and receive feedback on ideas and strategies and identify new approaches (McLoughlin, 2000). We created embedded discussion forums within steps and explicit prompts to enable staff to share and discuss ideas with their peers, and observe each other’s activities and successes (Osika, 2006).

We also included interactive activities at the end of each module where staff could check their understanding as they progressed, with explanatory feedback to assist in the learning process and foster motivation (Figure 2).

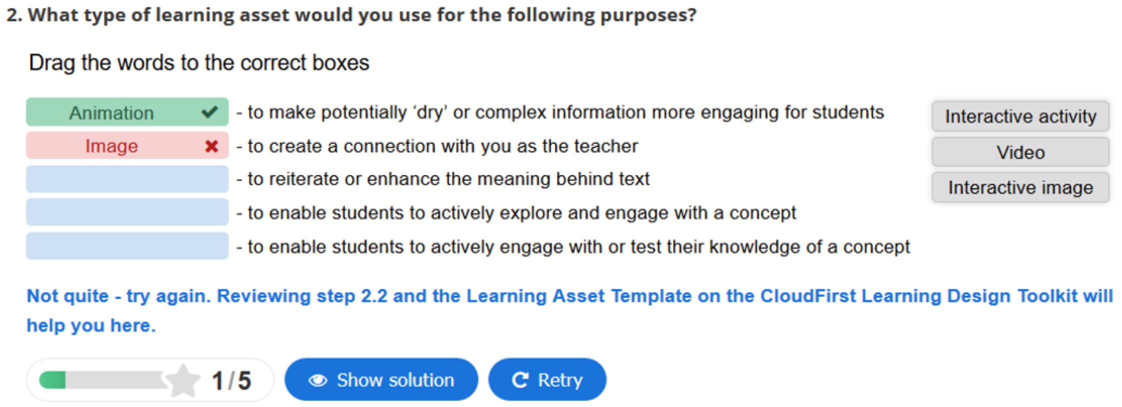

Figure 2: A sample quiz question for staff to check their understanding of the resource content

Learning is supported

Purpose-built images, interactive diagrams and videos were used throughout the site to illustrate concepts and facilitate learning. For example, a character was created for each learning design principle to act as a memory aid and to humanise these ideas (Figure 3).

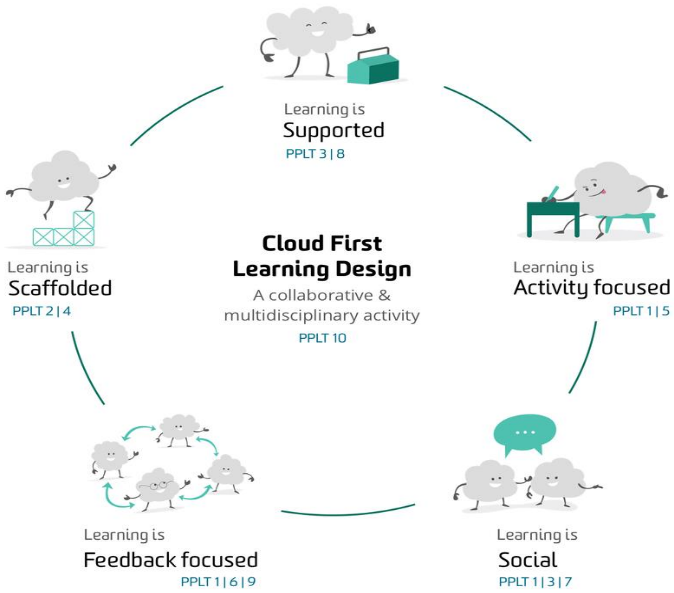

Figure 3: Characters were used to help learners remember the learning design principles

Recognising that staff would have varying levels of knowledge and experience of online learning design, the resource included links to additional resources so interested staff could easily access further information. Links to university resources and contact information for teams who could help staff build their expertise and apply the learning design principles in their own work were also provided.

To ensure accessibility of the resource, and to model the creation of fully-accessible resources, we worked with the university's Inclusive Education team to ensure that the learning materials adhered to WCAG2.1 accessibility standards. For example, heading levels were used to aid in navigation, ensured colour contrast was accessible and provided captions, transcripts and audio descriptions for all videos. Text alternatives were provided for any interactive diagram or activity that was not fully accessible by a screen-reader. The site was also audited by the Inclusive Education team, and a colleague with a vision impairment conducted a live screen-reader test of the site as part of a professional development session for the wider project team.

Learning is social

Learning is an inherently social activity, in which learners build their understanding through discussion and interaction with teachers and peers. Social interactions were facilitated through the embedded discussions and explicit discussion prompts described. We have also developed a synchronous workshop, offered both face-to-face and online, to complement these online resources, to provide additional opportunities for interaction and further model active learning and the flipped classroom approach. Additionally, academic staff were encouraged to work through the online materials with colleagues so they had a 'peer group' with whom they could discuss the content and trial new approaches and strategies.

Preliminary conclusions and next steps

A self-paced capacity building resource for staff that modelled online learning design was created to assist teachers to envisage and begin to operationalise a new approach to online teaching. By positioning teachers as learners and letting them experience the revised online learning design through a student lens, we aimed to influence a change in teaching practice. To further demonstrate the learning design principles, a pedagogical agent, the Cloud Coach was used to explicitly highlight how the learning design was being applied, and learning tasks were designed to prompt staff to apply these principles to their own teaching.

A formal evaluation of the resource has yet to occur, but preliminary anecdotal feedback suggests that staff have found it a useful introduction to the learning design approach and the principles. A second resource that explores aspects of online learning *delivery* is currently underway, with input from students to further model a student-centred approach to teaching. It is hoped that these resources support staff to develop the knowledge and skills required to teach in the contemporary higher education environment.

NB. *'we' refers to the project team. The authors would like to acknowledge the work of the project team and our colleagues from across the university in the creation of the resource.

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25 principles for effective instructional video design

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This paper reports on the first phase of a broader study into effective design of instructional video. While instructional videos are increasingly popular as learning objects, increasingly easy to create by any educator, and have been shown to support effective learning as well as being scalable and re-usable, there is a lack of clarity about what educators need to consider when creating or choosing them. Instructional videos differ from other film media in that they are primarily intended to teach content, concepts, or skills. Building on Mayer's (2014) work in which 15 instructional design principles were identified for multimedia learning, this paper presents 25 principles emerging from a broad-based exploratory literature review specifically focused on instructional video design.

Keywords: Instructional videos, cognitive theory of multimedia learning, instructional design.

Introduction

The use of instructional videos is increasingly common in higher education. Instructional videos are designed to teach specific content, skills or concepts, and differ from other educational videos such as narrative films, or those designed primarily to facilitate communication or collaboration. A growing body of literature affirms that instructional video is not only popular with students (Henderson, Selwyn, & Aston, 2015), but can also enhance student learning. For example, videos can facilitate learning by giving students control over the pace of instruction (Murray, Koziniec & McGill, 2015). An emerging advantage is that videos are also easily trackable for learning analytics (Kim, et al., 2014). In comparison with traditional texts such as static readings or diagrams, effectively designed videos have been found to facilitate greater learning (Castro-Alonso et al., 2019; Hoffler & Leutner, 2007) and increased motivation (Abeysekera & Dawson, 2014). Importantly, instructional videos are also believed to be advantageous because they are scalable, enduring, and re-usable. Scalability is an increasingly important factor in the context of increasingly massified classes. Such videos are also enduring and re-usable, allowing them to persist over time for re-use by students within a class, and re-use by educators for different classes or cohorts.

Given such advantages, it is understandable that universities are embracing the affordances of instructional videos. While videos created at universities previously consisted largely of lecture capture, many universities and other institutions of higher learning now create more deliberately produced content (see Chorianopoulos, 2018 for a taxonomy of video styles). These can be expensive, with Hollands and Tirthali (2015) estimating that a single hour of high quality, finished MOOC video can cost $US4300 to produce. Even videos made by individual educators using low budget tools cost time and take educators away from other activities. Unfortunately, this time and expense does not guarantee that the videos are efficient at teaching students the desired content, concept, or skill as many simply transfer questionable teaching methodologies from the lecture hall to the screen (Guo, et al., 2014; Ibrahim et al., 2012).

When students feel university produced videos do not adequately meet their needs, they often look for substitutes, particularly on YouTube (Henderson et al., 2015; Shoufan, 2018; Tan & Pearce, 2011). Unfortunately, students are not always in possession of the kind of syntactical subject knowledge to determine whether a video is a reliable substitute. As such, they can find themselves lost in a "vast wasteland of garbage and social parody that adds nothing to the learning process" (Jones & Cuthrell, 2011, p. 81), in which some content analyses have found as low as 4% of videos on a given topic considered highly accurate (Al-busaidi, Anderson, & Alamri, 2017). This is personified by an unfortunate sociology student in Tan and Pearce's (2011) study who was sure she'd found a good explainer video on feminism, only to be told it was in fact a parody produced by a US right wing extremist group. As such, for both economic and academic reasons, it is incumbent on universities and academics who produce instructional videos to do it well.

Cognitive Theory of Multimedia Learning and Cognitive Load Theory.

The design of instructional videos should take into account how humans process information, or "the effectiveness of instructional design is likely to be random" (Paas & Sweller, 2014, p. 27). Cognitive Theory of Multimedia Learning (CTML), which is based on Cognitive Load Theory (CLT) presents theoretical propositions and experimental data that aim to guide the process of multimedia design from the perspective of how the learner processes novel information. CTML is based on the premise that humans have a limited capacity to process new information, and that learning involves consciously organising this information into long term memory, which is effectively limitless (Ayers, 2015). By limiting extraneous processing imposed by poor instructional design, cognitive overload is avoided. This in turn allows cognitive processing to be allocated to the task of generating long term conceptual change, or schemas, which can also be encouraged through purposeful design (Muller et al., 2008). For a fuller explanation as to how each theory conceptualises human cognitive architecture, see Sweller, Ayers, and Kalyuga (2011) for CLT and Mayer (2014) for CTML. The two theories, while offering slightly different conceptions of human cognitive architecture, commonly agree on recommendations for instructional design. These principles of design have been shown to decrease extraneous cognitive load and therefore contribute to a more efficient learning experience, specifically for low proficiency learners (De Jong, 2010). Conversely, “poorly constructed materials” (Ayres, 2015, p. 632) that don’t take into account cognitive load tend to lead to inferior learning outcomes in experimental conditions. It is possible, therefore, as Mayer (2014) has done, to synthesise the experimental literature from the two fields into a single set of instructional design recommendations.

Methodology

This paper reports on the first phase of a broader study on the effectiveness of instructional video. In this phase a three stage literature review was conducted with the aim of providing the investigators with a synthesis of the research literature relating to the design of effective instructional video. An outcome of this process was the finding that there is considerable variation in what is understood to be effective design principles, as well as surprising silences in the literature, especially with respects to contextual and affective influences.

The principles in Table 1 emerged from a three stage literature review focused on effective design of instructional videos. Stage 1 involved searches of ERIC, ProQuest, and Google Scholar. Results were limited to peer reviewed journals, peer reviewed conference papers, and book chapters. The search terms combined each of Mayer’s (2014) 15 principles of multimedia instructional design with the terms animation or video. Due to the emerging nature of educational video design research, a second stage involved a broad-based exploratory search for papers investigating MOOC, YouTube and instructional video efficacy or design. Stage three consisted of a snowballing technique utilising the reference lists of the selected works. Sources were then excluded from the pool if they were not empirically based or if their analysis and findings did not specifically address design recommendations of instructional videos. Sources included experimental studies or meta-analyses of experimental studies, as well as descriptive case studies. The inclusion of qualitative studies is a deliberate break from the tradition of CTML/CLT, which preferences experimental designs (Mayer, 2014). Such studies, embedded in real world settings, are valuable in revealing considerations relating to the role of context and affect on the design and use of instructional videos. This review does not try to establish any comparative value between the principles, but rather to first identify what principles are relevant in instructional video design and as such, the inclusion of a range of study designs is deemed appropriate.

In total, 66 papers or chapters were then reviewed for explicit and empirically justified statements or principles regarding the design of effective instructional video. These statements were extracted and a theoretical thematic analysis was conducted similar to the process described by Braun and Clarke (2006). As such, an initial coding structure was based on Multimedia Learning Theory and in particular Mayer’s (2014) three categories and 15 principles of multimedia design. However, in recognition of the exploratory nature of this literature review, a constant comparative method was also adopted: when an extract did not fit with an existing code, a new code or category was created until all of the data had been incorporated and theoretical saturation had been achieved. These codes were then thematically analysed and resulted in 25 principles organised according to Mayer’s three categories, plus one additional category for interface design.

A complicating factor in developing this summary table was that the fields of CLT and CTML use different nomenclature for very similar concepts and principles, including the three kinds of cognitive processing that constitute the principle categories. As such, some principles on this list retain Mayer’s (2014) CTML titles, some are given their CLT titles, some are split or combined to better describe the variety of design considerations contained within a single principle, and new principles emerging from the literature have been named. Decisions on the title chosen for each principle were guided by the dominant title in the literature or when such a title did not emerge, the authors’ perception as to the most intuitive descriptor for each.

25 Principles of instructional video design

The first group of principles presented in Table 1 (audio quality, coherence, seductive detail, split attention, attention guiding, redundancy, worked examples, and animation type) are designed to minimise extraneous cognitive processing by reducing unnecessary distractions. The second group (modality, transient information, and optimal video length) help to manage intrinsic or essential processing, aiming to make learning the content as easy as possible. The third group (personalisation, emotional design, encouraging mental model making, misconceptions, and pre-training) encourage germane or generative processing, which aims to encourage students to connect novel information to existing schemas. In addition to Mayer's (2014) three categories, a fourth category ("Interface Design Principles") was derived from the data which included three principles regarding the interface used to display instructional videos in education (learner control, segmentation, and integrated activities). Table 1 lists the name and description of the principles, however, due to space constraints in this short paper, only one example source is cited for each principle [email the authors for the full table].

Table 1: Summary of CLT/CTML video design principles

Principle	Design advice	Example of literature
Extraneous Load Minimisation Principles		
Audio Quality	Audio should be clear, with no distracting hissing or interference	Kuhl et al. (2014)
Coherence	Only instructional material directly related to the key learning goal should be included.	Mayer & Fiorella (2014)
Seductive Detail (music)	Avoid including background music	Moreno & Mayer (2000)
Seductive Detail (visual distraction)	Avoid including interesting but unnecessary material in the name of entertainment or advertising	Park, Korbasch & Brunken (2015)
Split Attention (Temporal)	Related elements (such as narration and visuals) should be presented at the same time	Mayer & Fiorella (2014)
Split Attention (Spatial)	Related elements (animations and words) should be presented in close physical proximity on the screen	Schroeder & Cenkci (2018)
Split Attention (Competing Sources)	Visuals and narration sources should describe one learning focus at a time.	Ayers & Sweller, 2014
Attention Guiding Principle	Learners should have important information deliberately pointed out or selectively revealed during presentation. Use of arrows, highlighting, flashing etc.	Xie, Wang, Zhou, & Wu (2016)
Redundancy Effect	On screen text longer than four words should not be read out loud.	Mayer & Fiorella (2014)
Worked Example Effect	Videos should include full worked examples of the skill or concept, not force learners to generate answers through problem solving. (NA for content only videos)	Chen, Kalyuga, & Sweller (2015)
Animation Type	Style of animation should be guided by content, with conceptual learning best taught through animation and procedural 'how to' instruction taught through first person live capture. Must avoid simple decoration	Hoffler & Leutner (2007)
Intrinsic/Essential Load Management Principles		
Modality	Learning is enhanced when pictures are accompanied by simultaneous narration	Ginns (2005)
Transient Information Effect	Narration sections should be kept short and uncomplicated.	Leahy and Sweller (2015)
Optimal Video Length	Videos designed for secondary school students should not run longer than five minutes, and tertiary students six minutes. Longer videos should be edited or split.	Ibrahim, Antonenko, Greenwood, & Wheeler (2012)
Germane/Generative Processing Principles		
Personalisation (Human Voice)	Narrations should be recorded in a human voice rather than synthesised, machine voice.	Clark & Mayer (2016)
Personalisation (Conversational Voice)	Narrations should use first/second person conversational speech. Replacing "the" with "you or your" is effective.	Van der Meij (2017)

Personalisation (On screen agent)	On screen animated characters should exhibit 'human-like' gesturing rather than static, lifeless animation.	Mayer (2014)
Personalisation (Presenter's face)	Presenter's face should not be shown while complex visuals are being narrated. Otherwise, the practice is contested.	Van Gog & Rummel, (2010)
Emotional Design	Warm, high saturation colours should be used in videos.	Um, Plass, Hayward & Homer (2012)
Encouraging Mental Model Making	Videos should explicitly encourage learners to create mental models by prompting pausing of the video, contemplation statements, encouraging creative note-taking, and linking to previous learning.	Renkl (2014)
Misconception Effect	Conceptual videos should dispel common misconceptions at the start. Simple statements like "you might have thought…"	Muller, Bewes, Sharma, & Reimann (2008)
Pre-training principle	Key elements required to understand a concept should be taught to novice learners prior to watching the video, either by a tutor or in a preliminary video.	Mayer & Pilegard (2014)
Interface Design Principles		
Learner Control Effect	Video interface should be designed so that pause, play, speed up and slow down buttons are controlled by and clearly visible to the learner.	Kuhl, Eitel, Damnik & Korndle (2014)
Segmentation	The interface should be designed to pause after important information, prompting the learner to click 'continue'.	Mayer & Pilegard (2014)
Integrated Practice Activities	Designers should integrate practice activities, either during pauses in the presentation or following the video.	Szpunar, Jing & Schacter (2014)

Limitations and future research

Of the 66 papers and book chapters contributing to the principles in this research 55 were developed in experimental settings, which necessarily divorce the learning phenomenon from its real life context in teaching and learning environments. In education, context is central to pedagogical and technological decisions (Rosenberg & Koehler, 2015). As others have argued (see Winslett, 2014), more research needs to be undertaken to consider the impact context has on these principles and the impact of affective considerations on students' willingness to process information. Quite simply, the most 'cognitively effective' instructional video is useless if no educator selects it or no student is willing to learn from it.

Like previous approaches to rating instructional videos based on CLT/CTML principles (see Lucas & Abd Rahim, 2017) Table 1 appears to weight each design principle equally. The reality is, however, that reported effect sizes in the experimental literature vary wildly from audio quality at d=1.95 (Kuhl et al., 2014) to personalisation of on-screen agents at d=0.36 (Mayer, 2014). This suggests that time and money spent improving poor audio, such as by purchasing a quality microphone, is a more prescient investment than hiring an animator to improve on screen character movements. The ongoing systematic literature review is taking this into consideration and aims to establish a hierarchy of principles to triage design decisions. However, it is logical that there is a need for research into any moderating effect these design principles have on each other. Learner control, for instance, may reduce the impact of transient information.

Conclusion

This paper reports on an ongoing synthesis of literature to identify design principles that are specifically relevant for effective instructional videos. Instructional videos are an important, impactful and increasingly common instructional device. The 25 design principles described in this paper will assist educators in the difficult task of evaluating the instructional design of videos they are considering for use in pedagogical contexts, either during production, or when curating existing educational videos. The authors acknowledge that there are other important considerations that educators rightfully take into account when selecting instructional materials (factual accuracy, affect, student characteristics and interests etc.) and that this table and the research behind it is limited to the cognitive efficiency of design. Nevertheless, we argue that the 25 principles presented here represent a valuable starting point to promote purposeful cognitive design of instructional videos.

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Stakes in the potential of technology-enhanced learning: a STEM faculty case study

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To successfully enhance learning in higher education with technology, it is essential to understand the main stakes in the potential of technology-enhanced learning. This paper presents a case study of these stakes at a traditional, campus-based STEM faculty. Based on four surveys, the paper identifies which potential educational purposes of technology that are prioritised by the management, the educators in general, the educators engaged in Learning Design, and the students in general as well as which prioritisations that are convergent and divergent. Furthermore, the paper discusses how these stakes may inform building an efficient Learning Design practice.

Keywords: Technology-enhanced learning; Learning Design; stakes in TEL; efficiency; STEM.

Background

There is a widespread, general political agenda at universities that technology-enhanced learning (TEL) should improve, modernise, and make teaching more efficient (Daniel et al., 2009; The Government, 2016). However, the agenda rarely provides answers on how to efficiently enhance teaching with technology nor how to intepret the concepts of 'improved learning' and 'efficiency'. Recently, the Learning Design (LD) methodology has gained foothold as an educational development methodology across in particular Australasia and Europe for introducing technology in an efficient manner (Dalziel et al., 2016; Godsk, 2018). LD is characterised by educators being active designers of student-centred TEL supported by practical design aids and pedagogy theory as well as an underlying idea of sustainability in terms of supporting educators in developing, representing, sharing, and reusing effective teaching practices (Conole, 2013; Conole & Oliver, 2002; Dohn et al., 2019). This also means that LD has the potential to support an efficient introduction of TEL if effective practices are shared and disseminated. Nevertheless, to build an effective and efficient TEL and LD practice in higher education, it is important to look into how 'improved learning' would be perceived by understanding the main stakes in the potential of TEL.

The Faculty of Science and Technology (ST) is a large-scale, campus-based, research-intensive STEM faculty at Aarhus University (AU), Denmark. ST is one of the university's four faculties and has a total of 3,022 full-time equivalent staff (FTE), of which 1,696 FTEs are in full-time academic positions, and it has 7,045 students (in 2018). ST had a turnover of EUR 334 million in 2018 (Aarhus University, 2019), equivalent to 38% of AU's total turnover, of which the vast majority originates from research grants. Evidently, this balance makes research the top priority of the faculty. Nevertheless, an ambitious strategy for TEL was launched in 2011 (Aarhus Universitet, 2011) and further specified in 2018 (Aarhus Universitet, 2017; 2018) making the integration of technology in education a strategic priority supported by the Board, the pro-vice-chancellor (PVC), and the vice-deans responsible for education. The overarching, explicit aim of the integration at the institutional level is to improve the quality of the education and increase learning, and implicitly also to comply with government digitalisation goals (Aarhus Universitet, 2017; 2018). On faculty level, the aims are to support preparation before in-class teaching, create opportunities for more and better feedback, facilitate a progression of students' independence during their studies, support the development of collaborative and reflective competencies, and give educators insight into students' learning outcome and level of understanding (STLL, 2019) — in addition to any module-specific goals the educators may have. That is, in most cases TEL is not expected to be a vital component to facilitate the teaching. In 2019, it is estimated that less than 10% of the modules across AU include online activities and thus may be considered as 'blended' or 'online'. In addition, as most students are living close to and attend lessons on campus, the ambitions are primarily concerned with improving what happens before, during, and after these lessons instead of, e.g., providing online modules and programmes.

No specific educational development methodology has been provided at AU and, thus, it is up to ST and its educational unit to decide on a suitable methodology. Due to limited funding as well as negative experiences with the previous ad hoc-approach to technology-enhancement of modules, the educational unit adopted a Learning Design methodology in 2013 (Godsk & Hansen, 2016). The purpose was, in particular, to integrate technology in teaching and learning in a pedagogy-informed way using practical and suitable pedagogical models and other design aids as well as make the development efficient by supporting documentation, sharing, and reuse of good practice. However, to make this methodology efficient, one of the first questions that arise is on the actual interests in the technology's role and impact — or phrased as a research question: 'what are the main stakes in the potential of TEL in STEM undergraduate education?'

Methodology

The study was carried out using four online surveys in SurveyXact; one for each stakeholder: the institution, the educators in general, the educators engaged in Learning Design, and the students in general. Each survey included a corresponding battery of nine Likert-scale sub-questions on the potential of technology in higher education based on the nine identified themes of documented educational purposes of TEL in Price and Kirkwood's (2011) synthesis of evidence of technology in higher education. The questions were phrased in such a way that each respondent was asked to rate these nine purposes on a six-point Likert scale ranging from 'not at all' (0), 'a very limited extent' (1), 'a limited extent' (2), 'a certain extent' (3), 'a high extent' (4) to 'a very high extent' (5). The institutional stakeholder was asked to rate the educational purposes according to its importance for teaching at the university and faculty in general, whereas the educators were asked to rate the educational purposes regarding their teaching in general or the module they were designing. The students were asked to rate the educational purposes according to their studies in general.

The institutional perspective was represented by the PVC who represents the strategic level at the university and is the most senior responsible for teaching and learning at the university, and the head of the educational unit at the faculty responsible for the operational level. These two sub-surveys were carried out in December 2016 and November 2017. The educator perspective was represented by all science module responsible educators at the faculty (N = 397) and was carried out June–July 2015. 213 completed and 14 partially completed the survey, which corresponds to a 57% response rate and a 4.3% margin of error with a 95% confidence interval. 10 educators actively involved in an organised Learning Design process from 2018 to 2019 also represented the educator perspective. All first-year science students represented the student perspective. The survey was carried out in January 2015, which means that most of the students at that time would have participated in six undergraduate modules. 361 completed and 35 partially completed the survey, which corresponds to a 44% response rate and a 3.9% margin of error with a 95% confidence interval. This means that there is high confidence with the results on the institutional, educator, and student perspectives, whereas the results on the educators engaged in Learning Design mostly serve to provide perspective due to the low quantity. Upon completion of the surveys, the data was collected from the survey tool and processed in Excel for calculating average prioritisations (Mean), standard deviations (SD), and rankings (see Table 1).

Stakes in the potential of TEL

Table 1 illustrates the four stakeholders' average prioritisations of the nine educational purposes, together with their SD and ranking. The table shows several convergent and divergent views on the purposes that the technology may play — either between the different stakeholders or within the individual stakeholder groups (indicated by a high SD value).

Table 1: The main stakeholders' prioritisations of the educational purposes of technology

Stakeholder	Institution (n = 2)			Educators (all) (n = 219)			Educators (learning design) (n = 10)			Students (all) (n = 322)			All stakeholders (equal weight*)		
(Item) Educational purpose**	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank	Mean	SD	Rank
(1) That the students can study from where they want and do not always have to come to campus	2.5	0.5	8	1.88	1.12	9	2.5	1.6	9	3.22	1.43	9	2.74	0.68	9
(2) That the students can repeat lectures and other teaching activities as they prefer	2.5	0.5	8	2.34	1.10	8	3.7	0.7	6	3.87	1.08	6	3.35	0.84	8
(3) That feedback is provided to the students' learning process, their assignments, and answers to their questions	4.0	0.0	3	4.16	0.76	3	4.0	0.7	3	4.37	0.89	1	4.12	0.19	3
(4) That the students learn to link theory to practice	4.0	1.0	3	4.18	0.83	2	3.9	1.3	4	4.17	1.05	4	4.02	0.10	4
(5) That the students develop skills for a future job	4.5	0.5	1	3.87	0.96	4	4.2	0.8	2	4.06	1.06	5	4.26	0.32	2

(6) That the teaching supports collaboration and interaction among the students	3.5	0.5	7	3.79	1.00	6	3.7	0.9	5	3.68	1.11	8	3.63	0.15	7
(7) That the students find the teaching and learning is enjoyable	4.0	0.0	3	3.81	0.92	5	2.7	0.5	8	4.33	0.88	2	3.67	0.27	5
(8) That the examination reflects the curriculum and skills the students are supposed to have learnt	4.5	0.5	1	4.46	0.62	1	4.3	0.7	1	4.33	0.94	3	4.36	0.09	1
(9) That the teaching is in complete concordance with the formal requirements (i.e. learning goals and the estimated study time/ECTS)	4.0	0.0	3	3.39	1.18	7	3.1	1.6	7	3.81	1.13	7	3.65	0.31	6

*Equal weight is the average prioritisation of the institutional, educator, and student perspectives. **The educational purposes were phrased in the first person and Danish in the student survey.

It can be observed that all stakeholders find feedback to the students (item 3), linking theory to practice (item 4), and examination alignment (item 8) of high importance. Furthermore, all stakeholders find that students developing skills for a future job (item 5), collaboration and interaction among students (item 6), and teaching in concordance with formal requirements (item 9) are of some or high importance. Primarily the institution, the students, and, to some extent, the educators in general prioritise that students find teaching and learning enjoyable (item 7); however, this is of less concern to the educators involved in an actual Learning Design process. The place and pace flexibility potential of TEL (items 1 and 2) is of limited interest to all stakeholders; however, students and the educators involved in Learning Design are generally more interested in this than the other stakeholders.

Nevertheless, the SD values suggest that there is a diverse view on educational purposes within some stakeholder groups. For instance, a considerable share of the educators and students find the flexibility highly important, while others find it of little importance. In addition, a similar high variance exists among the views on the support for collaboration and interaction; the concordance with formal requirements; and linking theory to practice. The variance of the last two is particularly significant for the educators engaged in Learning Design. Comparing the two groups of educators, particularly the purpose of developing the students' skills for a future job and providing place flexible learning has a higher priority among the educators engaged in Learning Design. This suggests that there may be very diverse aims of enhancing learning with technology and that these aims may change and/or become more tangible when an educator becomes actively involved in Learning Design.

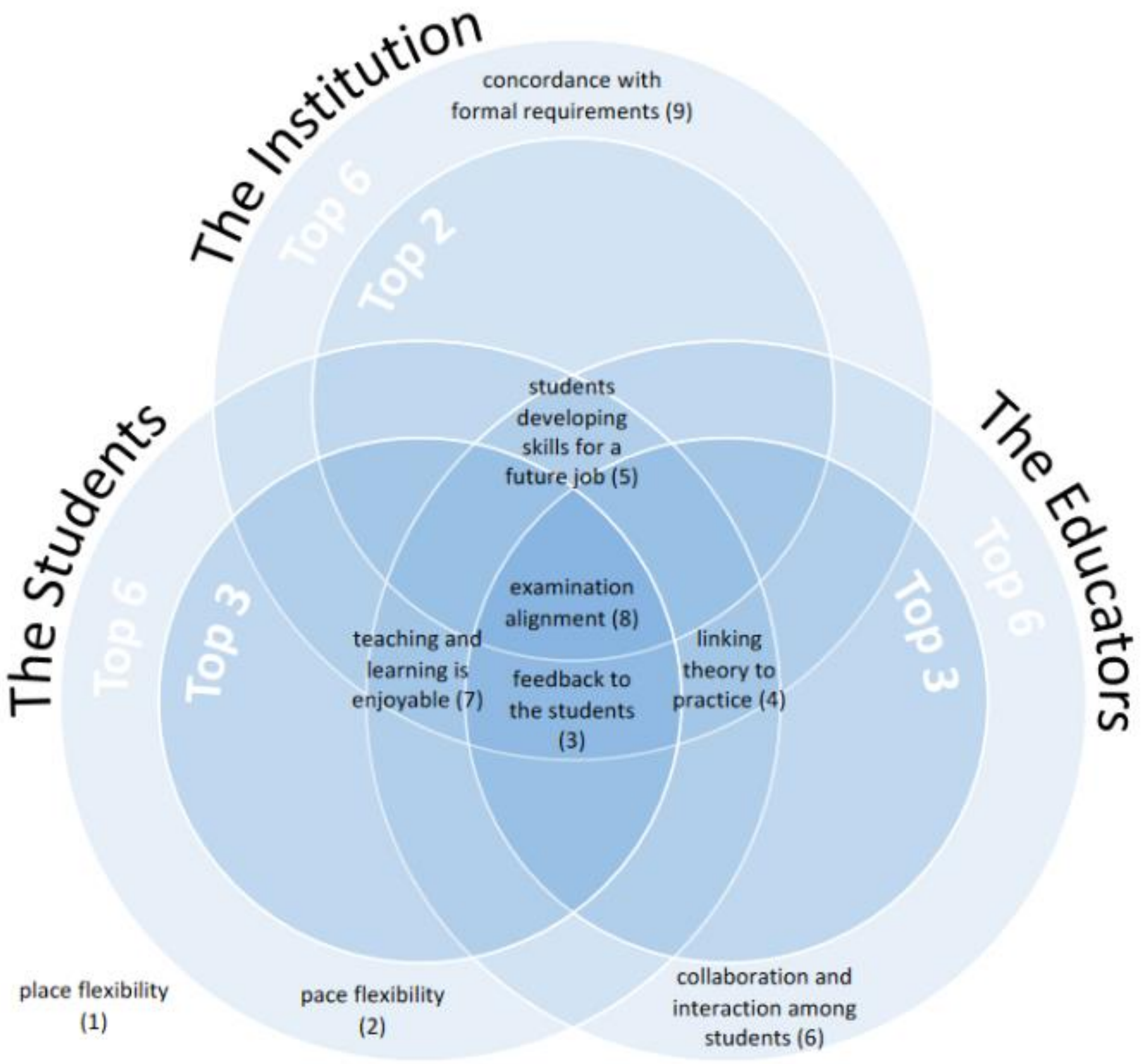

Figure 1: The convergence of the Top 2–3 (the inner circle) and Top 6 (the outer circle) prioritisations of the three main stakeholders in general. The digits refer to the item numbers.

However, as it is "cost-free" to assign high priority to all of the educational purposes, it also relevant to compare the ranking of the different items. Figure 1 shows a Venn diagram of which prioritisations with the highest rankings that are convergent among the institution, the educators, and the students in general. This illustrates that despite all stakeholders are assigning high priority to most of the educational purposes of technology (Table 1) there are pivotal differences. For instance, the institution is highly concerned with the aspects relating to teaching in concordance with formal requirements and technology used for developing the students' skills for a future job. However, the students are generally less concerned with these purposes and more interested in the pace flexibility, the feedback, and the enjoyable teaching and learning that the technology may provide. Likewise, the educators prioritise being able to support the students' collaboration and interaction as well as linking theory to practice through technology.

Building an efficient Learning Design practice

According to Encyclopaedia Britannica (2019), "efficiency" is defined as 'a measure of the input a system requires to achieve a specified output. A system that uses few resources to achieve its goals is efficient…'. Thus, in the context of a Learning Design practice, efficiency is the balance between the efforts associated with the facilitation, design, implementation, and teaching/learning processes; and the impact it has on its stakeholders, such as the institution, the educators, and the students when enhancing learning with technology (Godsk, 2018). Often impact is assessed based on the students' learning experience (Davids et al., 2013; Dawson et al., 2010; Pejuan et al.,

2012). However, it can also be assessed based on the institutional and educator perspectives, such as sustainability and cost-efficiency (Atkinson, 2011; Bai & Smith, 2010; Brown & Voltz; 2005; Daniel et al., 2009; Elliott & Sweeney, 2008; Godsk, 2018; Pankratius et al., 2005). In any case, this highlights the importance of understanding the interests in technology in education and that impact needs to be interpreted accordingly.
As Table 1 shows, generally there is a high level of interest in the educational purposes TEL may actualise. In particular, feedback, linking theory to practice, and examination alignment are of high common interest. Table 1 and Figure 1 also show that enjoyable teaching is of high interest to the students and the institution, and that flexibility is of high interest to some students and educators, but not all. The difference between the prioritisations of the educators in general and the educators engaged in Learning Design as well as within the group of designing educators suggest that interests will often be linked to the actual purpose of integrating technology in a specific module and differ from the general perspective.

That is, building a Learning Design practice that supports actualising some of these highly desired impacts of TEL as well as any additional strategic and module-specific aims has the potential to be interpreted as effective. Furthermore, the efforts ("inputs"), such as the costs and the sustainability of the Learning Design practice should be considered when assessing its efficiency. That is to say, to build an efficient Learning Design practice the main stakeholders' prioritisations of the educational purposes of technology, any additional strategic and module-specific aims with the integration of technology, and the various efforts associated with facilitating the Learning Design process and practice in general should be considered. At ST, this knowledge is used to inform the current Learning Design practice by assessing the efforts and impacts of Learning Design initiatives according to the stakeholders' prioritisations, including the module-specific aims.

Conclusion

Technology in higher education is often portrayed as a way to improve quality in higher education and make teaching more efficient, and Learning Design has the potential to introduce technology effectively and efficiently. However, to improve quality with technology, it is essential to understand what the main stakes in the potential of TEL are and use this to inform Learning Design practice. This paper has presented a case study of the main stakes in the potential of a TEL at a traditional, campus-based STEM faculty. The study revealed that there are several joint views on TEL as well as significant differences. These differences appear to be linked to the role of the stakeholder: the institution is highly concerned with aspects such as formal requirements and employability, the educators are concerned with aspects they believe will ensure good teaching, and the students are concerned with their own learning experience and preferences. This is not a surprising difference, but it suggests that there are diverse conceptions of and expectations to the educational purposes of technology in education. Furthermore, it also indicates how TEL initiatives will be perceived and thus the potential impact it will have on the main stakeholders. In the context of Learning Design, this may help to identify and build practices that efficiently support the integration of technology.

Though ST is traditional STEM faculty that most likely share characteristics with a large number of similar faculties, the exact prioritisations will vary. Thus, it would be relevant to conduct similar surveys at other faculties to further investigate to what extent the prioritisations apply.

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Using business principles to provide education solutions: On-demand exams supported by the progression pipeline

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This paper examines the journey from education literature to business principles to enable new ways for looking at an unsolved problem. This has resulted in the development of a highly scalable on-demand assessment model. Overall, results improved student acquisition of accounting skills as measured by grades.

Key words: Assessment, On-Demand Assessment, Progression Pipeline

Introduction

Each Saturday morning, I get up early so I can be at the start line of Parkrun by 8:00 am. This is an organised 5km run that happens every Saturday morning all over the world. When running in Armidale, it is typical that 20 minutes after the start, two or three people are finished, by 25 minutes this number would be up over 40, and by 30 minutes there are probably about 80 finishers. Over the next half hour or so another 80 people will finish. You're probably not surprised that people take different amounts of time to complete the 5km run. After all, we each come with different skills, levels of fitness, motivation, health, background, etc. People are different and so they are likely to take a different amount of time to complete a similar task.

Context

I coordinate an introductory accounting unit and, like many first-year units, we give students a start date, we set the assignment deadlines along the way, and the unit ends for all students on the day of the final exam. However, just like the Parkrunners, our students bring a rich tapestry of skills and experiences into the learning environment and this means we need to personalise their learning journey to enable them to successfully acquire the necessary accounting and thinking skills. We also need to do this in a way that is sensitive to effective resource utilisation. We call this 'scalable personalisation'.

Over the years, I relied on a wide range of educational literature. This includes attrition (back to Durkheim 1895 as quoted in Tinto (1975); Behaviourism (back to Pavlov (1940); and, Watson (1925)), Constructivism (back to Piaget and Vygotsky, as quoted in Pass (2004)); and Flow (Csikszentmihalyi, 1991). These frameworks help to develop excellent solutions for my representation of the typical student. After a decade of developing interventions that have significant benefit for some, but no benefit for others, I appreciated that a new way of thinking was needed to solve previously unsolved problems. The new way of thinking was, in fact, an old way. I moved to a business framework to help guide me towards developing an environment that would support a wider range of students. I have relied more heavily on business principals for four key reasons:

1. As a business school, part of our teaching should involve demonstrating business principals in action;
2. Substantial innovation often occurs when learnings from one sector are transplanted into another sector;
3. The solution to my problems require a holistic approach and I need to play to my strengths. My pre-academic career was spent researching and implementing strategies for business owners to increase their business returns. I apply this understanding, developing a learning environment that can cater for an increased range of needs; and
4. In simple terms, the role of accounting is to make things visible so that effective decisions can be made. I have worked on solving the problems that were visible to me. Now it is time to make the next level of issues visible so that these problems can be solved.

What I hoped to bring to higher education was an understanding of applying principals of improving business performance to improving student performance. My goal was to develop a scalable personalised learning ecosystem where students are put in situations that provide the opportunity for learning and the capacity to contribute to society through this learning. The focus of the learning would have a particular emphasis on making decisions that were sustainable long run and so have the capacity to add value to society. When people add value to society, they have a right to a share in that value.

I adopted one of the basic tools of innovation: chunking thinking to higher level of abstraction, and finding solutions there. The specific problem was helping students that were not engaging with the material because my solution did not fit their needs. When I chunked up to a higher level of abstraction, it led me to satisfying a range of needs. And, there were many solutions for this in a business context.

Relevant Literature

The key relevant literature from business relates to client segmentation and value propositions, and, more specifically, work related to understanding your customer. So, as I survey my library from my pre-academic life, I discovered the tattered books that survived the various culls. These books are survivors because they contained material that was successfully implemented. They were used and found relevant. These books contained not only lessons that I adhered to, but also lessons that I had failed to properly internalise. Two important examples that provided clear signposts to the necessary actions were Stephen Covey's (1989) 5th Habit – seek first to understand and then to be understood, and Whiteley and Hessan's (1996) guidance on moving from listening to hardwiring the customer voice. These habits provided a focus to better implement lessons so that I could build a value proposition for distinct student segments and then support them through the progress pipeline.

For context, the work discussed in this paper is built on previous interventions that relied heavily on feedback literature and are reported in a paper for the 2014 ASCILITE conference (Gregory, Uys & Gregory, 2014).

Reflective practice

My journey to deeply understand the mind of my students draws heavily on reflective practice. For me, this has always been built around the collection and analysis of data to identify opportunities and attention areas. For more than a decade, I have collected, collated and analysed data to see where the students were strong and where they needed help. I have analysed their learning styles and their mathematical skills to predict where they may need assistance and developed resources that will help them overcome deficiencies or cater for their preferred way of learning. As my reflective practices have matured and expanded, I have devoted increasing amounts of time to putting myself in the shoes of a varying cohort of students, not just what I had imagined as the typical student. As a result, over the last two years, I have placed more emphasis on understanding what students are thinking and especially identifying where their thinking is not supportive of their learning. The catalyst for this expansion of reflection activities was a result of feedback I received in a meeting with students at the end of Trimester 1, 2016, stating that I would benefit from developing better empathy for struggling students by learning something that I found challenging.

I took up this challenge by learning to play Pokémon Go. This seemingly simple journey was an education (see Gregory, Gregory & Gregory, 2016). It provided an example of how a business strategy was evolving and provided insight into one path large businesses are structuring themselves (Niantic, the creators of Pokémon Go are part of the Alphabet stable of companies) and it also showcased strategies for increasing engagement. In the context of reflection, it alerted me to two important lessons. Firstly, a student is not always ready to learn something the first time they encounter it. Secondly, the value that having a mentor or a fellow traveler brings on the learning journey. Significantly, the Pokémon Go journey crystallised that I did not have sufficient empathy or understanding for all of my students. I had been developing a learning environment for the students that I thought I had, but each student cohort was becoming increasingly diverse and not fitting the skill matrix that I had expected. The Pokémon Go journey helped me appreciate that while the content was important, not all students were getting access to that content. I needed to learn strategies to help them break through the blockages. I have put in place a series of strategies such as a personal background questionnaire and progression pipeline so I can identify exactly where a student hits a blockage.

This exploration process resulted in the introduction of On-Demand exams for Trimester 3 this year. On-Demand exams enables a student to sit their final exam (online) at any time during the trimester, or indeed in the following trimester provided that they have completed all gateway tasks. The gateway tasks include four assessable quizzes, plus other quizzes that helps the student appreciate if they are ready to go forward to the next level. In effect, the students travel through a knowledge pipeline that culminates in the final exam. They travel through the pipeline at their own pace, but with guidance and encouragement on the way. After all, many students need a deadline so that they will complete a task. I needed to provide motivation other than the deadline.

The existence of this pipeline has another major benefit. The teaching team can determine where any student is in the pipeline and if the student has hit a blockage. In some instances, the student can be directed to appropriate resources to help get through the blockage. For other instances (e.g., ineffective approaches to study), I needed to develop tools to help students.

On-demand assessments

This exploration process resulted in substantial change to the delivery of the unit. We now operate under a model we call on-demand assessment supported by a progression pipeline.

The unit has two streams. Firstly, there is the theoretical stream and students work through a number of scaffolded cycles. Each cycle comprises the core materials (topic notes and exercises) followed by a gateway task (tutorial quiz worth one mark). All tasks are automatically marked in the Learning Management System (LMS). If students achieve the required grade in the gateway task, the next set of resources opens for them. If they do not achieve the required score, they are directed to the support resources (topic videos, lecture videos, supporting PowerPoint presentations, online exercises, downloadable exercises, accounting triangle website for Cycle 1, forums). Students can then reattempt the gateway task so that the next set of resources will open for them. Many students who pass the gateway task will still use the supporting resources to strengthen their knowledge. At the end of the first four cycles is a summative assessment task (Assessable quiz). The exam is at the end of the 5th cycle. Students can move through the materials as quickly as they like. There are deadlines for the four assessable quizzes. The first iteration of this model was conducted without deadlines and this highlighted the importance of deadlines for student motivation. There is flexibility with the deadlines. Each day the progression pipeline report is produced and this reports how far each student has progressed through the progression pipeline. When a student falls sufficiently behind, an intervention kicks into place.

The theoretic stream is supported by the practice stream which comprises an Instant Feedback Accounting Practice Set (IFAPS) and 26 supporting videos. The IFAPS contains over 1,000 cells where students enter data. The cell turns green when the student makes a correct entry and their percentage complete will increase (for the task and the practice set as a whole). The IFAPS is designed to provide students with a vehicle to see how all items fit together from the start of the accounting cycle until its completion.

The IFAPS is a computerised formative assessment task that provides realism by simulating a business scenario through an Excel spreadsheet. Students are provided with a suite of videos to guide them through the tasks they need to undertake in the IFAPS spreadsheet and they receive immediate feedback on every entry they make into the practice set workbook. This was a very positive innovation for a large portion of the students that completed the unit and enabled many students to excel. The particular value of this for some students is highlighted by a comment in an end of trimester interview; "I thought we have already done topics because I knew what to do, but realised it was done in the practice set".

What did we learn?

The on-demand assessment model is best suited to calculation type subjects that can be automatically marked within the learning management system. The model can still be operated for other types of subjects, but when human intervention is required for marking, the scalability advantages diminish.

They learnings so far include:

- Because students were required to master the material in order to graduate to the next level of material, they understood the key concepts far better and this resulted in a much stronger knowledge as indicated by the higher proportion of students that excelled in the unit. Because of the strong base, students also tended to complete topics in the second half of the unit much more quickly than expected. See the section on results summary.
- A significant proportion of students found this a motivating environment. For instance, the first student to complete the unit said if there was another unit like this, he would have enrolled and started immediately. Students also appreciated the personalisation as indicated by the following comment; "Brent really understood that we as students all learn in different ways and so he catered to that."
- Automation improved the capacity to provide targeted feedback aimed at each students needs and student evaluations highlighted that students were impressed because "the levels of feedback that Brent provided was amazing."
- Repeat students tended to engage far more with the material in the learning management system to a much greater level than on their previous attempts.

- There are many students that need a deadline for assignments to provide them with the motivation to complete the task and so having totally flexible due dates is likely to result in less completions.
- It made visible problems that were previously not obvious.
- We are much more informed about our students and the issues they face. This was because we had early identification of 'at risk' students and engaged in a dialogue with those we could contact. We did find that for many of our students there were limiting factors not related to the structure of the unit. Commonly occurring factors included health of self and others, change in employment situation and change in domestic situation. Also, many students enter university without the necessary skills or mindset. We do need to find a way to support these students.
- We needed to ensure that students had some level of competence over the foundation material before they moved onto more complex material. While this has the appearance of putting blockages in a student's path, it does mean that they will much more rapidly progress in later parts of the unit. A comment from the student evaluations displays this from the student perspective; "The unit was structured very carefully to guide me through the steps to be able to grasp the basic concepts and carefully guide on to more challenging concepts." This is a strength that needs to be fine-tuned.

Results summary

To condense a complex journey into one image (Figure 1), students from the off-campus cohort in the first teaching period each year were allocated to three groups: Excel (High Distinction or Distinction), Pass (Credit and Pass) and Not Pass (N – Fail, NI – Fail Incomplete, and NC - Fail compulsory element). The performance profile has been reported at three key moments: Prior to the Instant Feedback Accounting Practice Set being introduced (average from 2011 and 2012); Prior to the direction change commencing in 2018 when business principles were overlayed with the academic literature to provide a solutions that better catered for the increasing diversity in the student cohort (2017T1OL – [2017, Trimester 1, OnLine]) and the current situation (2019T1OL). The current situation includes on-demand assessments and the Progression Pipeline.

These results highlight how, in the initial period, the percentage of students who did not pass fell noticeably (42% to 35%) and the percentage of students who excelled increased by a similar proportion (31% to 39%). This was despite a significant setback when teaching periods were reduced in length in 2016 due to trimesterisation. The introduction of the Progression Pipeline since 2017 has provided the environment where students make more progress through that pipeline. The measures taken to improve student performance mean that a significantly increased number of students are gaining the skills necessary to excel in the unit and add value to their career potential. For context, while this is for one student cohort, the story is similar for on-campus students and students in trimester 2.

Within the online cohort, there are a number of sub-cohorts, including accounting students, business students and pathway students. Improvement occurs across all cohorts and is more pronounced in the cohorts that typically underperform (e.g., pathway students), but this is as would be expected because it is more designed to cater for students that have not been performing. This is significant because much of the growth in student numbers is coming from traditionally underperforming groups. An indication of this changing composition can be gained by looking at result for other large cohort first year calculation type subjects. In 2019T1 this group achieved 25.7% of students in the excel group, 27.1% in the pass group and 48.7% of students in the Not Pass group and this represented a deterioration on the five-year average (28.3, 40 and 31.8). This indicates that the actual improvement achieved was in fact greater than the reported numbers because of the increasing diversity of the students.

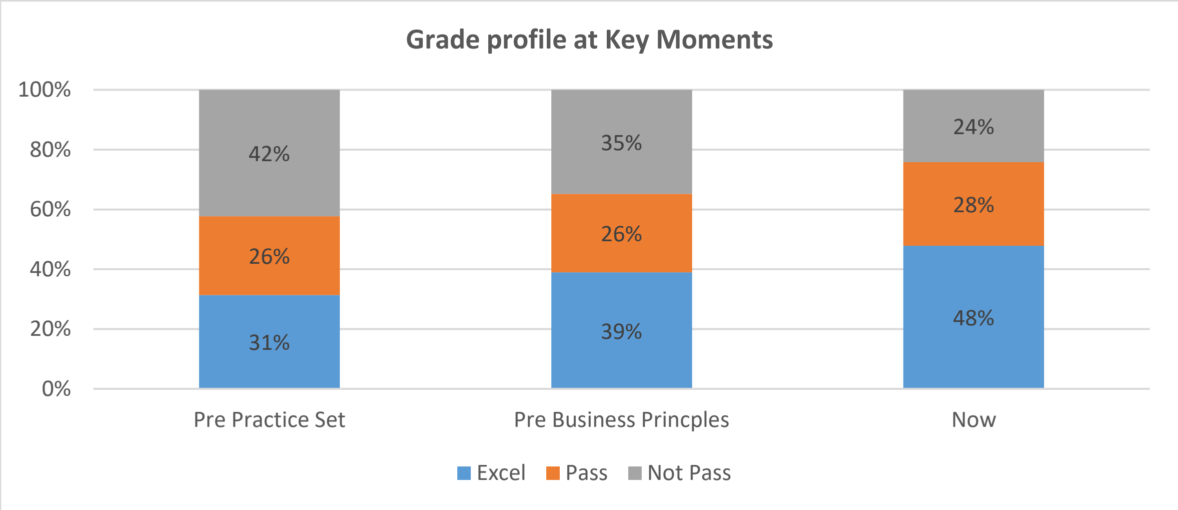

Figure 1: Grade profile at key moments 2011/12, 2017 and 2019

A comparison of the final exam for 2019T1 suggests that it is no easier than the exam for any comparison period. This approach was also applied to another similar unit that had a large cohort of international students enrolled. Of the 277 initially enrolled 262 students ultimately passed and while there is no historic group to compare with, this is a high pass rate for our international cohorts.

Conclusion

The model of on-demand exams, supported by a progression pipeline, is an attempt to marry business principles with the academic literature to build a scalable personalised learning environment that supports students learning of accounting skills. The great appeal of such an approach is that innovation often comes when an approach from one discipline can be integrated into another. This can provide a new way of engaging with challenging problems. In this case, it provided the leverage to increase the impact of previous interventions.

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Investigating lecturers' reasons for adoption of mobile learning in higher education: A case study

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The usage of Mobile Learning (M-learning) has grown among Institutes of Higher Learning worldwide as mobile technologies benefit teaching and learning. Despite this interest, there is a lack of M-learning research in formal educational contexts and the reasons for lecturers to adopt M-learning in a Singapore private education institute have been limited. Furthermore, the Teaching and Learning Division (TLD) of the institution which looks after the professional development of lecturers and sponsors innovative technology-mediated learning initiatives like M-learning is keen to find out how lecturers can be supported to encourage a greater usage of M-learning. After interviewing 10 lecturers, the research found that the following five reasons influence lecturers' adoption of M-learning from most important to the least: Usefulness in Teaching and Learning, Barriers to using M-Learning, Ease of use of mobile technology, Students' Motivation and Service quality of the M-learning systems. From this, TLD can identify and develop strategies to support the successful integration of M-learning. The five support aspects considered when implementing M-learning are found to be the following in descending order of importance: Professional Development, Social, Organisational, Technical and Advanced features to support teaching and learning. This research has clarified the existing literature in M-learning especially in formal learning contexts where learning is intentional and recognises the role that lecturers play in the future adoption of M-learning.

Keywords: M-learning, mobile technology, lecturers, technology-mediated, information and communication

Introduction

M-learning is defined as an educational environment where students can do their learning activities using any internet-enabled mobile devices over a wireless network anywhere, anytime in both formal and informal learning contexts (Pramana, 2018). In other words, learners have the freedom of the time and place for learning, with the aid of mobile devices and the internet, and learning can occur in the institute where learning is intentional with a purpose in mind or outside of the institute where learning is incidental and not consciously pursued as an end goal in mind. In the last decade, research into M-learning has been focused on the use of mobile technology to achieve anytime, anywhere, ubiquitous learning (Hung & Zhang, 2012) valuing predominantly its location awareness, motion detection and augmented reality (Baran, 2014), particularly in informal learning where learners learn spontaneously because of an immediate desire to know how to do or understand something. However, among the issues that were largely lacking in M-learning research are the use of M-learning in formal learning contexts and the reasons for M-learning integration from the teaching faculty's standpoint as pointed out by Pedro, Barbosa and Santos (2018).

Firstly, the use of mobile devices in formal learning environments have often been reframed as technology enhanced learning instead of M-learning although mobile devices are used to encourage active learning in the classrooms due to their positive characteristics of convenience and immediacy (Alamäki & Ab, 2003). For example, students can participate in a game quiz for lecturers to check for their understanding and lecturers can give immediate feedback to clarify common misconceptions. Regarding the educational contexts of M-learning studies, Chee et al. (2017) reported that when these contexts are revealed, informal learning contexts are predominant. This is ironic because academic institutions exist to promote formal learning in which learning is both intentional and the goal of all the activities that students engage in within the campus. Hence, M-learning should encompass the use of mobile devices for all learning activities that take place on campus in lectures and tutorials.

Secondly, although many lecturers are seeking to identify suitable technological devices and applications to engage their classes and promote active learning practices in their students, there are not so many studies that try to understand the integration and the actual results of M-learning practices from the faculty's perspective. Research in the past have tended to focus on students' opinions (Uzunboylu, & Ozdamli, 2011). Lecturers' adoption of M-learning is becoming increasingly important due to the fundamental role they play in the process of mobile technology integration. Although academic staff with higher academic ranks can influence lecturers to use M-learning (Hao, Dennen & Mei, 2017), lecturers' adoption of M-learning increases when they are given the autonomy to adopt M-learning instead of being mandated to do so (Akman & Kocoglu, 2016). M-learning is also gaining traction in higher education institutions due to its prevalent use among students who are millennials. Globally, more of such institutions are adopting M-learning due to their immense benefits such as allowing students to interact with their lecturers and peers, find answers, facilitate collaboration, share knowledge (Al-Emran, Elsherif & Shaalan, 2016). With the advent of educational mobile apps like 'Socrative' and 'Kahoot!', students can now interact with their lecturers and be more active in their own learning (Jackman, 2014). Hence, if lecturers can leverage M-learning in their teaching and learning, they will be able to engage their students more effectively and this will result in better overall learning outcomes. This also resonates with the conference theme on personalised learning. Lecturers want to be intentional in the design of their curriculum so that they can cater to the diverse learning styles of every student.

The Teaching and Learning Division (TLD) of the institution in this case study typically sponsors projects that deliver learning content via mobile platforms. These M-learning initiatives are introduced to improve students' higher education experience, prepare them for the future digital workplace and enable student-centred learning. The division also provides pedagogical guidance and technical support to lecturers in the delivery of M-learning. M-learning in the institution is at its infancy stages. Before carrying out this case study, there was an accurate ground sensing based on lesson observations by the division that the adoption of M-learning among lecturers within the institution is below the Management's expectations due to the following reasons: distraction by students, inertia by lecturers to teach with mobile technologies due to low tech-savviness. Lecturers resist adopting M-learning as they are afraid that their students will be distracted by their mobile devices during lessons which can be detrimental for learning. Multitasking with mobile devices is prevalent among students in classes nowadays (Chen & Yan, 2016). Moreover, most students feel guiltless when multitasking in class with their mobile devices for purposes unrelated to their lessons (Mueller et.al., 2012). As most of the lecturers in the institution are on part-time contracts, it is difficult for the Management to mandate lecturers to use

M-learning and assess whether they meet organisational targets of integrating mobile technologies in their lessons. Hence, many lecturers experience inertia; they seek to retain their existing teaching styles and maintain the status quo. Lecturers with a high level of inertia feel stressed about integrating a new technology as an instructional tool; they refrain from investing time to adjust to the change (Hamidi & Chavoshi,2017). Attitudes, including anxiety, impede the recognition of M-learning as an effective learning process (Celik & Yesilyurt, 2013). Although the potential of M-learning is now recognised, lecturers' lack of self-efficacy to exploit M-learning remains a barrier. Boosting lecturers' abilities to integrate mobile technologies in their lessons is essential. Technology alone does not enhance pedagogy; lecturers must be trained to evaluate the pedagogical affordances of M-learning tools to use them effectively. Cochrane's framework is used to guide this study as it supports creative pedagogies via Bring Your Own Devices (BYOD) (Cochrane, 2014). It models a community of practice (COP) focusing on redefining pedagogy and provides an appropriate technology support infrastructure. M-learning enables the nurturing of learning communities across varied contexts that would have been impossible previously. Focusing on student-centred learning via mobile platforms allows for student creativity and collaboration. By examining the reasons for M-learning adoption, TLD can then make informed decisions before investing limited funds into these projects. This study will bridge the two gaps by scrutinising the reasons influencing M-learning usage in formal learning contexts and find out lecturers' motivation to use
M-learning by obtaining detailed responses from them. The findings from this research will also expand the limited findings on the support needed by lecturers to adopt M-learning particularly in the Singapore context.

This case study seeks to answer the following research questions:

RQ1: What reasons do lecturers perceive to influence their adoption of M-learning for their teaching?
RQ2: What support do lecturers expect in the design, implementation and evaluation of their teaching?

Method

10 adjunct lecturers participated in face-to-face interviews organised within the campus. There was equal representation from both genders, five males and five females with a range of teaching experiences from 1 to 19 years. 60% of the lecturers have implemented some form of M-learning whereas 40% have not. The interview instrument was derived from previous literature and developed with a set of 'a priori' questions to collect qualitative data to answer the research questions. The objective of the interview questions was to collect in-depth responses and solicit both positive and negative responses to M-learning. A total of eighteen open-ended questions were posed in each interview. These questions relate to (a) reasons influencing M-learning Adoption, (b) support

needed to deliver M-learning effectively. An interview template was used to ensure that the participants were not predisposed to believe that the research was intended to reflect positively or negatively on M-learning. During the interview, participants were informed of the broad definition of M-learning which considers both formal and informal learning contexts. Consent was sought from the lecturers before their participation in the interviews. A consent form was signed by each lecturer before proceeding with the interview. Interview notes were taken and then used for data analysis. Interview transcripts were read repeatedly and interpreted using thematic analysis in a deductive way. Based on the 'a priori' framework, a set of codes organised into categories identified in previous literature have been developed based on the main reasons influencing M-learning adoption among lecturers namely Usefulness in Teaching and Learning, Ease of use of the technology, Service quality of the M-learning systems and the key support aspects required to assist lecturers in M-learning implementation specifically organisational, technical, social support and professional development. The framework summarises the data to focus on answering the two research questions.

During coding, lecturers' identities were replaced with an abbreviation system to preserve their confidentiality. A coding sample was completed at the beginning of one interview transcript and checked by the researcher's supervisor before the rest of the interviews were coded in the same manner. First, the interview text was searched for repeating ideas. Expressions of an idea or ideas relevant to both research questions were scoured and then coded as sub-themes. Responses from the interviews were then organised into a series of sub-themeswhich capture the meaning of the lecturers' responses in short phrases. The frequency of all the sub themes was then recorded. Sub-themes with similar ideas or meanings were subsequently grouped together into primary themes based on their common characteristics. Primary themes were then collapsed together to fall under the broader categories identified in the 'a priori' framework until no more common primary themes were identified for each category indicating that saturation point has been reached. It was found that most of the theme categories mirrored the reasons and support aspects identified in the literature review. Coding consistency was constantly checked via a reexamination of the initial assigned sub-themes during the coding process. When additional sub-themes were identified illustrating an unconsidered reason or support aspect not found in previous literature, existing categories from the 'a priori' framework was examined to include the newly emerged categories. These new categories were further confirmed by the lecturers to ensure consistency.

Findings

The analysis of the data generated from the interviews revealed five main thematic categories pertaining to the first research question as shown in Table 1 in ranking order from most important to least: Usefulness in Teaching and Learning, Barriers to using M-learning, Ease of use of mobile technology, Students' Motivation and Service quality of the M-learning systems and five thematic categories related to the second research question in ranking order from most important to least as shown in Table 2: Professional Development, Social, Organisational, Technical and Advanced features to support teaching and learning.

Table 1
Reasons influencing M-learning adoption

Rank	**1**	**2**	**3**	**4**	**5**
Categories	**Usefulness in Teaching and Learning**	**Barriers to using M-learning**	**Ease of use of mobile technology**	**Students' Motivation**	**Service quality of the M-learning systems**
Reasons	Usefulness in Students' Learning Usefulness in Teaching	Distractedness Limitations Time constraints	Perceived Ease of use Easy to learn	Students' self-directedness Students' interest	Technical

The results from this study suggested that M-learning's usefulness in Teaching and Learning is the main reason considered by lecturers when deciding to adopt M-learning. Lecturers must believe that M-learning can help their students learn better and enhance their delivery. This is followed by a new category that emerged which is the barriers to using M-learning. A prevalent theme that emerged among all lecturers was the problem of students' distraction with their mobile devices. Aligned with literature, the ease of use of mobile technology is the next necessary consideration. Lecturers are inclined to adopt M-learning when they have the necessary skills to implement it and mobile technologies are easy to use and navigate. Another new category that appeared was 'Students' Motivation'. Many lecturers felt that even though mobile platforms host a large repository of learning materials, these learning materials are redundant if students do not have the self- directedness to access them for learning. The last theme that emerged is the service quality of M-learning systems as a reliable IT infrastructure, robust access control mechanism to authenticate and authorise users, and elimination of technical issues are highly desired by lecturers.

Table 2
Support required for successful M-learning implementation

Rank	1	2	3	4	5
Categories	**Professional Development**	**Social**	**Organisational**	**Technical**	**Advanced features to support T&L**
Support	Type of Training Training Delivery style Disciplinary Learning	Intrinsic motivation Extrinsic motivation	Workload Policy Interdepartmental support	Quality of IT Operational Efficiency	Device attributes Affordances of M-learning

The main support category that emerged is the professional development of lecturers to enhance their instructional and technical knowledge. Next, social support in terms of peer pressure from their colleagues and interdepartmental support from key entities will ensure smooth M-learning implementations. This is followed by organisational reason in terms of workload related issues and institution's policy regarding the use of M-learning as a teaching and learning strategy. Subsequently, technical issues were highlighted to be as critical in the implementation of M-learning initiatives. The need for quality IT network in campus and operational efficiency to minimise technical problems are important. A new category 'Advanced features to support teaching and learning' emerged after coding. It comprises a list of device attributes and affordances that lecturers perceive to be helpful but only possible when mobile technology advances. This includes the control over students' use of their mobile devices in learning activities.

Discussion

This study contributes to the existing literature in several respects. Results from the first research question show that perceptions on any technology-mediated educational innovation will influence its practical integration and that M-learning system will not be utilised if it is deemed useless by lecturers (Huang, 2014). The results for the first research question showed that usefulness is the strongest reason for lecturers to adopt mobile learning. Usefulness in terms of enhancing students' learning took precedence over usefulness in terms of enhancing lecturers' lesson delivery. Mobile learning can transform pedagogy to cater to millennials because it offers the opportunity for active learning strategies like helping students distill complex topics into single words through the creation of a live word cloud, resulting in higher-level learning (Stoerger, 2013). With mobile technology, a group of learners can access content from electronic repositories, validate the content and help one another regardless of location. M-learning benefits learners because they can use mobile devices to learn in their own learning community where situated learning, authentic learning, context-aware learning, augmented reality mobile learning and personalised learning are encouraged (Quinn, 2013). Mobile technology allows learners from different cultures to express themselves more readily compared to face-to-face situations (Wang et. al., 2009). Half of the lecturers concurred with research by Wang et. al.'s (2019) research as they can obtain responses from all learners especially introverted students via M-learning. The usefulness in teaching is the second most valued subtheme as the use of mobile technology allows for cloud teaching where access to students to give immediate feedback and gather responses can occur regardless of location, aligning to Sutch's (2010) research. Furthermore, in line with previous research, the ease of use of mobile technology emerged as the third most important theme. User-friendly M-learning systems that are easy to follow as well as mobile applications that are easy to navigate will encourage usage. Otherwise, mobile technologies that are easy to learn must have clear instructions so that minimal efforts are required to pick up the skills to use them. Ishtaiwa et. al. (2015) noted that learning to use mobile technologies requires a wide range of complicated applications and activities so a certain level of tech-savviness is needed. The last theme that emerged is the Service quality of the M-learning systems which covers the availability of a reliable IT infrastructure, robust security system and low incidents of technical problems. This is to ensure that the quality of the videos on mobile platforms is good so that learners can learn at their own pace by speeding up or slowing down the playback of these videos.

Two new categories that emerged were the barriers to using M-learning and Students' Motivation. Barriers to using M-learning emerged in second place as lecturers were concerned that students would end up "doing other things since it is difficult to monitor what students are doing when they are using their mobile phones." This resonates with research by Ishtaiwa et. al. (2015) which included distractions like chatting, playing, posting and browsing on students' mobile devices. The next barrier is the limitations of M-learning system due to the lack of appropriate affordances for teaching as one lecturer remarked, "I must work around these limitations to deliver M-learning the way I want it." Finally, time constraint was highlighted as there is a trade-off between the time lecturers use to prepare M-learning resources and their personal time, thereby affecting their work-life balance. Another new category that surfaced in fourth place is Students' Motivation which is essential for M-learning to succeed. Students must be self-directed to complete the homework in informal learning with adequate positive reinforcements to ensure they learn out of the classroom. Despite the wide range of activities enabled by M-learning, lecturers pointed out that they "cannot use the same M-learning system or tool in every lecture as its novelty effect among students will wear out".

Results from the second research question reveal that lecturers need support at integrating M-learning into their practices. The support includes adequate training that is both 'hands-on' and 'practical'. A one-size-fits-all model of training would not adequately equip the lecturers with the needed skills as mentioned in Ishtaiwa et. al. (2015). In terms of disciplinary learning, lecturers wanted to be 'grouped according to their subject domains' with M-learning case studies to be 'subject specific'.

Social support come next as positive experiences and benefits of M-learning utility encourages lecturers intrinsically to implement M-learning. Most lecturers inherently want to share their M-learning experiences constructively if the benefits of M-learning to their students' learning are significant, no issues were encountered during M-learning deployment, and M-learning lends itself well to their content or subject. This is followed by extrinsic motivations such as having their M-learning work recognised for showcase to others. In third place is organisational support which saw workload-related issues taking the lead, followed by the institute's policy and interdepartmental support in this order. Most lecturers felt that making M-learning more prevalent in the institution will make their workload more demanding at first due to the 'initial switchover effort'. However, the workload may become less over time. The importance of having a systematic M-learning institutional plan across all programs is seen to be critical. Lecturers want to know clearly the institution's position on the use of M-learning as a teaching and learning strategy as well as the support from the various departments that work with them to ensure smooth M-learning implementation. Technical support appeared in fourth place as lecturers encountered Wi-Fi connectivity in some rooms within the campus. Students reported that their devices were not well-connected, thus preventing them from participating. It is obvious that technology integration does not produce ideal results if it is hindered by lack of infrastructure as shown by Alrasheedi et. al. (2015). 'Advanced features to support teaching and learning' emerged as a new, final category. Lecturers hoped for 'individualised content' to achieve learner-centric outcomes and 'personalised content' to cater to various learning styles of students. Since mobile technologies serve short nuggets of information, it may not promote deep thinking or critical thinking required from students in higher education.

Conclusion

This case study helps to identify the reasons on lecturers' adoption of M-learning and the support to encourage M-learning. This case study found that Usefulness in Teaching and Learning, Barriers to using M-learning, Ease of use of mobile technology, Students' Motivation and Service quality of the M-learning systems are reasons for lecturers' behavioral intention to implement M-learning. The negative roles of barriers to using M-learning and lack of students' motivation were newly highlighted in this study. Students' distraction and indifference to learn via M-learning deter lecturers from using M-learning. Professional Development, Social, Organisational, Technical and Advanced features to support teaching and learning are needed to successfully implement M-learning in the classroom. By focusing on students' needs in the use of learning technologies and through sound pedagogical practices, lecturers can be more intentional in their learning design of M-learning. The main limitation in this study is the use of self-reported interviews as a data collection method. The study was built on lecturers' perceptions of M-learning integration and may not reflect actual practices. Observational data on the actual integration of M-learning and students' perceptions about M-learning could be gathered to triangulate and reinforce the results found in this study.

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Seeing the wood for the trees: Insights into the complexity of developing pre-service teachers' digital competencies for future teaching

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Developing digital competencies is a critical component in pre-service teacher training for future practice. However, this is a complex process which includes a range of strategies, and little is known about how they should be implemented. Methods that can address this complexity are needed to improve understanding of strategies to develop digital competency in teacher training. In this paper, data mining approaches are used to explore this issue, through analysis of preservice teachers' experiences with six key digital competency strategies. Specifically, association rules analysis was conducted on a questionnaire dataset of 931 pre-service teachers' experiences in their training, with 24 different practices representing the six strategies. Results showed four distinct clusters of associated strategies, which illustrates how the approach was able to reveal some complexity among digital competency strategies. The most important strategies were Authentic Experiences, Instructional Design and Role Models, showing multiple relationships and effects across all four clusters. Implications for practice suggest certain combinations of strategies are necessary to support pre-service teachers' developing digital competencies. Future directions for research are discussed.

Keywords: digital competency, pre-service teaching, complexity, association rules analysis.

Introduction

To build pre-service teachers' digital competency and encourage effective integration of digital technologies in future teaching, training needs to incorporate a range of key strategies. However, research has shown that this is a complex process which requires combinations of strategies (Mouza, Karchmer-Klein, Nandakumar, Ozden, & Hu, 2014). Also, relationships among these strategies are complex. Research has suggested that a systems approach is needed to understand this complexity and how strategies should come together in practice (Tondeur, Aesaert, Prestridge, & Consuegra, 2018). Without a better understanding of how strategies for digital competence relate, how to best design pre-service teacher training to develop digital competence will remain obscured.

To explore the complexity of strategies and how they organize, methods able to address and visualize these phenomena are needed. In this paper, we present and initial exploration into complex relationships among digital competency strategies in teacher training. To do this, data mining techniques are employed to re-analyse and visualize questionnaire data from Tondeur et al.'s (2018) study exploring six effective strategies to develop pre-service teachers competencies to use ICT in their practice (see Tondeur et al., 2012). Data was analysed using a combined approach including association rules analysis and directed graphs to visualize the resulting relationships (see Howard, Ma, & Yang, 2016). Findings provide insight into complex relationships among strategies and how they were related in students' experiences in teacher training. Implications for practice andn future research will be explored.

Digital competency

To prepare pre-service teachers to effectively use digital technologies in their future teaching, a range of strategies are needed (Kay, 2007; Mouza et al., 2014). Tondeur et al.'s (2012) synthesis of qualitative evidence identified that these strategies should include: i) scaffolded authentic experiences, ii) collaboration, iii) learning to use digital technologies by design, iv) continuous feedback, v) reflecting on the role of digital technologies, and vi) teacher educator role models. These strategies have been combined to create a Synthesis of Qualitative Evidence (SQD) model (see Tondeur et al., 2018).

The SQD-model includes three levels of consideration when preparing pre-service teachers for technology use (Tondeur et al., 2018). The outer level includes systematic and systemic change efforts, along with aligning theory and practice. The second level considers aspects of the institution, such as technology planning and leadership, training staff, access to resources, or cooperation within and between the institutions. The inner circle includes the six micro level strategies such as using teacher educators as role models, or scaffolding authentic technology experiences (see Table 1). These six strategies will be the focus of the current analysis.

Table 1: The six SQD strategies for digital competence

Authentic experiences (AUT)	Experience the value to use ICT in education in authentic settings, doing rather than watching (e.g. Kimmons et al., 2015)
Collaboration (COL)	Mitigates feelings of insecurity when pre-service teachers need to design ICT related curriculum (cf. Koh & Chai, 2016)
Instructional design (DES)	Providing opportunities to learn about technology integration through design (e.g. Kay, 2007)
Feedback (FEE)	Feedback should be continually provided through discussions, questionnaires, interviews, and observations in order to follow how ICT competence develops, and what kind of problems pre-service teachers face in using ICT. (e.g. Boulton, 2014)
Reflection (REF)	Discussing and reflecting about the opportunities and risks of digital technology use in education (e.g. Mouza et al., 2017)
Role models (ROL)	Providing examples and is a crucial motivator for the development of digital competencies (e.g. Kaufman, 2015)

The review of the six SQD strategies found that effective preparation of pre-service teachers' digital competencies required attention to the separate strategies and combinations of strategies (Tondeur et al., 2012). Tondeur et al. (2018) analysis of combined strategies revealed complex relationships among those needed for pre-service teachers to successfully develop digital competency, and this was difficult to address.

Complexity of developing competencies for technology integration

The complexity of digital competencies is well known and often discussed as a 'wicked' problem (e.g. Borko, Whitcomb, & Liston, 2009). Effective digital technology use is "complex, contextual, and multi-faceted" (Kimmons, Miller, Amador, Desjardins, & Hall, 2015). However, factors of technology integration are often studied in isolation or in ways that are not able to account for complex relationships (Howard & Thompson, 2016). Consequently, strategies to prepare future teachers are also a complicated challenge.

As stated above, complex relationships exist among strategies to train pre-service teachers for technology use in teaching and learning. Using a system approach, Howard and Thompson (2016) have previously illustrated some of the complexity among factors known to have an effect on technology use in the classroom, such as teacher and students' beliefs about digital technologies, and school leadership. Analysis revealed complex and dynamic interactions among these factors and feedback in the system. A similar level of complexity needs to be taken into consideration when designing learning to develop pre-service teachers' digital competencies. To be effective, it is necessary to employ multiple strategies to develop digital competence. It is also important that pre-service teachers' are provided opportunities to develop and critically engage with technology-enhanced learning designs, and that they reflect on and evaluate these designs (Kimmons et al., 2015).

The multiple effects of relationships among these factors require methods able to address complexity to be understood. Data mining approaches can address some of this complexity, particularly large numbers of interrelated factors. Broadly, data mining can be defined as a process of automating discovery of patterns in large datasets. This is an inductive process, which provides insights based on patterns emerging from data, which is understood as 'knowledge discovery' (Romero & Ventura, 2013). Data mining approaches are agnostic of content or discipline, so they can be applied to any dataset. Importantly, it does not assume a linear model, which is a significant difference between traditional statistical procedures. This allows the complexity of relationships among data to be revealed, which can then be further analysed for contextual meaning and relevance. This brings us to the main aim of the current study.

Purpose of the study

The aim of the current analysis is to explore the use of data mining to better understand the complexity of digital competency strategies in teacher training. Data mining approaches are well suited to exploring complexity and extracting patterns from datasets. In regard to digital competency, this approach can provide insight into complex relationships among the six key strategies and how they were related in relation to students' experiences in teacher training. This has the potential to inform learning design in initial teacher training and improve pre-service teachers' preparedness to enter the classroom.

Approach and methods

The dataset

To explore the complexity of digital competency strategies, the current research will extend Tondeur et al. (2018) multilevel analysis of pre-service teachers' experiences with digital competency strategies in training. Pre-service teachers were asked to indicate their agreement with statements about their perceived support in teacher-training institutions with respect to the six SQD-strategies, e.g. "During my pre-service training I saw good examples of ICT practice that inspired me to use ICT" and "I received sufficient help in designing lessons that integrated ICT". The dataset included 931 final-year pre-service teachers from 20 teacher training institutions in Belgium. Seventy-two percent of respondents were females, which is representative of pre-service teachers in Flanders. The average age was 24.7 years (*SD*=7.02 years). Over half of the pre-service teachers had obtained a Bachelor's degree (57.8%) and 42.2% had obtained a specific teacher training degree.

Analysis

Initial analysis was a multivariate hierarchical regression, using a two-level design with pre-service teachers clustered in training institutions (Tondeur et al., 2018). The main result was that "more pre-service teachers perceive occurrences of the SQD-strategies during their teacher education, the higher their competence to use ICT for learning processes and to strengthen their instructional practice" (Tondeur et al., 2018, p. 38). However, multiple strategies were required to be successful.

The current analysis employed association rules analysis to explore which relationships among strategies were most frequently occurring in the dataset and how they related. Howard et al. (2016a) have previously used this approach to study perceptions of digital technology use in learning. Association rules analysis is commonly used for identifying relationships in a dataset. Relationships are identified based on the frequency of factors appearing together as a 'rule' in the data. Relationships occurring frequently are thought to be more 'important'.

A limitation of the approach is that smaller, less frequently occurring, but important relationships, can be missed. However, it provides a good starting point to explore datasets and identify initial phenomena. Relationships are expressed as rules, in the form of A→ C. 'A' is understood as the 'antecedent' while 'C' is understood as the 'consequent'. It can be read as 'IF A, THEN C'. Each part of the rule may contain single or multiple factors. The importance of relationships is assessed using three key measurements: support, confidence and lift. *Support* identifies the degree to which the antecedent and consequent occur simultaneously in a given dataset. *Confidence* indicates how frequently the consequent follows the antecedent. *Lift* indicates the correlation between antecedent and consequent, which can predict performance (see Howard et al., 2016a).

In this analysis, 80% Support and Confidence was used as the rule selection criteria. Twenty-four SQD items were included in analysis, addressing the six key factors, and each with five possible responses (i.e. five-point Likert-type scale). Possible answers to items are treated categorically, e.g. for each item Agree and Agree Strongly are treated as separate categories. Given that 24 variables were analysed, each with five possible responses, the number of resulting rules was very large. Therefore, for the initial exploration the top 20 rules were selected for analysis based on their levels of Support (>.10) and Confidence (>.80), which resulted in four clusters of associations (relationships). Solutions for the full set of rules were tested, but they did not show significantly different clustering. The 20 rules were then visualized as a directed graph. A directed graph is defined by showing relationships among the variables as 'ordered pairs'. Arrows indicate the relationship and its direction, with the beginning of the arrow being the Antecedent and the arrowhead being the Consequent. Clusters of variables in the dataset have been circled, but are only heuristics for the purpose of discussion. Clusters have not been calculated for this initial analysis.

Results

The association rules analysis revealed a total of 7,812 rules, with an average length of 3.76 items (combined antecedent and consequent). The average support was .11 and confidence was .84, meaning the antecedents and consequents occurred together 11% of the time in the dataset and, of that, 84% of the time the consequent followed the antecedent. The average lift was 3.71, meaning the rule was 3.71 times more predictive than random choice.

Figures 1 presents a directed graph visualizing the 20 most important (frequently occurring) rules in the dataset. Four clusters can be observed in Figure 1, with two clusters connected by FEE3 and two clusters occurring independently. Rule consequents are at the centre of each cluster. The antecedents are fanned around the outside. For example, in Cluster 1 the rule 'REF3, AUT3-> DES3' can be understood as: if a student Agreed 'There was room for discussion about our experiences with ICT in the classroom (REF3)' and 'I was stimulated to gain experience with ICT in class practice (AUT3)', they were also likely to Agree 'We were supported to develop educational material using ICT.' REF3 and AUT3 are the antecedents and agreement on both must be present to be likely to result in agreement with DES3. Of the 24 SQD items, 11 items occurred in the 20 rules and they were all 'Agree' categories. Each of the six strategies were represented by at least one antecedent or consequent in the rules. The most frequently occurring strategies were Authentic Experiences (AUT), Instructional Design (DES) and Role Models (ROL), items appeared in 18, 13 and 10 rules respectively. The most frequently occurring individual item was AUT3, occurring in 18 rules (seven as antecedent). The second most frequently occurring item was DES3, appearing in 11 rules (seven as antecedent). Key relationships andimplications are discussed in the next section.

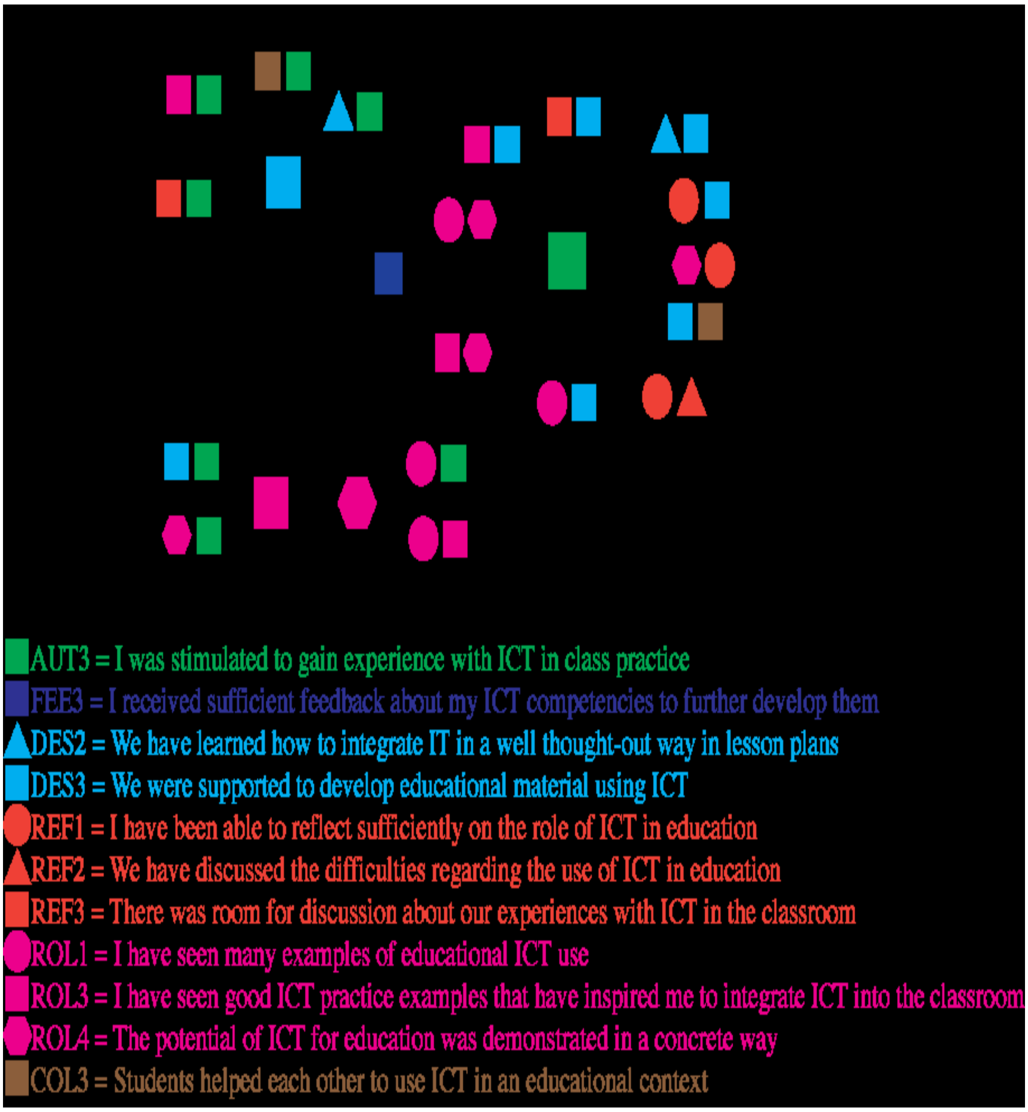

Figure 1. Patterns observed in the full dataset (20-rule solution)

Discussion and conclusions

Association rule analysis and graphing of the six SQD strategies (24 items) is able to demonstrate some of the complexity among digital competencies. Importantly, the current analysis only presents an initial descriptive discussion of relationships appearing among the SQD-strategies, which will guide future research and application. The main finding is that the four observed clusters are able to demonstrate some complex relationships among strategies. In the following section three key results will be addressed: the presence of Role Models, the power of Feedback, and importance of Instructional Design and Authentic Experiences.

First, Tondeur et al. (2018) found strong positive beliefs about experiences with Role Models items and less positive beliefs about Feedback. In the current analysis, all four clusters include Role Models items as antecedents, with ROL4 and ROL3 as consequents in Clusters 3 and 4. The high frequency of Role Model items in the rules suggests the importance of Role Models as a strategy. This also reflects results from other studies (e.g. Kauffman, 2015). In contrast, only one Feedback item (FEE3) is observed in the clusters, but it is a unique result. While not frequently occurring, FEE3, suggest a critical link between Clusters 1 and 2. This relationship demonstrates that if students feel positively about feedback on their developing digital competencies, they are likely to feel positively about support received to develop materials (DES3) and gaining experience using ICTs in classroom practice (AUT3). While less positive in this dataset, the importance of feedback across learning is well identified (e.g. Boulton, 2014). FEE3 is not frequently occurring across the four clusters, but it has a singular direct effect on Instructional Design and Authentic Experiences. Other rules all include multiple antecedents. This result suggests FEE3 has a more direct effect on pre-service teachers' developing competencies. In regard training, ensuring sufficient feedback about digital competencies may be a direct way to increase pre-service teachers' positive feeling about Instructional Design (DES3).

Finally, the most complex group of practices relates to students feeling positively about AUT3. Authentic experiences (AUT) can be interpreted as the most important strategy in the dataset, as they are the most frequently occurring in rules. Authentic experiences allow pre-service teachers to apply their knowledge of digital technologies, leading to a better understanding of links between theory and practice. AUT3, as an antecedent, suggests an effect in three clusters. In practice, AUT3 could be addressed individually and have a positive effect on experiences with several strategies. However, it was also the consequent in Cluster 2, which is very complex. The variety of strategies (as antecedents) presents a range of ways instructors may consider creating an experience that could result in a positive effect on Authentic Experiences. Given the high frequency of DES3 in Cluster 2 and its potential impact on AUT3, this could be an important area of focus.

The findings provide a way to view the complexity of digital competence strategies as a system, using association rules and directed graphs. A limitation of the study is that less frequently occurring relationships may be missed, but may be important. However, these are captured in the analysis, and can be explored separately. Future research should explore confirming these relationships and pre-service teachers' experiences, to validate clusters and relationships. Being able to isolate relationships provides a better understanding of preservice teachers' digital competencies and how they can be developed for future teaching practice.

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Improving return on investment in higher education retention: Leveraging data analytics insights

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This article describes data analytics action research initiatives that have gained traction at a university in Western Australia, with a focus on the return on investment of improving retention. In this report we focus on how actionable data can be provided and insights supported to the right stakeholders at various levels of the organisation. The article will detail experiences with three levels of initiatives that have been implemented at the university: high level insights being delivered to faculty staff, the provision of integrated reports for lecturing staff, and the curation of 'at-risk' student lists for triage by student support staff. In conclusion, higher education institutions may consider five dimensions of learning and teaching operations: finding and selecting students; knowing learners and their expectations; just-in-time services, content, mentoring and support; anytime, anywhere accessibility; and global connectivity.

Keywords: Return on investment, retention; learning analytics; data analytics

Introduction

Higher education institutions are grappling with the crucial issue of retention, which is often defined as the process that leads students to remain within the study program and institution in which they enrolled to earn a degree (Mah & Ifenthaler, 2017, 2018). The *Higher Education Standards Panel* report of 2017 outlines related concerns including: raising expectations for completion rates, enhancing access to information, transparency and accountability; and improving articulation across the tertiary sector. In addition, the report points out the need for strengthening outreach, providing career advice and support services to assist with completion, creating intermediate qualifications, creating, embedding and sharing innovative practices including international models, and regulating the system for effective and efficient use of government resources (Higher Education Standards Panel, 2017).

A broad but pressing research question for improving retention is: given the need to prioritise and address these kinds of concerns, how can actionable data be provided and insights supported to the right stakeholders at various levels of the organisation? Return on investment (ROI) for higher education institutions is conceptualised as the potential of a desired impact in relation to the effort needed to develop a causal intervention such as a new learning experience or an enhancement to an existing one (Psacharopoulos, 2014). Retention ROI is often summarised as potential tuition retained or as potential revenue lost. But ROI can also be expressed with other costs and benefits, such as *faculty time, appropriate selection and implementation of interventions,* and *university reputation lost* if students return home unsuccessful and the news spreads by word of mouth to friends and community (Menon, 2014). Data analytics presents a unique challenge, but also opportunity for higher education, offering means to automate historically complex and resource-intensive processes. With such opportunities, universities must clearly articulate their value proposition, and adapt to a more customer-focused approach to the management of education (Buckingham Shum & McKay, 2018).

In this article, data analytics initiatives that have gained traction at a university in Western Australia are discussed. These initiatives are action research based (Argyris & Schon, 1974). At the macro level, insights are being delivered that help faculty staff to target retention initiatives. At the meso level, reports are being delivered to lecturers in order to enable widespread data-driven teaching improvement opportunities. At the micro level, 'at-risk' student lists are being provided to student support staff, enabling them to triage and prompt individual students to take corrective action. By injecting information at all three levels, and by observing how the data is used, awareness of the university system and data-informed action is improved, which is itself a measure of success.

Profiles of analytics tools and methods

The university's analytics team in the learning and teaching (L&T) area is tasked with delivering benefits to students and staff through the use of learning analytics, educational data mining and academic analytics. Since 2016, the team has created an initial catalogue of data products aimed at a variety of key stakeholders in learning, teaching, and curriculum design (Gibson, Huband, Ifenthaler, & Parkin, 2018). Each of the products targets a different level of the system, and has been met with varying levels of adoption (see Table). Given the adoption levels, the greatest ROI can be attributed to the Student Discovery Model (SDM) Insights, the Integrated Reports, the Disengaged Student List, and the Irregular Enrolment Student List. These are discussed in further detail below.

Table 1: System level of the intended actor and level of adoption of available data products

Data Product	Description	Level	Adoption
SDM Retention Data Pack	Per-student Excel retention data, with multiple enhancements (e.g., handling of replacement packages and majors/streams).	Macro	Poor
SDM Insights	Insights that are built on top of the SDM Retention Data Pack.	Macro	Good
Integrated Reports	Available to all teaching staff according to their LMS access.	Meso	Good
Disengaged Students List	Enables staff to identify and contact students who have not been assessing one or more of their LMS sites.	Micro	Good
Irregular Enrolment Student List	Enables staff to identify and contact students enrolled in units that aren't expected to be attempted until a subsequent study period or year.	Micro	Good
Unit Outcomes (aka *Pass Rates*)	Enables insights into pass rates, withdraw rates, average marks, unit enrolments, and other outcomes, for different cohorts.	Macro	Average
Enrolment Trends	Visualizing year-on-year enrolment trends.	Macro	Poor

Analytics for divisions and schools: SDM insights

A criticism of the original SDM was that relevant stakeholder actors did not have any access to the underlying data. The SDM Retention Data Pack helped to address this criticism, but in practice the sheer size and dimensionality of the data makes it inaccessible to most staff. Instead, L&T has itself leveraged the data pack in order to deliver faster turnaround times to analytics queries, and at a level of granularity and business sensitivity that enhances the offerings of the university's Business Intelligence area. For example, in the second half of 2018, L&T was asked to provide insights into the performance of an undergraduate 'feeder' program, which exists as a pathway for successful first year students to gain admission into other programs to which they cannot be directly admitted. Although the feeder program was criticised as having a significantly worse retention rate than other programs in the same faculty, L&T was able to show that when comparing 'like-for-like', performance was near comparable to other 'normal' degree programs (see Figure). Key to this was the ability to limit historical analysis to students in their first academic year, a capability that is not currently possible through other systems at the university, and yet is crucial in this case, as the feeder program is predominantly comprised of first year students. This scenario illustrates how different audiences at different levels of the same organisation can have conflicting views of the same underlying student information.

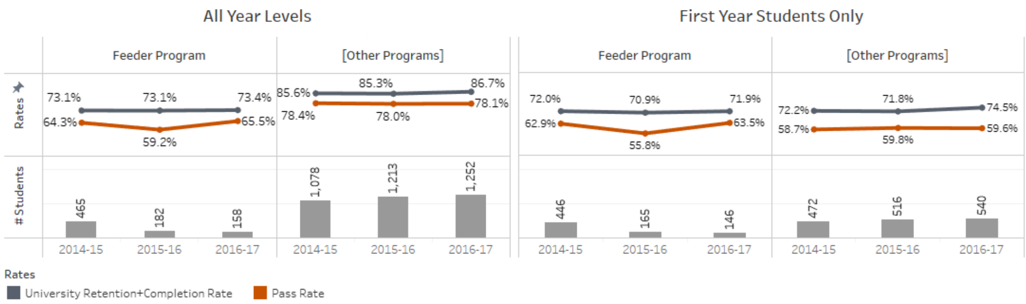

Figure 1: Year-on-year retention and pass rates of the feeder program versus other programs

SDM Insights has also become a key source of data for a number of the schools at the university. School engagement begins with an overview of year-on-year retention data, which incorporates three enhancements over other data sources.

First, what constitutes a ‘program’ is allowed to vary from the strict encoding used by the Student Information System (SIS) by disaggregating overly large programs into majors of study and ‘common core’ first years. This insight helps create focus and priority for action, saving time and money.

Second, details are only presented for programs with the highest number of attritions, with other programs being aggregated into a single group. This feature helps people target their intervention efforts, again focusing effort and high-value actions.

Third, in addition to presenting a traditional retention rate calculation, both pass rate information and a combined ‘retention + completion’ calculation are presented. This latter calculation is not a standard metric at the university, and yet is helpful to several stakeholder actors, as it provides a more holistic view of the ‘success rate’, and is a more stable measure than the traditional retention calculation, particularly for short programs.

The year-on-year overview offers no detailed information on the nature of the attritions, nor does it allow for ‘false positives’ involving students who return to studies after ‘attrition’ gap years. The concept of ‘lifetime’ attrition is used by the SDM to address the second issue, where the status is calculated only once per student per program (not yearly). The lifetime attrition status of each student is calculated relative to the first year of their program, and students are only considered a university attrition if they have not subsequently completed any program at the university, and if they did not undertake any studies at the university in the last full calendar year. Schools are then presented a view that only includes lifetime attritions (see Figure 2).

This view categorises lifetime attritions by how far through a program the student managed to progress (credits accrued x-axis), and by their performance in the program (outcome y-axis), and can be tabularised for schools so that they can review the academic transcripts for students in areas of concern. This enables schools to quickly assess if attritions are occurring early or late in studies, and if attrition relates to low or high performing students. The insights gained here help ROI by pinpointing timing as well as the structural focus of interventions.

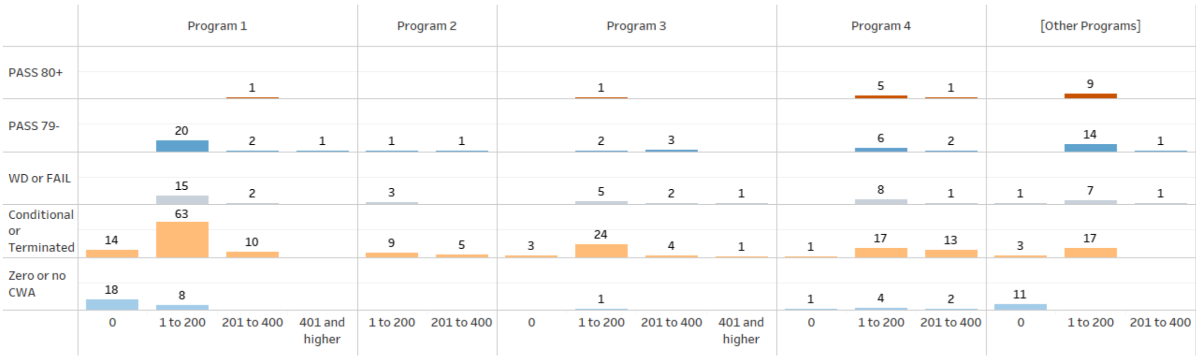

Figure 2: Lifetime attritions by credits accrued and attempt outcome

Feedback from faculty staff on this view of retention data has been positive, with one of the key stakeholder indicating it *“has underpinned the conversations, and subsequent initiatives and development, to support further improvements of our student retention [and has] allowed for deeper understanding across several factors, […] which has lead the discipline areas to investigate further into the reasons and factors that might explain [the loss of high performing students] with a view to design and communicate ways to reduce this.”*

Tools for teachers: Integrated reports

Reports integrated with the Blackboard Learn LMS offer nightly updated views of student background information, student engagement with unit materials, current grade scores, and types of work submissions. Five reports provide teachers with different views of these meso-level data (see Table 2). Feedback from staff suggests they often leverage the Student-at-a-Glance report in the context of student appeals, as it includes an ‘audit log’ of all of the engagement and submission activity for a student. Other feedback has highlighted the benefits of simple functionality in the Student Background that lists the number of students enrolled in a unit by their program (or ‘course’ as it is known at this university) of study. This data has had a beneficial non-financial ROI impact on teaching, because previously teaching staff often had poor visibility over the programs of study into which their set of classes was being offered. With the goal of maximising the ROI of the integrated reports, a communications plan was implemented at the start of 2018, and continued into 2019. Five distinct communications are emailed during each semester to all lecturers, each flagging a single use case, including student background review, identification of disengaged students, identification of under-performing students, review of student engagement and performance, and unit content review. The communications have successfully resulted in an uplift in the usage of the reports, but overall usage is still relatively low, with only 15.6% of 2019 Semester 1 units having leveraged the reports. In reflecting on the relatively low rate of usage, we are planning to incorporate more personalised messaging to staff in a subsequent communications cycle.

Table 2: Blackboard Learn LMS integrated reports

Report	Provides	Usage
Student Background	Information about the background of the students in the LMS site.	Through better understanding, help to enable teaching to be tailored to the needs of the cohort.
Unit Activity	Information about the overall activity of the students in the unit.	Learn how active students compared to their other units, as well as when they are most/least active.
Item Activity	Information about student interaction with the unit content.	See the level of activity that students have with each item in the unit, and when they are accessing it.
Contribution and Performance	Information about the contribution and performance of students in the unit.	Learn how students' activity in the unit correlates to their grade, and what students are submitting and when, and what their grades are for each item.
Student-at-a-Glance	Consolidated information about a particular student.	Compare how a student is interacting and performing compared to the rest of the unit.

Methods to identify and assist students-at-risk

A pilot Student Retention Prediction system was unsuccessful because the target measurement was based on a timeline that was too long for 'student success workers' to make timely use of the insights. Despite this, there remains a healthy appetite for initiatives targeting students-at-risk, particularly in anticipation of government imposed performance-based funding (Department of Education and Training, 2018). As such, L&T has initially chosen to focus on identifying at-risk students via simple heuristics that are easy to interpret and triage.

Disengaged student list

A problem experienced by the university involves students who do not sufficiently engage in an enrolled unit, which can result in a 'fail incomplete' with a mark of 0. In extreme cases, students might not remember they were enrolled for an entire year, resulting in unnecessary fees and poor academic transcripts, which in turn reflects poorly on the university with respect to government measures around student success and retention. Some staff use LMS functionality to identify disengaged students on their own initiative, but this practice only happens in a relatively limited number of units. To address this, in 2018 L&T piloted a university wide consolidated list of disengaged students, enabling all faculties to identify and contact students deemed to be at-risk due to never having accessed the LMS materials for one or more of their units. By 2019, this initiative has been through several action research cycles, and it has become standard practice for each faculty to leverage the data prior to the semester 1 and 2 census dates. Although the list is conceptually simple, in practice it has proven to be tricky to eliminate false positives. For example, of the 2,236 unit enrolments in the 2019 Semester 1 list, 80% were flagged as being possible false positives. Students may also be inactive in some units, but active in others (i.e., partially engaged), perhaps because there has yet to be a strong need to access some units (e.g., no early assessment). Consequently the system is not yet ready for automation. False positives considered include:

- Incarcerated students, who cannot access the LMS.
- Students seeking recognition of prior learning, who may believe that it is pointless to engage with the unit.
- Some teachers deliver material using a different (non-standard) LMS, to which access is not tracked.
- Automation at the university creates LMS sites, even if there is little or no unit material to host.

Irregular enrolment student list

Students sometimes study units at the university in an atypical sequence, by enrolling in units that are not expected to be attempted until a subsequent study period or year. Whilst this may be intentional in some cases, for example to exploit the flexible study options, it is frequently the case that such decisions are inadvertent. Poor choices can result in study plans with complications, potentially affecting retention, performance, and the student experience. In one case, a high-performing student inadvertently studied a second year unit instead of the expected first year unit, and as a result of this 'irregular enrolment', it will not be until their third year that their study plan will return to a 'normal' state. This single mistake has caused the following issues:

1. The student has had to study a unit of higher difficult than expected, without all of the 'scaffolding' intended by the program designers.
2. The student has had to meet with academic staff to obtain pre-requisite waivers, and to be granted permission to overload their studies, in order to circumvent unit availability constraints that would otherwise have delayed their anticipated graduation date.
3. The student has had timetable clashes, as a result of studying non-standard combinations of units.

In 2019, L&T produced a university-wide dataset to enable staff to identify and contact new-to-program undergraduate students with irregular enrolments such as this. The first run identified 1,240 students with enrolments that did not strictly follow the template specified for their study plan, with 23% of the students having selected a unit of the wrong year level. Even though the list was provided on short notice, the data was well received by faculty staff, with feedback such as "*it was very useful for identifying students incorrectly enrolled*" and "*all [in this program] were incorrectly enrolled (so what a neat report that is!!)*". Anecdotal feedback also indicates that students were grateful to have been contacted about their irregular enrolments.

Conclusion

Alongside the evolving social and organisational context, higher education must transform its processes to accommodate new conceptualizations of student capability and success (Vey, Fandel-Meyer, Zipp, & Schneider, 2017). In particular, universities must reconsider five important dimensions of higher education learning and teaching operations: finding and selecting students; knowing learners and their expectations; just-in-time services, content, mentoring and support; anytime, anywhere accessibility; and global connectivity (Henry, Gibson, Flodin, & Ifenthaler, 2018). The findings of this action research are limited as they are of preliminary status. Our current efforts focus on reflecting on the impact at all stakeholder levels as well as through deep data analytics strategies with a longitudinal perspective.

To sum up, with technology offering significant opportunities to enhance access and success in higher education, technology-enabled learning and teaching approaches present an important avenue for innovations, facilitating unique opportunities to identify and develop talent for today's university and beyond.

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Higher Education Stakeholders' Views on Guiding the Implementation of Learning Analytics for Study Success

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Learning analytics show promise to support study success in higher education. Hence, they are increasingly adopted in higher education institutions. This study examines higher education stakeholders' views on learning analytics utilisation to support study success. Our main research question was to investigate how ready higher education institutions are to adopt learning analytics. We derived policy guidelines from an international systematic review of the last five years of learning analytics research. Due to the lack of rigorous learning analytics research and adoption, this study examines how ready university stakeholders are to adopt learning analytics. In order to validate the guidelines, we conducted an interview study with 37 higher education stakeholders. The majority of participants stated that their institutions required further resources in order to adopt learning analytics but were able to identify what these resources were in order for successful implementation. Overall, stakeholders agree that learning analytics show much promise to support study success at higher education institutions.

Keywords: Learning analytics; study success; adoption; policy recommendation

Introduction

Learning analytics are increasingly adopted and utilised in higher education institutions in countries such as Australia, UK and the USA (Sclater & Mullan, 2017). Learning analytics are regarded as the use of static and dynamic information about learners and learning environments, assessing, eliciting and analysing it, for real-time modelling, prediction and optimization of learning processes, learning environments, as well as educational decision-making (Ifenthaler, 2015). They are essential data-driven tools, which allow educators to view the learning progress of students so that they can be supported if they are under-achieving or at risk. Learning analytics can also be used to motivate students to stay on their university courses and therefore facilitate and increase study success (Mah & Ifenthaler, 2018). Learning analytics can be descriptive, predictive or prescriptive and offer different ways in which they can be designed, implemented and deployed to facilitate students' learning and their retention on courses (Ferguson et al., 2016; Glick et al., 2019). Learning analytics data for summative reporting are obtained from sources such as course assessments, surveys, student information systems, learning management system activities, and forum interactions by *descriptive analytics* (Arthars et al., 2019). Similar data from those sources and attempts to measure onward learning success or failure are utilised by *predictive analytics* (Glick et al., 2019). Algorithms to predict commonly the study success and whether students retain on their courses as well as suggesting immediate interventions are deployed by *prescriptive analytics* (Baker & Siemens, 2015). Typically, a student profile and their associated learning progress can be viewed, examined and appropriate alerts and/or actions can be taken (Klasen & Ifenthaler, 2019). The benefits of utilising learning analytics in learning environments are a) increasing students' learning (experiences and effectiveness) and their learning motivation (Schumacher & Ifenthaler, 2018), and thereby, reducing student dropout or inactivity and increasing study completion (Chai & Gibson, 2015), and b) providing personalised and/or adaptive learning paths via the specific goals set by the teacher or student to support the learning process (Fuchs, Henning, & Hartmann, 2016). However, the use of learning analytics outside Australia, UK and the USA is still relatively rare (Ferguson et al., 2016; Sclater, Peasgood, & Mullan, 2016).

In order to validate derived guidelines from a systematic review of learning analytics literature (Ifenthaler, Mah, & Yau, 2019), this contribution focusses on the acceptance of the learning analytics tools to increase the study success by higher education stakeholders.

Learning analytics and study success

Study success includes the successful completion of a first degree in higher education to the largest extent, and the successful completion of individual learning tasks to the smallest extent (Sarrico, 2018). As some of the more common and broader definitions of study success include terms such as retention, persistence, graduation rate and the opposing terms include withdrawal, dropout, non-completion, attrition and failure (Mah, 2016).

Learning analytics show promise to enhance study success in higher education (Pistilli & Arnold, 2010). For example, students often enter higher education academically unprepared and with unrealistic perceptions and expectations of academic competencies for their studies (Mah & Ifenthaler, 2017). Both, the inability to cope with academic requirements as well as unrealistic perceptions and expectations of university life, in particular with regard to academic competencies, are important factors for leaving the institution prior to degree completion (Mah, 2016). However, Sclater and Mullan (2017) reported on the difficulty to isolate the influence of the use of LA, as often they are used in addition to wider initiatives to improve student retention and academic achievement. Still, a number of reports currently exist in the area of LA including policy recommendations, each of which are detailing their individual policy recommendations for their geographical contexts. For example, Colvin et al. (2015, p. 3) provided a set of policy recommendations for the Australian context:

1) "Facilitating broader institutional, cross institutional and government discussions of LA and its capacity to inform sectorial challenges;
2) Developing capacity building initiatives. This may manifest as professional development, secondments, and postgraduate course opportunities;
3) Developing and supporting new models of education leadership that embrace complexity and enables innovation, organisational agility and adaptivity".

Five successful LA implementation-enabling factors in Australia include (Colvin et al., 2015, p. 20): 1) "Higher education leaders coordinate a high-level LA task force; 2) Leverage existing national data and analytics strategies and frameworks; Establish guidelines for privacy and ethics; Promote a coordinated leadership programme to build institutional leadership capacity; Develop an open and shared analytics curriculum (to develop systematic capacity for LA by training skilled professionals and researchers)." A similar set of policy recommendations was provided by Ferguson et al. (2016) in the European context, who also presented a discussion on how some countries such as Australia, Denmark, The Netherlands and Norway have successfully adopted LA. From an integrative review based on five years of research on learning analytics and study success, the following guidelines have been derived (Ifenthaler et al., 2019):

- Developing flexible learning analytics systems which cater for the needs of individual institutions, i.e., their learning culture, requirements of specific study programmes, students and lecturers dispositions, technical and administrative specifications as well as the broader context of the institution.
- Defining requirements for data and algorithms of learning analytics systems.
- Involving all higher education stakeholders in the development of a learning analytics system.
- Establishing organisational, technological and pedagogical structures and process for the application of learning analytics systems as well as providing support for all involved stakeholders for a sustainable operation.
- Informing all stakeholders with regard to ethical issues and data privacy regulations including professional learning opportunities.
- Building a robust quality assurance process focussing on the validity and veracity of learning analytics systems, data, algorithms and interventions.
- Funding of research regarding questions on learning analytics within single institutions, research associations and national schemes.
- Constituting local, regional and national learning analytics committees including stakeholders from science, economy and politics with a focus on adequate development and implementation (and accreditation) of learning analytics systems.

Research questions and methodology

The current study aims to validate learning analytics guidelines for the higher education sector which were derived from the findings of a systematic review (Ifenthaler et al., 2019). The overriding research question is as follows: Do experts of the higher education sector confirm and accept guidelines for the implementation of learning analytics for supporting study success in?

Our structured interview study (Mayring, 2015) was conducted over a period of three months including N = 37 participants. We first collected a list of suitable participants; they were all had experience in educational technology and were a professional staff at a higher educational institution. Some of these stakeholders work directly or indirectly with learning analytics and have different degrees of knowledge of learning analytics. The list was drawn from participants' list from e-learning conferences. Subsequently, we contacted them via email to request whether they were willing to participate in the interview study. The interview study was initiated by a pilot study of six stakeholders from our university and these were conducted face-to-face. The pilot study confirmed the expected comprehension by stakeholders and that the questions would be answered as intended and thus eliminating any ambiguity.

Participants in the main interview series included N = 31 stakeholder. The interview was conducted via remote conferencing due to practical reasons given the time and resources constraints. All of the interviews were recorded with the participants' consent and stored securely for later anonymous transcription and analysis. 10 out of 37 participants were female and the age range was from 27 to 60. Their areas of expertise include Information Management (with focus on workplace learning), Business Mathematics/Education, Educational Science, Computer/Data Science, Electronic/Mechanical Engineering, Psychology, and Web Technologies.
The interview was divided into eight sections – 1) Learning culture, 2) Study success, 3) Technology acceptance, 4) Understanding of learning analytics, 5) Current learning analytics projects (if any), 6) Strategies, policies and guidelines, 7) Time and resources, and 8) Demographic information.

The interview transcriptions were analysed using content data analysis and specifically we searched for evidence in the interview transcriptions to support/reject our guidelines based on iteratively created categories (Mayring, 2015). The limitations of this study include the subjective opinions of each participant, which may not represent their institution truly. Two different researchers conducted the interviews due to practical reasons; this may also cause subjectivity by each researcher in the way the questions were posed. The researcher analysing the interview transcripts may also interpret the interviews subjectively according to his/her knowledge in this domain. Coding and analysis of the interviews was realised by the research team, communicating about possible inconsistencies with regard to the research questions and categories using f4/f5 software (https://www.audiotranskription.de).

Results and discussion

Understanding of learning analytics, current projects, barriers to adoption

Most participants could provide an accurate description of what learning analytics constitutes. The following elaborations of a potential definition/description of learning analytics was provided by participants, for example participant IP3:

> **"***If you collect enough data, one can probably observe patterns of some things that can be improved. It is a type of data analysis, where one can see some practices, which relate to better results of the students in the end or some practices, which may lead to poorer results. Maybe one can also observe when students have more difficulties with their courses and when they are struggling more with one course more than another. This provides another way to know how the learners are coping in the courses in addition to the normal teaching/learning processes where there is minimum interaction. So one can identify which of the used teaching practices lead to either better or worse results for the students."*

Still, due to the novelty of learning analytics, there is limited research, or resources dedicated for the implementation of learning analytics systems at higher education. For example, one participant experienced a number of difficulties concerning data protection when attempting to implement a learning analytics system. Most of the mentioned barriers to learning analytics adoption were mostly financial constraints including personnel costs (sufficient and qualified multi-disciplinary staff required to operate the different parts of the learning analytics system, for example, pedagogical staff concerning the learning materials, data protection staff concerning data privacy aspects, IT staff concerning technical implementation and maintenance) and actual software, server and licensing costs for the implementation of the learning analytics system. Most participants mentioned that there were not any learning analytics projects currently operating at their institution. In summary, most participants agreed and emphasised that the first, large obstacle to learning analytics implementation was data protection. The regulations to data protection are very important. For example, students have the rights not to provide directly information on how many hours they spent studying, or indirectly via traces of data left when logging on and off a learning management system. Another obstacle is the workload this creates on members of staff. A concern specified by a participant being "*The more data one collects, the better it would be for the learning analytics. However, it might imply possible administering several surveys and questionnaires during the course and may conflict with the dynamics of the course and some teaching staff may not be willing to do so easily*."
Whilst these two points are seen as obstacles, one participant views it rather as a difficulty that can be navigated and overcome. The difficulties lie also on different levels for example one level is linked strongly with trust which

according to the participant who is a computer scientist emphasized that a) they may not trust as much with other knowing their data as staff/students from students from other disciplines purely because they may have a better understanding about what one can do with the data, and b) trust requires a very social component which some computer scientists do not like/are not social. In order to overcome these issues, some strategies can be put in place such as reinstating that not all students' private data will be collected, only those relevant required and with the students' consent. There are also technical aspects, which include the connection of different systems inclusive of data protection issues, which require technical expertise of IT staff and can be problematic.

Readiness to adopt LA and validation of policy recommendations

We examined the responses to the interview question "How ready is your institution to adopt learning analytics?". Six participants expressed that their institution was ready to adopt learning analytics because their institution currently has learning analytics research projects and possibly a system in place and they may effectively adopt more projects or implement learning analytics in students' existing courses in a relatively straight-forward manner. It is also the case that some of these participants stated that they also have currently the personnel required including a professor, a postdoc and doctoral students in this area of research. The majority of participants (N = 30) expressed that there are currently resources required by their institution before they can go ahead and adopt learning analytics. In general, these participants expressed that their institution is mentally ready to adopt learning analytics as the benefits of study success outweigh the costs (West, Heath, & Huijser, 2016). The required resources include staff and technological capabilities. Several participants emphasised the problem that there is a lack of learner's personal data relating to their learning processes, exam grades and so on, which makes predictions very difficult. Due to the strict data protection regulations (e.g., EU-GDPR), this is not allowed and therefore eliminates/decreases the ability for learning analytics systems to make accurate predictions based on students' data. The participant could be understand why the data cannot be made available especially given that the data can be anonymised (Ifenthaler & Schumacher, 2019). A further analysis of responses focussed on the validation of the guidelines for the higher education sector. One participant stressed the importance of learning leadership and role models because learning analytics are still a very new field (Buckingham Shum & McKay, 2018). Experimental 'playgrounds' are required to understand, discuss, debate, test out all learning analytics ideas and put them into practice and learn from these good/bad experiences and studies. It is interesting to note that many of the participants have similar ideas about the advantages and disadvantages of learning analytics implementation and ways to overcome the specific challenges. This implies that current challenges in successful learning analytics implementation are widely known within the higher education sector and research community, hence, a list of protocol can be put together to accommodate the requirements and desires of stakeholders in order to adopt learning analytics.

Conclusion and future work

The implications how to support stakeholders at higher education institutions in utilising learning analytics to support study success are still under-documented (Ifenthaler et al., 2019). Remaining questions for future research are: Will students be able to respond positively and proactively when informed that their learning progress is hindered or inactivated?; Will instructors be able to influence the at-risk students positively so that they will re-engage with the studies? In addition, ethical dimensions regarding descriptive, predictive and prescriptive learning analytics need to be addressed with further empirical studies and linked to study success indicators (West, Huijser, & Heath, 2016). As this research reports qualitative data, the findings are limited with regard to their external validity. Hence, further research is required to build further rigorous findings towards the effects of learning analytics systems for supporting study success. As higher education institutions further adopt analytics systems, pedagogical and psychological advances may help to further inform the design, development and evaluation of learning analytics systems.

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A Proposal for Enhancing Students' Evaluations through an Adaptive and Progressive Digital Feedback System

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Students enrolled in a course are asked to complete an anonymous Student Evaluation Survey (SES) towards the end of the term that will provide the university with student feedback. The aim of the SES is to collect and use student feedback to enhance the overall design, delivery and outcomes as part course quality and enhancement processes. However, this traditional SES model is not without limitations. It has been observed that there has been a decline in response rate of SESs across universities risking insufficient sample sizes for meaningful and valid analysis. This coupled with their infrequent deployment, limited duration and inability to capture informal, time-sensitive feedback suggests that exploration into new ways of facilitating surveys is necessary. In this paper we present a work-in-progress collaborative project that proposes to augment traditional SES methods in a way that responds to the afore mentioned limitations, reimagining SESs to include regular informal weekly engagement with students.

Keywords: Learning and Teaching; Adaptive and Progressive Digital Feedback System.

Introduction

Many universities and higher education institutions are using online student course evaluation surveys at the end of the term to evaluate the quality of learning and teaching in the classroom (Anderson, Cain and Bird, 2005; Alderman, Towers and Bannah, 2012). Student evaluation surveys are the primary means by which most universities assess their faculty's teaching skills (Kozub, 2010; Simpson and Siguaw, 2000). With the growth of electronic means for information exchange and social media, teaching evaluations are now also becoming a publicly visible reflection of a university's quality of educational services (Estelami, 2015). The Student Evaluation Survey (SES) measures five aspects of a student experience: Skills Development, Learner Engagement, Teaching Quality, Student Support, and Learning Resources (SES National Report, 2017). However, it has been observed that there is a decline in response rate of the SES. The response rate for the 2013 University Evaluation Survey on students experience and satisfaction was 29.3%. Institutional response rates ranged from 50.5% to 17.9% (University Experience Survey National Report, 2014). There is evidence to suggest that there is an ongoing decline in survey response rates among Australian universities. As quoted by Nair (2017), "Six of eight universities have experienced a sharp decline in response rate (>18%)" (Graduate Careers Australia, 2014). With the rapidly evolving environment of Higher Education, the traditional online course evaluation survey may be obsolete as it does not provide real-time feedback and has limited utility with respect to adjusting learning and teaching resources within the term (Grant, 2014). Exploring new ways of administering surveys is sensible given declining survey response rates (Massey and Tourangeau, 2013).

Moreover, research indicates that there is a significant gap between teaching approaches and actual practices in higher education (Kim and Bonk, 2006). Attention has shifted from student experience to student engagement (Klemenčič et al., 2015) which conceives students as active partners in the educational process and as responsible for their own learning and formation (Taylor et al., 2011). To ensure continuous improvement of student learning, a requirement of Universities as detailed in the Higher Education Standards Framework (2015), universities would benefit from progressive and formative feedback in conjunction with the end of term SES to enhance courses and their delivery (Pugliese, 2016). These data-adaptive solutions need to be able to differentiate instruction at a personalised level of learning (Appleton-Knapp and Krentler, 2006), and allow students to own their learning journey through real-time response to their ongoing detailed feedback for self-mediation (Pugliese, 2016). The synergistic relationship between learning design and learning analytics has the potential to improve learning and teaching in near real-time (Ifenthaler et at., 2017). With the advancement in new technology and the universal use of digital media by students (Gardner and Davis, 2013), research is already underway seeking to adapt qualitative empirical methods to digital use, enabling canvassing of data on student experience on a large scale (Klemenčič et al., 2015), and facilitate more exploratory and innovative research in this area. To serve students better, the higher education systems should develop student satisfaction monitoring procedures representing an emergent condition (Moler, 2006). Almost all universities have requirements that formal course evaluations be made (Alderman, Towers, and Bannah 2012). But, what about the informal? With the proliferation of online education in recent decades, the opportunity to capture informal and time-sensitive feedback, such as informal classroom discussions, has diminished (Svensson et al., 1999). Little has emerged within the sector to fill this void.

In this paper, a design is proposed for a new progressive and adaptive feedback model to resolve the issue of declining survey response rates and to improve the collection of meaningful, timely, and sometimes overlooked, informal student feedback (Svensson et al., 1999) that can be acted upon during term. This model is designed to receive informal, real-time, adaptive feedback from students during the term to satisfy students' learning needs and improve learning outcomes through student engagement. This will bring ownership and investment in learning from students and teachers, which in turn will establish a sense of equity and form a course design team.

The remainder of the paper discusses issues with existing online SESs and a proposed alternate model based on previous research, intervention design, research design and finally, conclusion and future work.

Models of SES - Reimagined

There appears to be a consensus that student feedback helps to improve courses. Student feedback is helpful for teachers and learners to improve their learning and teaching (Klemenčič et al., 2015; Alderman et. al., 2012). Therefore, one of the important issues for improving learning and teaching is obtaining feedback for optimising the learning environment and learners themselves.

However, current models for SESs are not without issue. A significant limitation of traditional online SESs relates to their timing and frequency. Typically, the student evaluation survey is facilitated once per student, per unit of study, per term, where it is recommended that responses are solicited for a period of 3 to 5 weeks (Shah et. al., 2017). This blunt instrument swung once per term grossly inhibits a teacher's ability to be agile and responsive to student feedback during the term.

Svensson et. al. (1999) recognised this issue, and in response, developed the Course Barometer. The Course Barometer captured students' moods or attitudes at any time the student wishes to express it throughout the term. It achieved this using a simple web interface where students would select either a green or red rectangle connoting a positive or negative feeling. If they submitted the web form without selecting a coloured rectangle, the response was taken as neutral.

Jones (2002), continued the work of Svensson et. al. by introducing a commensurate service for his own teaching (and subsequently, faculty-wide at his institution) similarly called a Course Barometer. As part of Jones' (2002) first study, he detailed an instance in which the Course Barometer facilitated improvement to the student experience during the term. Issues about lecture quality were raised by students who at that time, were attending via video broadcast. Jones (2002) noted:

> "Often problems such as this would have continued throughout the term with little or no change. However, in this case the problems raised were addressed in a variety of ways and from week 4 onwards the overall student feeling on the barometer was positive".

Despite the potential for responsiveness to student feedback, and like traditional SESs, Course Barometers also suffer challenges in relation to student response rates with the Course Barometer (Jones, 2003). In his second study, survey responses from two different student cohorts collectively indicated:

1. Students were not holistically made aware that the Course Barometers existed;
2. Students didn't perceive any action or expected any action in response to the feedback that they provided via the Course Barometer

These factors among others are mirrored by more recent and holistic research (Shah et. al., 2016). Reimagining SES on a weekly basis must also consider these factors.

Intervention Design

It's clear from the literature that a problem exists with existing SES instruments, and that a more adaptive approach is needed. Based on the literature review, this new system needs to be easy for students and teachers to use, quick to implement, and provide feedback that can be quickly actioned in a real-time fashion. For this reason, this paper is proposing an adaptive and progressive feedback system that can collect multiple forms of feedback (or data) from participants to support meaningful understanding of the course content on a weekly basis. An example of the feedback design which will be used in this study is shown in Figure 1. The Shareable Content Object Reference Model (SCORM) framework, which is supported by many Learning Management Systems (LMS) and eLearning authoring tools, can be used as a scaffold for the creation of bespoke content to facilitate this approach.

Figure 1: Examples of Adaptive and Progressive Digital Feedback for Students

The proposed system will be called the Adaptive and Progressive Digital Feedback (APDF) system. The APDF system will collect data for three dimensions (teaching and learning activities, institutional material base, and support services) whilst challenging students to be self-reflective and actively engaged with their learning journey. Not only does this approach promote responsive learning design and cater for future needs, but it also provides a mechanism to monitor the progress of the active student cohort and conduct timely interventions to enhance their learning experience. This philosophy is a paradigm shift from existing online SESs which are more concerned with the collection of feedback to improve the prospects for students on the subsequent course. By taking this approach it is envisaged that educators will demonstrate that they are not only committed to improving the quality of the learning journey for current students, but that they are willing to provide active pastoral care in a bid to maintain student engagement and combat attrition. The contemporary educational space is competitive, flexible and adaptive, so the content that exists within it should share the same characteristics.

Research Design

Parker (2011) has shown how a design-based research (DBR) approach is being used to design and develop authentic e-learning within the higher education sector. It is an iterative research process which Reeves (2006) described as four connected phases and is shown in Figure 2. We will be using DBR methodology as the collected data will inform improvements to the APDF system and this will support multiple iterations which will be used in future, for instance over multiple terms where data collected, and lessons learned are incorporated into APDF for ongoing improvement.

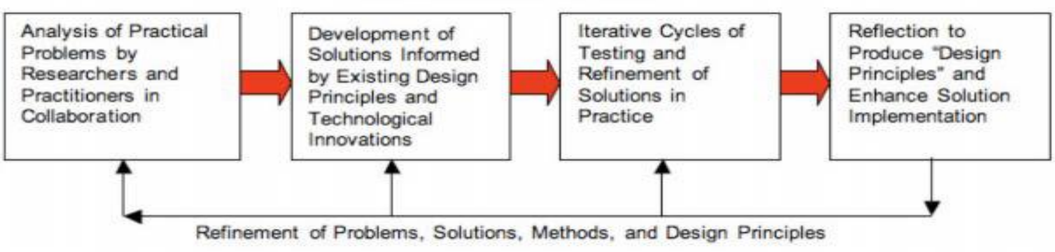

Figure 2: Four phases of design research (Reeves, 2006)

This research approach is being used in education to investigate innovation using technology-based initiatives, because it “embraces the complexity of learning and teaching and adopts interventionist and iterative posture towards it” (Kelly, 2004, p. 105). The iterative phases required in our research are:

Phase 1: Analysis of practical problems: This requires us to select data sets to identify the problems. Often, teachers fail to create meaningful opportunities for interaction within their learning objects, creating a sense of isolation within the student cohort (Maor and Volet, 2007). The information students are not engaged with, what works and what does not work for them will be identified on weekly basis.

Phase 2: Solutions will be developed to the identified problems, which can then be implemented in the learning environment. This solution is an identified intervention which will able to solve issues related to the timing and frequency of traditional Online SES. Details of the first iteration of this intervention are described above; this intervention will then be updated and modified in later loops of the DBR process based on student and staff feedback.

Phase 3: The solutions developed will be implemented as a design phase. Data will be collected and analysed to ascertain the effectiveness of the implemented solution. This study will utilise a mixed methods data collection to examine the impact of the APDF system on class participation and interaction for both online and face-to-face classes in a postgraduate and an undergraduate course. Quantitative and qualitative data will be collected from students enrolled in courses with the feedback system implemented. Data collected on the use of APDF can be compared with the data collected by the end of the term SES survey. A survey/interview will be conducted for the teaching team involved in teaching courses where these digital feedback systems will be used. Twenty teaching members across different locations have been identified. This research will use a variety of quantitative analytic techniques using Clustering (K-Means), and Classification (Decision Tree Induction) to generate insights about the APDF system. We will perform a t-test on the control and treatment groups.

Phase 4: Once the APDF system has been implemented, the entire project will be reviewed, with dissemination to the stakeholders and broader educational community. Design principles are fundamental to the conduct of educational design research (or DBR) studies. Design principles can be used to guide the design and development of learning environments in higher education that are based on sound practical and theoretical principles, and that can promote student engagement through innovative learning tasks. Reflections from this phase will also be fed back into subsequent loops of the DBR methodology in future studies (Herrington et. al., 2011).

Conclusion and Future Work

The study has found that student feedback is perceived positively by universities. When conducted and utilised appropriately, student evaluations are a valid and reliable source of information for the enhancement of courses and learning and teaching practices. In this paper, we have reported on a work-in-progress proposal for the APDF system, concerned with building an adaptive and progressive feedback system to overcome the limitations of traditional SESs. The design phase will be iterative of our proposed APDF system and will be implemented in a form that can be used. As a designer we will test aspects of the educational intervention, or whether the educational intervention as conceived has achieved its goal. Once the design has been achieved, we will test our APDF system to collect feedback about the success of the design and the validity of the theoretical propositions. It will tell us whether the design has achieved its practical and theoretical goals.

The next step in the project is to test the conceptual design of our proposed APDF system.

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Diverse Goals but One Heart with Mixed Reality in Information Systems

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The use of Mixed Reality (MR) in Information Systems learning and teaching pedagogies is becoming more widely accepted as providing a reflection of possible realities. The aim of using MR in learning design is to extend the student experience by helping them not only to 'see the unseen' through the capacity of MR but also to visualise and interact with complex and abstract concepts. This study expands on the current literature by applying design science to use, survey and evaluate Microsoft HoloLens, a MR device, in an Information Systems classroom. The significance of this study is the use of MR in an Information Systems class to understand and learn the technology and provide an authentic learning experience to prepare the students for technological disruption and the future of work. Student survey responses were positive, with high student satisfaction in the classroom, demonstrating critical and creative engagement with the technological limitations and challenges with the user experience. This paper concludes with suggestions of specific pedagogical models that could be used in Information Systems education.

Keywords: Mixed reality; Information Systems; design science

Background

Mixed Reality (MR) is an emerging technology and is a budding form of experience (Milgram & Kishina, 1994). MR overlays 2D and 3D objects into the real world (Azuma et al., 2001). The user can view the real world through a handheld or head mounted device (Harborth, 2017). Microsoft HoloLens is an example of a MR device. MR applications are used in various fields like health (Stretton et al., 2018), business (Soliman et al., 2018) and education (Alexander et al., 2019; Leonard & Fitzgerald, 2018). MR offers the chance to reshape clinical simulation spaces for learning and teaching in healthcare higher education (Magana, 2014). A MR system is defined by Azuma et al., (2001, pp. 34) as one that "combines real and virtual objects in a real environment; runs interactively and in real time; and registers (aligns) real and virtual objects with each other".

Today Augmented Reality (AR) refers to the overlay of data onto the visible world, while MR refers to the display of virtual objects over the real-world background. With MR, an overlay of virtual objects over the real visible world, enhance our sensory-motor engagement with the world (Lindgren et al., 2016). A systematic literature review by Harborth (2017), highlights a shortage of MR related work in Information Systems and outlines many promising areas for future work. In a recent study MR was used to help students learn the anatomy of the human body mediastinum and it was found to strengthen the students' self-efficacy and motivation, improved learning, and provided a good learning experience (Nørgaard et al., 2018). The differences between VR and MR in learning design was highlighted by Hugues, Fuchs, & Nannipieri, (2011) and they emphasised that there is a strong argument available to set aside the technical similarities of the technologies and to treat them separately (Hugues, Fuchs, & Nannipieri, 2011). In many respects, the affordances of virtual reality have been well explored in the literature on the educational use of video games (Waddington, 2015). However, the immersive nature of more advanced VR technologies does appear to enhance these effects (Clark, Tanner-Smith, & Killingsworth, 2016; Martín-Gutiérrez et al., 2017).

Visualizing various data both big and small in a real and physical environment is the next promising area in this MR related research. The first promising area in visualizing is a system with immersive analytic features of MR developed by Mahfoud et al., (2018). Przybilla et al., (2018) used design thinking and proposed a human-centric approach for documenting chronic wounds using augmented reality smart glass application. Studies in health-related areas include, exploring on interactions with the neuropsychologist's avatar in virtual locations using a VR social network (Bernard et al., 2018) and, creation of a hybrid augmented experience merging physical and virtual worlds for immersive e-therapy (Gorini et al., 2008). Given the maturity and availability of MR technology, the adoption of MR applications to support the Information Systems education process is a realistic application scenario within the context of digital disruption. Hence, the aim of this study is to design, trial and evaluate the use of a MR device - Microsoft HoloLens, as a teaching tool in Information Systems classrooms.

Methodology

Design science is a promising research paradigm in Information Systems education (Gregor & Hevner, 2013; Laurillard, 2013) and it is used to answer a research question by building socio-technical artefacts (Myers & Venable, 2014). The key principle of design science research is the identification and understanding of a design problem, and its solutions are developed in the construction of an artefact. In teaching, Laurillard states that design science provides a framework for improving learning and teaching contexts when introducing and evaluating an emerging technology in the classroom (2013). For this study, the design problem is the use of MR technology to provide an authentic learning experience in an Information Systems class to support students to learn, and to support teachers to evaluate the technology.

The solution to the design problem in this study is to evaluate Microsoft HoloLens in an Information Systems class as an artefact. Microsoft HoloLens was used by 180 students studying an undergraduate and a postgraduate unit about Information Systems in Organisations. Six HoloLens devices were used in ten different workshop classes to review the concepts taught. Each workshop consisted of approximately twenty students. Four tutors were involved in the orientation of the use of HoloLens in class. The lesson plan was prepared and shared with the tutors as given in Table 1. Tutors were also familiarised with the lesson plan and the HoloLens. Three members from the education team were also involved in helping the 180 students use the HoloLens in class for the first time. Table 1gives a demonstration of the lesson plan to introduce HoloLens in class.

Table 1: Lesson Plan used to introduce HoloLens in class

Time	Stage of Lesson	Details
5 minutes	HoloLens orientation	Watch HoloLens Orientation Video and demonstration.
5 minutes	Introduction to the task for the class	Discuss the question to solve and how to work in groups.
5 minutes	Group formation	Groups are formed with a maximum of four students in a group.
30 minutes	Initialization with HoloLens	Each student in a group can start using HoloLens and familiarize themselves in using HoloLens and communicating with their team members.
30 minutes	Design with HoloLens	Students choose the question to work on and work towards designing their solution in HoloLens.
30 minutes	Present the solution	Students present their findings with HoloLens.
10 minutes	Survey	Students answer the survey.
5 minutes	Conclusion	The session is concluded with a summary of lessons learnt.

Figure 1. Use of HoloLens in class.

HoloTour application gives a view to explore the beauty and history of Rome or to uncover the hidden secrets of Machu Picchu. HoloStudio is a HoloLens app that allows developers to create holograms of your own design and turn them into physical objects with 3D print compatibility. After an initial orientation to MR and the various applications of the technology, students formed groups of four. HoloLens was circulated between each of the group members for them to experience one of the available Apps. Students then discussed the opportunities and capabilities of the immersive tourism HoloTour App and the 3D hologram creation HoloStudio App. Based on a previously chosen industry or business area for analysis, students were asked to consider how MR and these types of Apps might transform the future and associated opportunities for their chosen industry or business area. At the end of the class, students were asked to participate in a short survey to ascertain their views on the user experience and critique the affordances of the technology. This doubled as a formative learning moment to inform their final assignments which required students to analyse the impact of innovative technologies and the effect of change on their chosen industry/business. At the end of the session, students were asked to rate their experience. The findings from the survey are presented in the next section.

Findings

The results from the survey conducted is given in Table 2. The highest scored question was “This App would make learning more interesting” which scored 89% agreement. The question that scored second was “It was enjoyable to use” with a mean on 84%. Students were very frank in telling that it was not easy to use as it scored low with a mean of 72%. The correlation matrix of the eight questions are plotted in Figure 2.

Table 2. Survey questions and the average score

No.	Variable	Mean	SD
1	It was enjoyable to use.	8.4	2.1
2	It was easy to use	7.2	2.2
3	It worked well	8.0	1.9
4	This App helped me understand the main idea.	8.0	2.1
5	I found it helpful to be able to walk around the object/s.	8.1	2.3
6	This App would make learning more interesting	8.9	2.0
7	This App would help me learn better than normal classroom activities.	8.1	2.5
8	I would like teachers to use this App in the classroom	8.3	2.5

	1	2	3	4	5	6	7	8
1	-	0.633	0.698	0.799	0.732	0.842	0.714	0.818
	-	0.565	0.537	0.666	0.592	0.624	0.564	0.650
	-	0.488	0.457	0.579	0.509	0.562	0.489	0.570
2	0.633	-	0.763	0.616	0.605	0.548	0.490	0.570
	0.565	-	0.695	0.519	0.512	0.469	0.434	0.471
	0.488	-	0.588	0.424	0.418	0.394	0.360	0.390
3	0.698	0.763	-	0.707	0.625	0.627	0.602	0.676
	0.537	0.695	-	0.638	0.539	0.507	0.518	0.560
	0.457	0.588	-	0.545	0.448	0.439	0.432	0.473
4	0.799	0.616	0.707	-	0.658	0.756	0.681	0.722
	0.666	0.519	0.638	-	0.593	0.574	0.570	0.624
	0.579	0.424	0.545	-	0.500	0.504	0.484	0.527
5	0.732	0.605	0.625	0.658	-	0.708	0.609	0.667
	0.592	0.512	0.539	0.593	-	0.628	0.545	0.596
	0.509	0.418	0.448	0.500	-	0.550	0.455	0.507
6	0.842	0.548	0.627	0.756	0.708	-	0.746	0.810
	0.624	0.469	0.507	0.574	0.628	-	0.681	0.712
	0.562	0.394	0.439	0.504	0.550	-	0.609	0.642
7	0.714	0.490	0.602	0.681	0.609	0.746	-	0.885
	0.564	0.434	0.518	0.570	0.545	0.681	-	0.817
	0.489	0.360	0.432	0.484	0.455	0.609	-	0.750
8	0.818	0.570	0.676	0.722	0.667	0.810	0.885	-
	0.650	0.471	0.560	0.624	0.596	0.712	0.817	-
	0.570	0.390	0.473	0.527	0.507	0.642	0.750	-

Figure 2. Correlation matrix

Among the positive aspects of HoloLens, the promising future of MR technology was evident in the students' answers to the open-ended questions regarding the best and worst aspects of the HoloLens Apps and what could be added or changed. Students indicated that HoloLens and MR technology are the future of "next generation digital native dependency" and that these technologies are "new, exciting, innovative, engaging and responsive". The students were confident about the interface experience and the human computer interaction component of the HoloLens. "It was amazing to experience a place away from the classroom, and also be taken back to historical periods and move around and view the place as if you were there" and "Amazing user experience" are examples of quotes related to human computer interaction. The feedback also highlighted that HoloLens enhanced student learning and experience as stated in the following quotes: "Best way for students to learn something new"; and "Excellent for teaching in class". These responses, perhaps not surprisingly, highlight the benefit of the innovative learning experience for students, as well as aspects of the user experience of the technology itself.

Students also highlighted some negative aspects of HoloLens. "Hard to use at the beginning"; and "Not easy to use," clearly indicated some of the difficulties using the technology. The same point was also highlighted in the answers to the survey question: "It was easy to use". These responses indicate that students analysed the user experience while being immersed in the experience. This sense of user empathy is an essential element for the future of work and the design and development of Information Systems solutions. Some students were also not comfortable with the eye view, especially if they wore glasses. Some examples that highlighted viewing issues included "Users can't use it without glasses"; "it could possibly hurt people's eyes"; "eye strain"; and "it was difficult to see at times". There were also issues related to the view and the controls listed as "screen was too small" and "it was very hard to use the controls".

To the final question about suggested improvements, some student responses indicated a limited view of the potential of MR. Comments about the gamification elements such as "Make it like PS VR Game" and "NBA games", while other student responses indicated that they are thinking about the potential future of the nexus between Information Systems, MR and human interaction/empathy. Some examples for the same are listed as "more options and more computer human interactions" and "more interactive communication".

Conclusion

Diverse student goals and objectives can be explored using MR in the classroom as it provides a positive environment for creative and critical inquiry and technological exploration. HoloLens is an example of digital disruption in the way students see the unseen and experience a transformative technology that facilitates learning while simultaneously producing immersive classes that are engaging and entertaining for the student. While MR is resurfacing from previously discussed theoretical frameworks to actual implementations that are set to disrupt business and society alike, further investment in MR in Information Systems education is clearly warranted, as shown in this study.

This study presents the trial and findings of the evaluation of using Microsoft HoloLens as a teaching tool in Information Systems classes. The findings of this study shed light about how MR is succeeding in bringing the outside world into the classroom by making learning collaborative and interactive. The new learning experience with MR provided students with the opportunity to exercise authentic, critical and creative inquiry which was demonstrated by students' comments on both opportunities and limitations of the technology. Student comments also demonstrated that authentic experiential learning led to professional practice thinking about their potential future. The students also brought their learning experience with HoloLens in their final assessment. For example, one assessment presented how to use HoloLens in the watch repair industry. Another set of students proposed a personal trainer using HoloLens.

One of the main limitations for this study is the cost of HoloLens. The current version of HoloLens costs USD4500.00. Hence, we were limited to using 6 HoloLens in workshop classes. The applications are also expensive so we used freely available applications like "HoloTour". In future, we aim to develop applications for the next phase of the study as it not only helps us to use it but will also involve students specializing in programming to the develop application. There is a need to work towards improving accessibility and comfort with other 'needs', for example, students who are wearing glasses, as reflected in the survey. As the technology is not easy to use, there is a need to include more time for the students to be familiar with the use of technology.

Information Systems research on the use of MR technologies for education is really in its infancy. The new version of Microsoft HoloLens that was released in February 2019 worked with companies like PTC Vuforia solutions, Philips and Bentley to give a transformative MR experiences for industrial customers. These are leading examples of how work can change. This study points to a different set of affordances, and the early research in this area is overwhelmingly positive about its effects on learning, motivation and providing students with authentic learning experiences.

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Analysing student interactions in a flipped engineering course

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Flipped classrooms can support more open, flexible and collaborative student-centred learning. There is evidence that flipping learning can result in more effective learning processes and outcomes. However, not much is known about students' learning process in terms of their interactions while working collaboratively in a flipped class context. This understanding is essential to inform lecturers' timely and relevant facilitation of student learning. This paper reports on the findings from a study focused on the interactions, specifically types of talk, first-year undergraduate engineering students engaged in while collaboratively solving problem tasks in their practical lab sessions as part of a flipped class learning approach in a New Zealand university. Data were collected from a six-week video observation of student interactions. Herrington and Oliver's (1999) analytical framework on higher order, lower order, procedural, and social talk was used to analyse the video data. Findings revealed that the highest proportion of student interactions were procedural in nature followed by higher order, lower order, and finally, social talk types. These indicate the potential of the flipped class approach in fostering higher order talk in support of learning. Implications for practice are offered.

Keywords: Flipped class, engineering education, student interaction, dialogic process, talk analysis, problem solving

Introduction

Flipped classrooms have gained increasing interest and rapidly adopted in universities and various learning institutions worldwide. The flipped classroom is an active student-centred educational approach which typically requires students to prepare for class – through readings, pre-assessments, or watching videos – in order to gain basic information in their own time, prior to attending class/lectures. The class/lecturer time is thus freed up for students to apply the knowledge through problem solving activities with guidance from the teacher. Flipping the focus of class time allows students to take increased responsibility for their own learning through active investigation both in and outside of class time. This changes the class time focus and dynamics from the transmission of knowledge to one involving collaborative, interactive learning and just-in-time teaching (Bonk & Khoo, 2014). It provides more flexibility for lecturers and students to participate in discussion and collaborative and guided problem solving activities in ways that are known to address student misconceptions (O'Toole, 2013).The general findings from flipped class research appear consistently positive (Bishop & Verleger, 2013) and suggest that students are differentially suited to a flipped teaching environment.

Although active student learning and peer collaboration are essential in a flipped class context, a gap exists in understanding the quality of and how students are interacting to ensure they are well supported in a timely and relevant manner. This is important as others have found that not all students involved in collaborative group learning in digitally-supported contexts were able to engage in a productive collaboration process (Chang et al., 2017) implying that collaboration between students also needs to be trained or supported. Analyses of student dialogues can also importantly be used to determine the composition of collaborative groups or to inform guidelines for collaboration in technology-supported learning environments (Duque, Gómez-Pérez, Nieto-Reyes, & Bravo, 2015). With the exception of Miller et al. (2016) and Lin and Hwang (2018) very few studies have focused on analyzing student interactions in flipped classrooms.

This paper reports on a study focused on the analysis of student interactions as they engage in collaborative problem-solving tasks to understand their learning processes. The study is part of a wider two-year funded research project conducted to investigate the impact of adopting a flipped class approach on first-year engineering students' learning of threshold concepts in a New Zealand university. The next sections of this paper will describe the study context, research design, analytical framing and emerging findings from the study. The paper concludes with a discussion and recommendations for practice.

Research Context

The "Introduction to Electronics" course is a compulsory undergraduate course for engineering students at the University of Waikato, New Zealand. It has a typical enrolment of approximately 150 first-year students and is co-taught by two lecturers. The course is regarded by many students to be a conceptually challenging one with a relatively heavy conceptual load, particularly in the analog electronics section. The organisational model for this course has traditionally consisted of three one-hour long lectures, an hour-long tutorial session, and one three-hour laboratory session each week of the semester. It is expected that all students would attend all lectures. Each student is expected to attend one of 5 parallel laboratory streams which run once a day on each day of the week.

Research Design

The research team consisted of collaborations between two educational researchers and the two course lecturers. In the project, a design-based research approach with practitioner-led cyclical processes of planning, design, and implementation was adopted to develop, trial and evaluate the flipped class approach (Collins, Joseph, & Bielaczyc, 2004). Components of the flipped class design included:

- Lecturer-developed instructional videos. The videos were a combination of “Khan-Academy-style” videos lasting between four to 13 minutes long as well as those developed using PowerPoint and PowerPoint add-ons with embedded quizzes. The videos were created with careful reference to recommendations from cognitive principles shown to be effective in multimedia learning (Sorden, 2005). Completed videos were then linked into the course Moodle site. Students could access, view and review the videos to engage with the new course material outside of class time.
- Continuous assessment. Traditionally in the course, students were assessed through two quizzes and a final exam. In the flipped class intervention, students were assessed continuously either biweekly or weekly depending on the length of a semester.
- Online tutorials. Students were required to complete a series of online tutorials that gave them practice in understanding basic concepts.
- Problem-solving activities. From the onset of the study, the lecturers created problems relevant to particular weeks’ videos and the practical lab work. During the face-to-face in-class (practical lab) time, students worked in pairs or in groups of four to solve these problems, with lecturers and tutors at hand to help. Students could re-watch the instructional videos while solving these problems or during the lab work. Lecturers also devoted some of the lab time to conduct 10–15-minute mini-lectures to address students’ questions or in relation to test results.

Five cycles of the flipped class approach were progressively implemented over a two-year period with increasing refinements made to enhancing the course design, materials, and assessment based on the results of the previous cycle. This paper focuses on the data collected in the fourth iteration of the intervention. In this iteration, the class was fully flipped in that students no longer attended lectures but had to watch the instructional videos prior to attending their practical lab sessions. This study thus aimed to obtain a deeper understanding of student interactions with their peers while working collaboratively to solve problem tasks within the fully flipped class context.

Data Collection and Analysis

Multiple data sources were collected in each flipped class cycle but for the purposes of this paper and due to limits of space, only the analysis of video data will be reported. Other aspects of the flipped class design and learning outcomes have been reported elsewhere (AUTHOR 1).

The course was offered over the summer semester and was a more compressed version of the regular semester; across a shorter six-week period. Fourteen students enrolled in the course. Of these six students (three pairs) consented to being videoed while working collaboratively with their lab partners during the practical lab sessions as part of their flipped class learning. The research team videoed their interactions and discussions over the six-week period for an hour each time. However only interactions from five weeks were considered for analysis. Their discussions were transcribed and analysed using a combination of Nvivo software and Microsoft Excel. The research project received formal university-level human research ethics approval.

Analytical Framework

The video data was analysed based on an adaptation of Herrington and Oliver's (1999) coding scheme (see Table 1). Their original study investigated preservice student teachers' levels of higher order thinking while working through an interactive multimedia programme. Adopting a situated learning theoretical frame, they analysed student talk as they engaged with the programme. Table 1 presents each type of student talk, their descriptions and examples of student talk that guided the analysis. Higher order types of talk refer to the kinds of talk students engage in while considering new information, relates this to and/or extends this new information to achieve a learning goal. It can be further delineated into six other kinds of sub-talk; imposing meaning, judgement, metacognition, multiple perspectives, paths of action and uncertainty. Although these six characterisations of student talk offer a useful analysis of higher order student talk. Herrington and Oliver further proposed a coding scheme to distinguish these from non higher order talk: Social, Procedural and Lower order talk types. We adapted the scheme (higher order, lower order, procedural, and social) to suit our flipped class context of student pairs working collaboratively to solve problem tasks and having access to resources such as the flipped class videos through the computers in the lab or on their mobile devices; the tools/resources available to them in the lab as well as being able to approach the lecturer/tutor for assistance. The main adaptation was in the Procedural category which is a non-talk category that considered student actions in using the equipment, software, computer to complete their learning task.

Table 1: An adaptation of Herrington and Oliver's coding scheme on higher order talk types

Types of interactions	**Sub-category**	**Description**	**Example**
Higher order	Imposing meaning	Student talk that raises a possible solution to a problem or suggests alternative solution. Usually expressed as a summary, decision or a new idea, or a conclusion.	'I guess if you were looking at the bulbs separately, they would count as being "in series", but...'
	Judgement	Student talk that attempts to interpret and defend his/her understanding of an issue.	'to me though, that [points to image] would be in parallel with that, and that would be parallel with that...'
	Metacognition	Student comments which indicate his/her awareness of own thinking and performance, and comments related to the use of this awareness to improve performance.	'Oh no, I divide that by six instead…'
	Multiple perspectives	Student talk that suggests an alternative approach or challenges a conclusion/ previously made point by providing an alternative perspective.	'You could actually just use a 99 Ohm resister...Yes, but using a number that actually exists.'
	Deciding on a path(s) of action	Any student talk proposing actions to take, e.g., What parts of the problem to solve, decisions about what to write in lab books and negotiations of how to proceed.	'So LP1 is not going to change, the resistance across there [points to image] will remain the same'
	Uncertainty	Any student talk which expresses some uncertainty about an approach to adopt, a course of action, or any expression of dilemma or uncertainty.	'..so the tutor is doing 3 plus 1000, rather than 3 times 1000 so V equals...No, wait...'

Non higher order	Lower order	Any student talk which is routine, requiring little thought, or the mechanical application of well-known rules.	Reading a question/ problem aloud, or repeating basic principles of electronics.
	Social	Talk between lab partner or with other students that can either be; (i) off task (not related to the subject), or, (ii) on task (social statements which relate in some way to the task).	Discussing the weather, or a grade received in another paper
	Procedural	Actions involving the use of equipment, software, computer that is related in some way to the task.	Reading the problem sheet or their own notes, writing task-related notes in their lab book, using a digital device or a calculator, watching the flip videos, or searching online for answers.

The unit of analysis for coding student talk was based on the unit of meaning focusing on a single thought, idea, argument or information regardless of its length (Henry, 1992). The coding was conducted by a member of the research team and verified by other team members.

Findings

The overall findings indicated that across the three pairs of students, procedural interactions were most commonly exhibited by students (37%), followed by higher order (28%), lower order (22%), and social types of talk (13%) (see Figure 1).

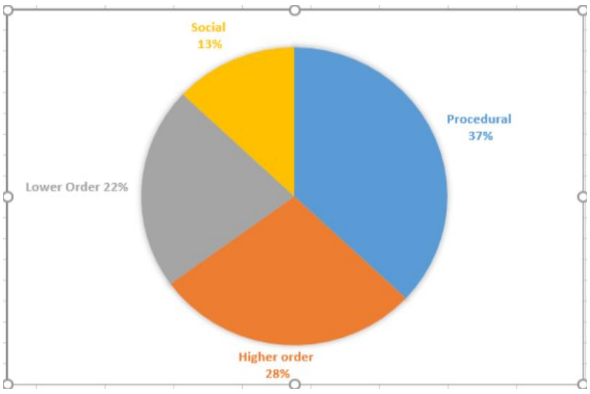

Figure 1: Overall interactions

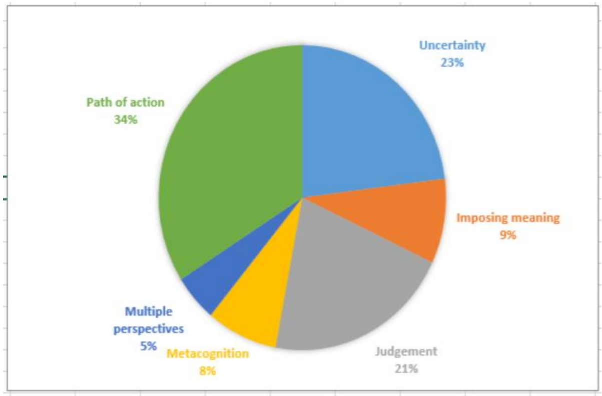

Figure 2. Types of higher order talk

Analysis of higher order talk between the student pairs revealed 'Path of action' (34%) was observed most often (see Figure 2). This talk involved decisions about which parts of the problem to solve, decisions about what to save in the note book and negotiations of how to proceed to solve a problem task. 'Uncertainty' was the second most common higher-order talk type (23%) followed by 'Judgement' (21%), which refers to students' attempts to interpret and defend their understanding of the issues presented in the assessment program. These three talk types denote the fact students are actively interacting with their peer to solve task, voiced uncertainties to clarify confusion or dilemma before making a judgement to defend their opinions. A comparison of the frequency of higher order and lower order talk indicated that they both varied over the duration of the course. The variations in the amount and the quality of discussions mostly depended on the requirement of the problem that was being discussed to elicit either a higher order or more procedural talk type. Investigation into the social talk type revealed students engaged in on-task more often (52%) than off-task (48%) talk.

Discussion and Conclusion

This study investigated the types of student talk to evidence their learning in a flipped classroom. Implications for practice exist from the findings. In successful technology-supported learning environments there needs to exist different levels of interactions between student-content, student-teacher, and student-student (Bonk & Khoo, 2014). Our work indicates this to be the case for student-peer interactions. The findings also dispels common misconceptions and tendencies to think that all that is needed for a flipped class to work is to prepare videos and relevant resources for students to access before attending a class. Our findings, as well as those of others, indicate that a focus on both before-class preparation and in-class work are of essence (Roach, 2014). Our findings highlight that student procedural actions in the problem solving task sessions to be an important part of informing their work and in their interactions with peers. This places value on the kinds of resources (digital and/ or physical equipment) that they can draw from. For example, the type and characteristic of the problem task assigned to students is a consideration as it can promote either higher order talk or procedural type interactions. The instructional videos assigned to students to watch prior coming to the labs also need to be relevant to the class problem solving activities and practical lab work for each week. A coherent course design with clear and explicit connections between course elements and resources are therefore fundamental to enhance students' productive talk, understanding and application of ideas.

The findings also support lecturer and student changing roles. A common issue in the flipped class approach is that first year students from traditional educational backgrounds are unused to the greater degree of self-directed learning and responsibility required. By understanding the kinds of higher order talk supportive of student learning, lecturers can offer guidelines and assist students to identify and model what these might look like as part of helping them develop awareness and learn to take a more active role and responsibility for their learning. Lecturers need to relinquish traditional role of 'telling' to become a facilitator of student learning, placing value on students interacting with their peers productively as part of learning. The course structure and teaching-learning activities need to be streamlined to support students' increasing responsibility for their own learning.

As flipped classrooms are increasingly adopted in tertiary settings, the findings from our study highlight that understanding the ways students interact with one another and the quality of their talk can offer a productive approach to identify and establish more timely and relevant pedagogical and learning supports to maximise their learning opportunities and outcomes.

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A Learning Analytics Approach to Model and Predict Learners' Success in Digital Learning

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Learning analytics methods are widely applied in the educational field to gain insights on hidden patterns from educational data. Methods like predictive learning analytics are used to identify and measure patterns in learning data and extrapolate future behaviours. It can be used to enable the learners to be more self-aware of their learning behaviours and to enable the instructor to take appropriate actions informed by the trace of data. Thus such methods can empower learners as they progress through online training, and allows them to be self-regulated in order to solidify their learning and develop positive habits that will enhance their learning experiences. This paper reports on the use of a popular decision tree classification algorithm using behavioural features from a public domain dataset to develop a predictive model for predicting learning performance. Among the five behavioural features, we find that the measure of *visited resources* provides the most discriminating rules in the classifier.

Keywords: learning analytics, data mining classification, learners' success, learning behaviour, digital learning

1.0 Introduction

Learning analytics (LA) is an emerging field where it involves intricate analytic techniques to enhance teaching methods and learning activities (Bharara, Sabitha, & Bansal, 2018). With LA, education data can be converted into useful information and thereon to motivate actions to support learning experiences (Dyckhoff, Zielke, Bültmann, Chatti, & Schroeder, 2012). The analytics can gain hidden knowledge and insights about learners and to optimize learning (Romero & Ventura, 2010).

With the application of big data techniques in the educational sector, vital information such as learning behaviour can be extracted to understand the learners better. Learning behaviour features were included in the development of predictive models to predict learners' success and retention. For instance, Smith, Lange, and Huston (2012) included the number of times the learners log in to LMS and the number of times the learners engage in the material as features in predicting learners' performance in the course.

Learning behavioural features play a vital role in the explanation learners' successful (and unsuccessful) learning process. Recent research provides strong evidence that learner behaviour in online environments may predict learner success (Essa & Ayad, 2012). For example, Khor (2019) found that there was a significant relationship between learners' learning behaviour and academic performance. There is an improvement of the model accuracy when using learning behavioural features. This research work developed a learner's academic performance model based on learning behavioural features.

Various data mining techniques and algorithms have been implemented in predictive analytics to develop a model for predictions. For example, data mining techniques had been applied to forecast success in a course in Intelligent Tutoring Systems (Hämäläinen & Vinni, 2006); predict learner final marks based on Moodle usage data (Romero, Ventura, Espejo, & Hervás, 2008); and predict learner final grade based on features extracted from logged data (Minaei-Bidgoli, Kashy, Kortemeyer, & Punch, 2003). The techniques for predicting and analyzing student performance include decision tree methods like C4.5, RepTree and Cart, k-nearest neighbour, sequential minimal optimization, multi-layer neural networks and clustering methods. The advantage of a decision tree method is that the model provides readable rules that enable some intuitive understanding of the prediction mechanisms unlike other black box models. Hence, this study used the decision tree method to test whether it was an accurate predictor of learner' performance based on learning behaviour.

2.0 Methodology

In this study, a learner's academic performance model was developed based on learning behavioural features available from a public domain dataset. Table 1 illustrates the details of learning behavioural features. The popular decision tree classification algorithm was used to build the model. A decision tree is a classifier to classify an instance by following a path of satisfied conditions from the root until it reaches an end node (Romero et al., 2008). The algorithm develops methods to explore the unique types of educational data and the techniques are helpful to understand learners better.

Table 1: Descriptions and Data Types of Learning Behavioural Features

Features		**Description**	**Data Type**
Learning Behavioural	*raised_hand*	The number of times the learners asked questions.	Numeric
	visited_resources	The number of times the learners download the course materials	Numeric
	announcements_view	The number of times the learners view the announcement.	Numeric
	discussion	The number of times the learners participate in a discussion.	Numeric
	learner_absence	Learner's absence days.	Nominal

2.1 Description of Dataset

The source of the dataset was from Amrieh, Hamtini, and Aljarah (2016). The dataset was collected from Learning Management system (LMS) event log data using Experience API (xAPI). Data were collected from 500 learners in two educational Semesters and cleaned to remove 20 records with missing values from the data set. Of the 480 learners, 305 were male and 175 were female. For their education stages, 199 were lower level, 248 were middle school and 33 were high school.

2.2 Modelling Process

The modelling process for this study is presented in Figure 1. Data pre-processing techniques were performed on the dataset. Data pre-processing is the first step in the process of modelling to convert raw data into an appropriate form and comprises data cleaning, data transformation and feature selection (Miksovsky, Matousek, & Kouba, 2002).

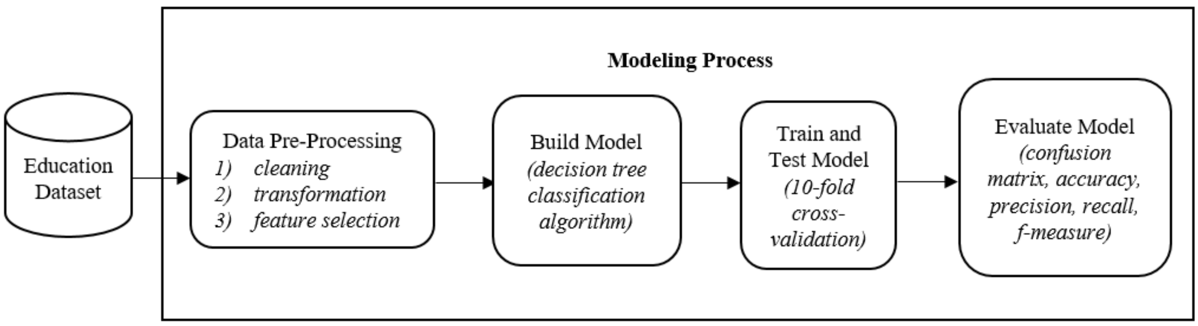

Figure 1: Summary of Modelling Process

Data cleaning was performed to check for the missing value of selected target data and to remove the noisy data. Data transformation was conducted to convert from a numerical (continuous) attribute to a nominal (categorical) value where the value of a numeric attribute is divided into a smaller number of intervals. In this study, learners' total final marks were converted from the numerical values to nominal values. Learners' success was categorised into three groups based on learners' marks: low-performer class (L) (marks between 0 and 69), moderate-performer class (M) (marks between 70 and 89) and high-performer class (marks between 90 and 100).

For feature selection, univariate feature selection was applied to increase the level of accuracy. Univariate feature selection chooses the best features based on univariate statistical tests. The score indicates the relationship of the features with the output variable. The higher the score, the stronger the relationship. Data mining classification process was carried out after the process of data pre-processing. A predictive model was then built using decision tree classifier. The inputs of the model included (1) *raised_hand*, (2) *visited_resources*, (3) *announcements_view*, (4) *discussion* and (5) *learner_absence*. The output of the models was *class_label* (academic performance).

Random sub-sampling 10-fold cross-validation was performed to categorise the dataset into training and testing groups. After running the model multiple times in randomized environment, an average result was produced (Smith et al., 2012). The performance of the developed model was then measured using a confusion matrix. A confusion matrix reports the classification of the actual and predicted class. The model was evaluated further with the value of accuracy, precision, recall and f-measure from the result of the confusion matrix.

3.0 Analysis and Results

The chi-squared scoring functions used in the univariate feature selection process is summarized in Table 2. These scores were used to identify the vital features of learning success in order to build the predictive model. As observed in Table 2, the feature *visited_resources* contained the highest weight, followed by *raised_hand*, *announcements_view*, *discussion* and *learner_absence*.

Table 2: Chi-squared Scoring Functions

Feature Selection	***raised_hand***	***visited_resources***	***announcements_view***	***discussion***	***learner_absence***
chi-squared (score function)	4124	4700	2618	809	135

Figure 2 shows parts of the constructed decision tree. It illustrates the rule-based classification generated for the high-performer class. The model achieved a 68.54% accuracy rate in classifying the instances correctly, meaning that 329 out of 480 instances were correctly classified. The results of the confusion matrix are presented in Table 3.

The performance of the developed model was also illustrated in terms of true positive (TP) rate, false positive (FP) rate, precision, recall, f-measure for the class label, L, M, and H respectively (Table 4). Out of 127 low-performers, 106 were classified as ‘L’. Hence, the TP rate and the FP rate of class ‘L’ were found to be 0.835 and 0.059 respectively. For middle-performers, 123 of 211 were classified as ‘M’. Therefore, the TP rate was 0.583 and the FP rate is 0.223. There were 100 out of 142 high-performers were classified as ‘H’ with 0.704 TP rates and 0.207 FP rates.

Table 3: Confusion Matrix Result

		Predicted Class		
		L	M	H
Actual Class	L	106	19	2
	M	20	123	68
	H	1	41	100

Table 4: Classification Report

Class	**TP Rate**	**FP Rate**	**Precision**	**Recall**	**F-Measure**
L	0.835	0.059	0.835	0.835	0.835
M	0.583	0.223	0.672	0.583	0.624
H	0.704	0.207	0.588	0.704	0.641

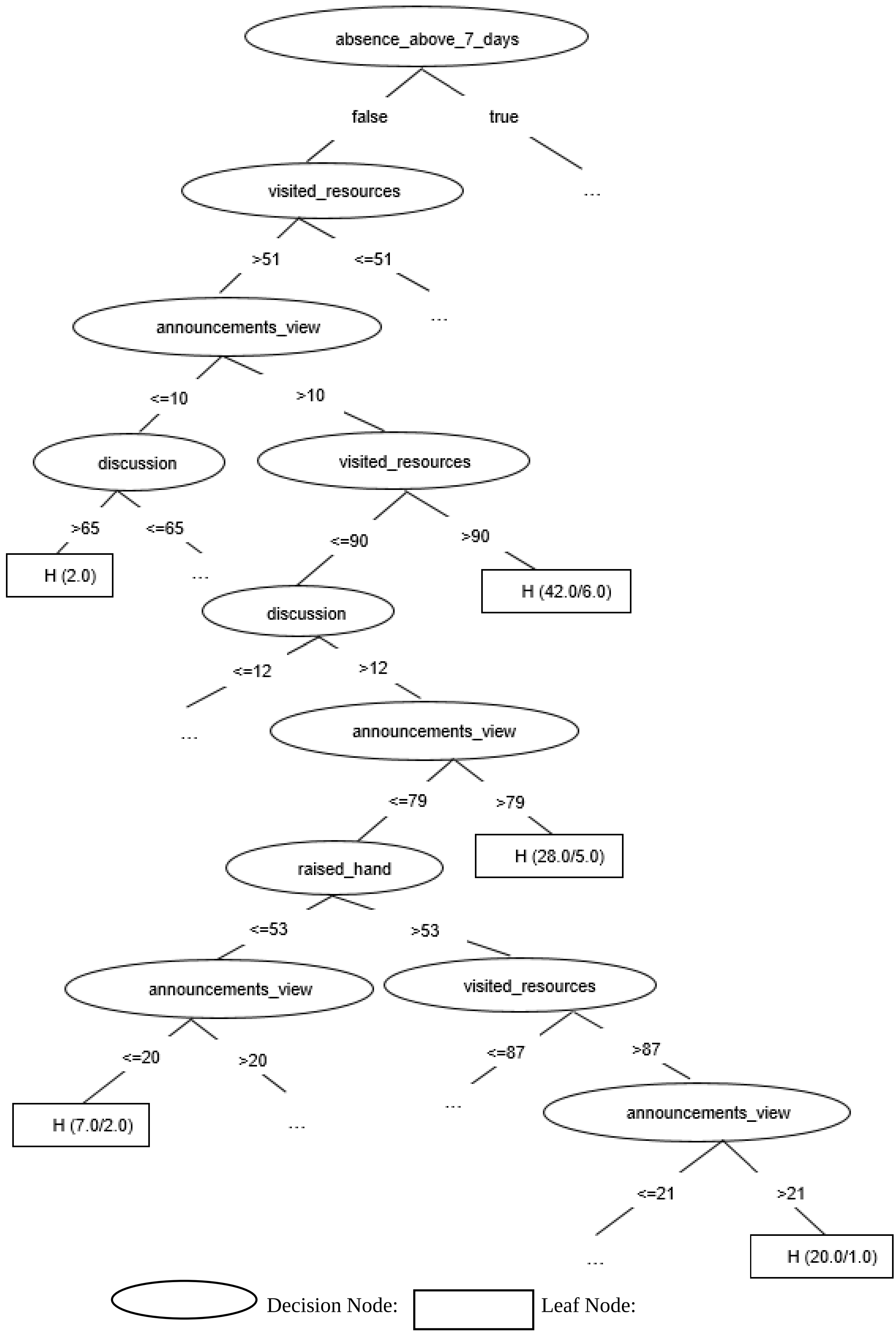

Figure 2: Constructed Decision Tree for High-Performer Class (H)

4.0 Conclusions

In this study, a predictive model was built using a decision tree classification algorithm. Specifically, C4.5 decision tree algorithms were applied to perform classifications on the dataset. For this dataset, the study found that the most important feature was *visited_resources*. The accuracy achieved using the decision tree classifier was encouraging, since the accuracy level is 68.54%. The class precision (0.835, 0.672, 0.588) and the class recall (0.835, 0.624, 0.641) for the three class labels (L, M, H) were appealing as well. The model can be used to make future predictions about learners' learning performance based on their learning behaviour. Proactive approaches and just-in-time interventions can be provided to at-risk learners to support their retention. While the field of learning analytics continues to develop, this study shows that classic classifier algorithms can still play their part in tackling specific classes of prediction problems in learning performance. Future works may include ensemble methods to gain better predictive process and enhance the performance of the model.

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Evaluating the implementation of an active learning platform in a team-based learning postgraduate Medical Program

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"Active learning is generally defined as any instructional method that engages students in the learning process. In short, active learning requires students to do meaningful learning activities and think about what they are doing" (Prince, 2004). Basing his definition on foundational work done by Bonwell and Eison (Bonwell, 2000 and Eison, 2010), this definition of active learning has been widely accepted. In the first decade of the 21st century, notwithstanding educational technological tools were not as ubiquitous as it is now, strategies for active learning have already been developed to help direct teachers to better plan their lesson to incorporate such style of learning. The advancement of technology vis-à-vis the proliferation of student response applications have revolutionized the way such learning is captured in the classroom.

This paper presents a context of a Medical School in the Faculty of Health, Medical Sciences (FHMS) of the University of Western Australia (UWA) undergoing changes to its cased-based learning (CBL) curriculum to a more time-efficient Team-based (TBL) one. At about the same time, there was an institution-wide implementation of an active learning platform in the institution. Juxtaposing the two elements led to this preliminary study of capturing student's active learning in a Team-based context using the Analytic Dashboard from the active learning platform. Student engagement scores captured in the dashboard were very positive and the use of Eric Mazur Concept Testing Model helped achieve the active learning goals of the TBL sessions. Moving forward, future iterations of team-based learning sessions with the active learning platform could be deployed in other schools within FHMS that have case-based studies (CBL) in their curriculum and compared them to the TBL practice in Medical School.

Keywords: active learning, team-based learning, student engagement, student engagement scores.

Introduction

Team-based learning (TBL) is a strategy for small group learning in a large group context. Originating in business education (Michaelsen, Knight & Fink, 2002), the TBL approach has been gaining ground in medical education over the last decade (Parmelee, Michaelsen, Cooke & Hudes, 2012). From a teaching and learning perspective, TBL is a student-centred active learning model that encourages collaborative group learning by collectively applying knowledge to solve problems.

Case-based learning (CBL), on the other hand, is an approach that engages students in discussion of specific scenarios that resemble real-world problems. This method is also learner-centered with students participating in group discussion to build knowledge and work collaboratively to reason through the case. CBL in the small group setting encourages development of a broader set of competencies and in the medical student context, competency involves demonstration of additional skills expected of a doctor, including teamwork, leadership, professional behaviour and adult learning (Govaerts, 2008).

In short, whilst TBL and CBL operate in small groups, the learning outcomes differ in how learning is measured – the former counts team work, collaboration, peer and group review as part of its outcomes and the latter measures competencies and skills that would help the students in their future work place.

Background and context

In the context of UWA Medical School, a shift to a biomedical science focus in the early years of our Medical program led to a lean curriculum that focuses on the diagnostic and management aspects of the program's core conditions and presentations. Additionally, a rationalisation of program resourcing led to the decision to deliver CBL content in a more efficient TBL format that was new to both staff and students. Hence, a blend of CBL and

TBL approach is attractive from a resourcing perspective, as it permits higher student-to-teacher ratios of approximately 120:1. The institution’s challenge was to maintain the broad competencies, previously achieved via CBL, in the TBL context.

Additionally, the format of delivering CBL content in a TBL format was facilitated by the institution’s recent acquisition of key physical and technological resources. At about the time when the new TBL format was introduced in the Medical School, UWA was promoting a new Echo360 active learning platform (ALP), designed to go beyond passive lecture captures and encourage active engagement of students. The Medical School has also recently invested in building several e-learning suites with each suite accommodating 15 tables and two large 40-inch LED screens at each table (Figure 1). 8 students could be assigned to each table as their BYOD could be connected wirelessly to the LED TV screens. The design of the e-learning suite encourages collaborative study, enabling students to ‘huddle together’ in groups whilst discussing the cases presented, as well as engaging with activities in the ALP shown on the LED screens. The ALP employs a number of active learning tools, including real-time polling in which results are shown immediately to stimulate further discussion, ‘live’ Q&A to further facilitate inter-group discussions, and other functionality that promote formative and summative assessment. Two repeated TBL classes were scheduled back-to-back in a 2-hour 120-students class, optimising the use of teaching staff time.

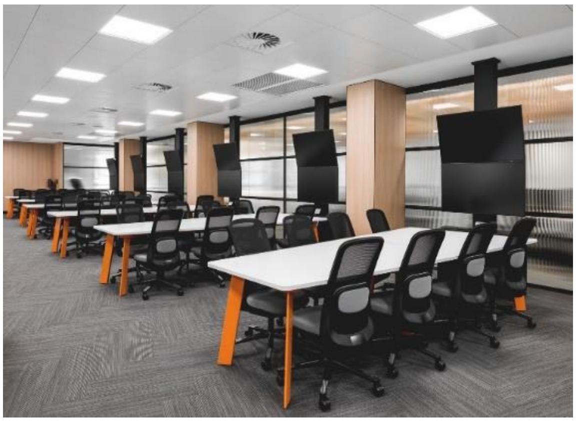

Figure 1: Medical School e-learning suite

In light of the CBL/TBL challenges faced by the Medical School and the preliminary solution of implementing an active learning approach with a technology-enhanced platform to the new format TBL sessions, this paper aims to evaluate the effectiveness of this new approach in three areas:

- Student engagement with the active learning tools
- Staff delivery of the TBL following a pedagogic Active Learning approach
- Sustainable ALP features to check active learning in a TBL setting

Methodology

A mixed-method approach was used in this preliminary study to analyse the statistical data collected from 11 TBL sessions using the Echo360 Analytics Dashboard and the qualitative feedback written by the students towards the end of every TBL session. The analytics provided insights to student engagement with the TBL session and their interaction with the activity slides inserted by the teaching staff.

The capabilities of the ALP together with Eric Mazur’s Peer Instruction Manual (1997) enabled the researches to customise a model of a quality Active Learning approach in TBL. A modified version of Mazur’s Concept Testing that the current study employs is set out in Figure 2 below. Triangulating the data obtained in ALP by analysing student’s end-of-TBL session feedback with the Echo360 Data Analytics Metrics determine, preliminarily, the effectiveness of implementing a technology-enhance platform to the TBL format in UWA Medical School. Additionally, moving forward, the data would help formulate a working framework/template that would inform future implementation of similar CBL using a TBL format with an active learning approach and technology-enhanced tools in other schools within FHMS.

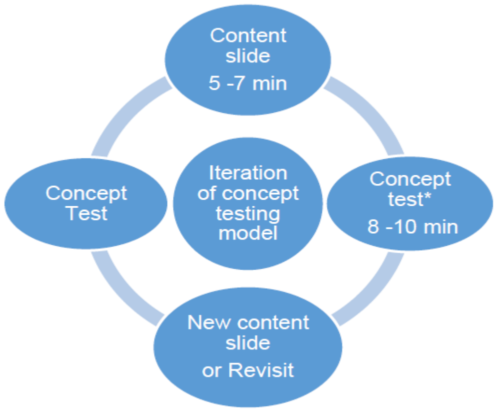

Figure 2 - Modified Version of Eric Mazur's Concept Testing Model for UWA Medical School TBL

Concept test approach:

1. Question posed – 1 min
2. Students given time to think – 1 min
3. Students poll group response
4. Students given time to discuss and convince group members – 5 min
5. Feedback from teacher – 2 min

Discussion of Findings

In this section of the paper, we will discuss the statistical analytics generated by Echo360 ALP (Table 1) and qualitative feedback from the students towards the end of every TBL(Table 2) to evaluate the effectiveness of this study in three areas:

- Student engagement with active learning tools
- Staff delivery of the TBL following a pedagogic Active Learning approach
- Sustainable framework/template for future active learning implementation in a TBL setting

Table 1: Student Engagement analysed in 11 TBL sessions with Echo360 Analytics Dashboard

TBL Session	Total Engagement	Video Views	Slide Deck Views	Polling Responses	Note Events	Q&A Events	Confusion Flags
10	1184	0	240	792	152	0	0
1	1138	0	297	723	103	1	14
11	959	0	236	652	71	0	0
6	906	0	217	593	93	1	2
8	855	0	227	537	88	0	3
5	816	0	191	504	121	0	0
3	598	0	212	223	162	0	1
7	568	0	289	256	21	1	1
2	535	0	256	113	165	0	1
9	317	0	220	54	41	2	0
4	97	0	83	14	0	0	0

Student engagement with active learning tools

Students welcomed the opportunity to use the technology to drive their learning as recorded in both the positive qualitative feedback obtained at the end of each class and the total engagement statistics obtained from Echo360 Analytics. The metrics of total student engagement is a cumulative total score of all of the "countable" data points. These data points include: Video Views, Slide Deck Views, Polling Responses, Q&A Entries, Note Events, and Confusion markers (Echo360 Resource Center). An analysis of the engagement metrics showed that in Semester 1 across UWA, TBL in our unit for Medical students had the highest student engagement scores (1184 in Table 1 – TBL Session 1) of any unit across the University. 82% of the TBL sessions (9 out of 11) had engagement ratings of 500 or more.

A cross reference to the qualitative feedback given by the students in Table 2 showed the enthusiastic response of the students counting interactive nature of the TBLs, critical thinking, CBLs, group discussions, team quizzes as the most prized aspects of their learning. One telling remark mentioned in TBL Session 7 that the student/s appreciated being asked if 'they were learning well rather than if they understood the content'. This echoed

Chonkar et al. (2018) conclusion that the majority of medical students in a Singapore context predominantly utilised the deep and strategic learning approach and as in our context, they wanted their academics to be concerned about this aspect of their learning approach rather than being shepherded through the 'technical mumbo jumbo'.

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Table 2: Qualitative Feedback obtained through Echo360 Short Answer Polling Question

TBL Sessions	Qualitative Feedback	
	Most effective aspects	Most ineffective aspects
1	Interactive; interesting; engaged (justifying answer promotes quality/critical thinking; Cases; clinical scenarios; Collaboration (19 responses)	Overall, the positive comments from the previous question spilled over to this part of the feedback. (22 responses)
2	Useful when interactive; discussion bits that got us to do active learning; appreciated the tool and screening method taught (9 responses)	Went a little too long and draggy; too much teaching that could have been covered in pre-TBL; not much discussion and interactivity; everything that wasn't active or when lecturer was talking; mic issues (8 responses)
3	ECG following a CBL and clinical reasoning was fun; hands on session with questions embedded to get students to think critically (8 responses)	Different version of slides was confusing; too much going on at too hurried a pace; too rush given the 2-hour TBL and so much content to cover and no time to digest; very challenging to start off with an irregular ECG → suggestion to start with a 'normal' one (5 responses)
4	NIL	NIL
5	Discussion questions with recommended links were helpful; (1 response)	Students were leaving and not staying on to give feedback; (1response)
6	CBL; good videos and interactive questions on slides; explaining the responses from class was helpful as groups were given different sets of questions (8 responses)	A lot of content is covered; not enough time given for group discussion; not enough vMDs; (4 responses)
7	Team quiz in kahoots!; kahoot with Echo360; worksheet format was effective and competitive (we're competitive) element embedded within TBL; being asked about the learning that takes place rather than being asked if content is understood!; (72 responses)	Therapeutic guidelines not updated wrt strontium ranelate; first hour was slow; waste of paper (re: worksheet); engagement was lacking; have some of the slides earlier before the TBL and hide answers; don't hide slides as it was difficult to follow as students' computers were off; don't know how to complete the GP chronic patient assignment; too much explanation on how to do wards; (21 responses)
8	NIL	NIL
9	4 cases presented and related diagnoses; role plays; interactive; kahoots! And TB quiz; ranking activity; best TBL session so far (25 responses)	Not enough time for 4 cases; more difficult and challenging questions should be posed; don't like role play activity; Constantly being given XRs and other imaging to review and diagnose every week with zero teaching is completely unreasonable and pretty distressing to be honest. This NEEDS to be taught to us. We need a method of going through scans and not just having them thrown at us with the next slide saying 'what is the diagnosis' (as per this week..). I would like to stress we have not had ONE teaching session on imaging... Would make a very good TBL. (13 responses)
10	NIL	NIL
11	Kahoots and CBL; clinical reasoning; (4 responses)	Liam's video/slides was interesting but pace could be faster and more engaging (the presenter?); sepsis quiz too challenging; too much time for discussion and then boredom sets in; technical mumbo jumbo; (8 responses)

Staff delivery of the TBL following a pedagogic Active Learning approach

Delivery of the TBL took a total of eight hours of staff time, compared to 40 hours in the small group CBL curriculum. This allowed academic time to be invested in developing authentic clinical cases, quality student activities, and the inclusion of locally generated evidence-based guidelines. The large group element of the format allowed short pre-recorded audio or video by content experts to precede and inform subsequent learning activities.

Additionally, the teaching staff were briefed on the use of the Echo360 ALP by the Educational Enhancement Unit team of Learning Designers and Educational Technologist. What ensued was a modified version of following Mazur's Concept Testing model (Figure 2) for the active learning approach adopted together with the new ALP.

An analysis of the data in Table 1 showed that TBL sessions 1 and 10 had the highest engagement scores of 1138 and 1184 respectively. One look at the lessons showed that TBL 1 had 86 PPT slides and 17 Activity slides (which are either MCQ, Short Answer, Image Quiz or Ordering types of questions) spread across the lesson at an average of 1 interactive slide (which is the Concept Testing Stage in Figure 2) per 5 content/teaching PPT slides. This session garnered 723 polling responses in total and very positive feedback (Table 2) with key words like 'interactive', 'engaged', 'interesting', 'collaboration' repeatedly mentioned in the student's feedback. Likewise, TBL10 had 70 PPT slides and 16 Activity slides, making it an average of 1 Activity slide inserted between 4.5 teaching/content slides.

Overall, we do believe that there is a strong correlation between applying Mazur's concept testing model in a TBL and the strong engagement scores.

Sustainable ALP features to check active learning in a TBL setting

As the ALP is relatively new to the institution, there were many engagement functionalities like Q&A events and Confusion Flags that were not fully exploited. In Table 1, the Q&A events and Confusion Flags had the lowest engagement scores. The use of Q&A events are like discussion board that happen in real time and takes the preparatory load off the teaching staff in preparing activity slides, hence the reason why it is termed sustainable. Judging from some of the comments given in Table 2, this feature could take the place when students found that there was too much didactic delivery of lecture content.

Confusion Flags are flag buttons for students to click on to flag their confusion at any stage of the lesson. Teaching staff would be alerted with a notification number representing the count of any students who have marked that location or slide in the classroom as confusing. If checked during class, this information can provide vital feedback on whether students have struggled to understand any part of the session, and offers the opportunity to address it immediately, after class or addressing the confusion in the next class.

Conclusion and Recommendations

Overall, marrying an active learning approach with technology-enhanced platform for the new format TBL sessions have positively enhanced student engagement in active learning. Notably, the teaching staff have saved copious amount of time when the CBL curriculum was embedded into the new TBL format, freeing up time for them to develop not only authentic clinical cases but pedagogically sound quality active learning activities.

As the ALP is relatively new to the institution, there were many functionalities in the system that were not capitalised. However, due to the positive feedback from both teaching staff and students, the future iterations of the TBL sessions would look into such features like 'live' Q&A discussion forums, Confusion Flags etc. in order to capture real-time feedback with a particular focus on the learning and teaching implications of using such features in measuring active learning.

Notably, as this is using CBL content in a TBL format, one of the interesting future research to undertake would be to compare the difference in student learning outcomes between the CBL and TBL approaches and to ascertain which approach facilitate the students to achieve better learning outcomes.

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Using social annotations to support collaborative learning in a Life Sciences module

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We used an online social annotation platform for Life Sciences undergraduates to develop self-efficacy in their own learning and to leverage on collaborative learning while annotating in groups. In particular, we were interested in supporting students in a large-class setting as they learn to read research articles as a means of integrating concepts with critical thinking. Students were tasked to post annotations based on their reading of two research articles. A graded quiz based on each article was administered after each reading. We used content analysis to analyse students' annotations based on the ICAP framework as a proxy measure of cognitive engagement. Students actively participated in the assignment, with most annotations classified as constructive and interactive. However, the percentage of interactive annotations was low, suggesting that students do not perceive the need for interaction to understand the research article. The interactive annotations were further examined for quality of writing using the SOLO taxonomy. The quality of interactive annotations were high, with majority of the annotations at the "Relational" level. We propose that the use of social annotations provided a student-centered environment for individual learning, but scaffolds could be incorporated to foster interactions and collaborative learning among students.

Keywords: online social annotations, interactive, ICAP, SOLO taxonomy

Introduction

The use of research articles in Life Sciences undergraduate modules has been part of our instructional design to introduce students to the practice of scientific investigations. Moreover, using research articles is a good way to integrate concepts with critical thinking among undergraduates. However, in our year-two Cell Biology module, the large class size of more than 200 students normally makes it difficult for instructors to provide immediate feedback to students who are learning to read research articles.

As such, we used an online social annotation tool Perusall as a means to support students as they are able to post annotations including comments, questions and answers on the article as they read and try to understand the research article. The aim was for them to learn to apply the concepts learnt in lectures in the context of research questions in the research articles. As not all undergraduates are familiar with reading research articles, the students were organised into groups to encourage collaborative learning through their annotations and interactions.

Theoretical framework

The theoretical frameworks that underpin our work involve both the ideas of student-centered learning and social constructivism. Student-centered learning that emphasises less-structured environments where students regulate their own learning, (Hannafin, 2012), is especially common in institutions of higher learning. This model is in line with our approach to reduce the level of dogmatic teaching and help students develop a sense of self-efficacy in their own learning (Bandura, 1995) that has been correlated with achievement (Lawson, Banks, & Logvin, 2007).

The idea of collaborative learning has roots in social constructivism (Vygotsky, 1978) that has been proposed to provide higher levels of cognitive engagement based on the ICAP cognitive engagement theory (Chi & Wylie, 2014). Accordingly, the authors had proposed that interactive (I) is greater than constructive (C) which is greater than active (A) which is greater than passive learning (P). This is because interactive learning constitutes generative learning, has elements of co-construction or co-building from one another's ideas.

With the advent of technology, collaborative learning has been an important mode of learning in computer-assisted learning environments such as for peer discussions (Schellens & Valcke, 2006). Hence, we leveraged on the use of an online platform (Miller, Lukoff, King, & Mazur, 2018; Miller, Zyto, Karger, Yoo, & Mazur, 2016) for students to share annotations while reading a research article as a form of collaborative learning when they interact through their annotations. It remains unclear whether student-centered learning environments can indeed support cognitive engagement, given that a substantial level of prior knowledge, experience and metacognition is required (Hannafin, Hill, Land, & Lee, 2014). Hence, we set out to explore the possible benefits of social annotation on student learning.

Research questions

In this exploratory study, we wanted to examine:

1. The engagement behaviour of students when using the social annotation platform Perusall
2. The quality of the annotations generated through interaction among students

Materials and Methods

Module information and recruitment for the study

The elective module was on Cell Biology and spanned 13 weeks. A total of 224 students enrolled in the module. The students were mostly second-year undergraduates from the Life Sciences degree programme. Institutional consent was obtained for this study (IRB S-17-214E). Student volunteers were requested in class and their consent were obtained for the analysis of their annotations. Among students who provided consent, 30 students were randomly chosen for analysis.

Social annotation assignment

Students had to read two research articles to be able to answer two quizzes linked to the articles. We used the social annotation platform Perusall (www.perusall.com). Students were randomly assigned by Perusall into groups of 6. Students were given 2 weeks to read each article using the social annotation platform to help one another understand the articles. For instance, students within a group could post questions and answers related to content in the articles. The support provided by the instructors include a short guide on how to read research articles, background on the research topic, videos and lectures on techniques used in the article, and discussion on misconceptions found in students' annotations. 6% of student's final marks were awarded for 12 best annotations per article. After each article, the students had to take a graded quiz that accounted for 3% of their final marks. For this paper, we analysed the annotations on the second research article.

Examining engagement behaviour using ICAP framework

The engagement behaviour of students was examined using the ICAP framework. We first checked if students annotated on the article to determine the participation rate in the assignment. For the other students who annotated, we classified their annotations as active (A), constructive (C) and interactive (I), with each annotation as the unit of analysis. An overview of the ICAP classification is presented in Table 1. The various categories of annotations are presented using descriptive statistics.

Table 1: Interpreted ICAP descriptors and examples of student's annotations

Classification	Description	Typical characteristics	*Examples of annotations*
Passive	Student did not participate in the assignment.	No annotations observed.	N.A.
Active	Student posted annotations without or with minimal thinking and consideration of contents in the research article.	Simple acknowledgement, simple labelling of materials, reiterating of contents stated in the research article.	*Shows the position of the nucleus.*
Constructive	Student posted annotations with clear thinking and consideration of the contents in the research article. There was no interaction between students.	Questioning, analysing methods and results, providing inferences, explanations and suggestions, making claims. Not interacting with other students.	*How is the localization of Akt to the nucleus related to its phosphorylation in ser-473? Could it be that the phosphorylation occurs at the nucleus?*
Interactive	Student posted annotations with clear thinking and consideration of the contents in the research article. There was interaction between students.	Evaluating other students' annotations. Referencing to students' annotations and building on contents contributed by other students.	*If I understand correctly, you are referring to ... If so, ... Hence, I think p27 may also not be present in non-dividing cells.*

Examining quality of posts using SOLO framework

To further examine students' level of understanding of research topic when interacting among peers, we coded all "I" annotations using SOLO taxonomy (Boulton-Lewis, 1995) with each annotation as the unit of analysis. The annotations were classified according to level of understanding. Table 2 presents the overview of SOLO categorization of annotations. The various categories of annotations are presented using descriptive statistics.

Table 2: SOLO categorization of "Interactive" posts by students in Perusall social annotation assignment

Level of understanding	Description	Typical characteristics	*Examples of annotations*
Pre-structural	Student had no understanding of the concepts in the paper. Information provided was irrelevant.	N.A.	N.A.
Uni-structural	Student dealt with only one aspect/concept of the paper. Information provided was reductive or had low value and significance.	Straight forward response to a peer's question. Short replies which only focused on one main concept with no elaboration.	*I guess it is not very clear if this is implied here but I agree with your statement that the nuclear Akt activity and phosphorylation is not the main focus of this article.*
Multi-structural	Student dealt with multiple aspects/concepts of the paper and was able to make some connections within these aspects. However, overall significance of these aspects was not shown.	Elaborated a concept with accuracy but short of providing any significance. Attempted to link different concepts together but the link might not be entirely accurate.	*Yup, it probably occurs in G1 phase. I think it is possible that phosphorylation occurs in other phases (with whatever p27 is left in the cytoplasm) but it may be too late and not have any effect on the cell cycle.*
Relational	Student dealt with multiple aspects/concepts of the paper and was able to make clear connections. The integration showed	Explained results with conclusion. Interpreted results with some inference on the student's end. Argued	*I think that @ABC answers are very feasible, but I would like to propose a step further and conclude that… When I first read the article, what I noticed was...*

	the understanding of significance of parts, and parts to whole.	their stand in a discussion. Explained cause and effect.	*How I interpreted it was that... But from the bands seen, it seems…*
Extended Abstract	Student was able to generalize what they had learnt to a new area, beyond that of the scope of the research article.	Generalization of ideas.	*To add to the above point… prevent cell cycle progression. The lack of cell division may pose a huge problem in organs where the surfaces experience 'wear and tear'. …stem cells in the gut cannot produce new gut epithelial cells to replace the old worn out cells. As a result, the wall of the gut may be damaged and deteriorate.*

Results and Discussion

Students demonstrated active participation in the assignment

Learning on Perusall revolves around meaning construction and interaction between peers through annotations. Thus, active participation through posting annotations is a prerequisite to learning through the assignment. Among the 30 students selected randomly for our analysis, the participation rate was very high (96.67%), with only one student not posting any annotations. The other 29 students posted a total of 475 annotations, which equated to an average of 16.4 annotations per student who annotated. This number was higher than the minimal 12 annotations set for the assignment. The high participation rate could be attributed to the design of the experiment. The marks awarded for participation and completion of the quiz might act as external motivating factors to push students to participate and understand the contents of the research article thoroughly. Even with external motivating factors, interest in the assignment might also decrease if the perceived difficulty is high (Hom & Maxwell, 1983). Scaffolds provided by instructors might have lowered the perceived difficulty of the assignment. Students were not penalized for any misconceptions, which provided a safe environment that could have encouraged students to post annotations. Overall, the low-risk design of the Perusall assignment, together with formative assessments could have contributed to the active participation in the assignment.

ICAP analysis suggests high levels of cognitive engagement, but low levels of interaction between students

The different modes of engagement behaviour correspond to different knowledge processes, which in turn correlate to different levels of learning (Chi & Wylie, 2014). To study engagement behaviour, we looked at the annotations posted by students, and classified the annotations to the mode of engagement behaviour using the ICAP framework. From these 475 annotations posted, less than 5% of the posts were in the “A” category, with majority of the annotations falling within “C” and “I” categories (Table 3). These results suggest that students were highly engaged in using the platform to generate meaning and understanding of the research article (shown as “C” and “I”). However, interaction between students remained relatively low (16%). Upon reflection, we did not include any assessments on group work. Furthermore, there was no strict enforcement for students to interact with each other through the Perusall platform. Thus, students seemed to work on the annotation exercise individually and did not see the need to interact with other peers. Nonetheless, we concluded that students were highly engaged in the Perusall assignment, but there were low levels of interaction between students.

Table 3: Frequency count of ICAP categorized engagement levels demonstrated by students’ annotations

ICAP classification	Number of annotations (Total: 475)
Active	20 (4.21%)
Constructive	378 (79.58%)
Interactive	77 (16.21%)

Annotations in the “Interactive” category demonstrated higher-order levels of understanding of the topic

Interactive learning is believed to be greater than individual learning as it constitutes generative learning (Chi & Wylie, 2014). To further understand the level of understanding afforded by interaction, we analysed the quality of the "I" annotations using SOLO taxonomy. Categorization of the 77 "I" posts using SOLO taxonomy showed that a large percentage of annotations achieved knowledge levels of multi-structural and above (> 92%). In particular, 76% of these posts showed relational knowledge level with clear connections between different concepts and meaningful understanding. We also observed an annotation that is classified as extended abstract, the highest level of classification in SOLO taxonomy. These results show that interaction between students generated higher-order levels of understanding of the research topic, with the potential of generalization beyond that of the research topic. As such, collaborative learning through interaction between students might improve the level of understanding of the research topic.

Table 4: Frequency count of the SOLO taxonomy categorized levels of understanding demonstrated by "Interactive" annotations

SOLO Taxonomy	Number of annotations (Total: 77)
Uni-structural	6 (7.79%)
Multi-structural	11 (14.29%)
Relational	59 (76.62%)
Extended Abstract	1 (1.30%)

Conclusion and future directions

In this exploratory study, we report that students were highly engaged in the social annotation assignment using Perusall as the platform. The use of technology was informative in allowing instructors to observe learner-centered behaviours. Annotations on the platform served as student artefacts reflecting levels of cognitive engagement, as well as levels of understanding. Analysis of these observations allow instructors to improve on the design of activity to achieve better student learning outcomes.

One observation from the study was the low interaction levels between students. To foster more collaboration, we could include the element of group accountability in the assessment (Brame and Biel, 2015). One possibility is to grade the groups based on transcripts of their interaction as seen in Perusall. The level of group interdependence could also be increased by adjusting the amount of guidance provided by the instructors (van Leeuwen & Janssen, 2019). For example, misconceptions could be rephrased as prompting questions to facilitate discussion among the students during the period of assignment. These misconceptions could be addressed by the instructors after the assignment is closed should the misconceptions persist. Finally, understanding students' perspectives of the assignment would allow us to make optimal changes in design of collaborative learning activities.

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Basic competence in online teaching: Preliminary lessons learned from a university's approach to assure faculty readiness in teaching online

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While there have been studies into the roles and competencies of faculty in online learning environments, scholarly literature in the context of faculty accreditation is limited. This paper reports on the implementation of Technology Enhanced Learning framework in a university that aims at empowering the faculty members to use the best appropriate technology that enhance students' learning outcomes. We present the process of overcoming multi-faceted challenges of designing and implementation of a work-in-progress initiative intended to ensure its faculty will be ready to teach online (and remotely) on their own. The initiative was designed to identify the most essential competencies of teaching online at a university, help faculty understand these competencies, evaluate their current skill level in relation to these competencies, and close any gaps in skills. Change management strategies of challenging current teaching and learning regime, sharing common vision, motivating for actions are used. Preliminary observations from the pilot indicate that this approach allowed faculty to measure their current skills and take steps to address skill deficiency, though various challenges in ensuring the entire faculty population is prepared for online teaching still exist.

Keywords: competencies; technology-enhanced learning; academic development; higher education.

Introduction

Technology, if used effectively, has been shown to improve student outcomes, the quality of teaching and learning experience (Mcknight et al., 2016, Davies, Mullan, & Feldman, 2017). Any situation where technology is being utilised to help people learn can be considered technology enhanced learning (TEL) (Goodyear & Retalis, 2010). One of the top barriers to TEL development in higher education institutions is the lack of faculty knowledge or competencies to work in online environments (Walker et al., 2018). Despite hearing evidence on more effective pedagogies or use of TEL, another big roadblock for change in practice is faculty's appetite for risk (Smith & Herckis, 2018). Besides having more TEL-related professional development offerings, some institutes may rigidly apply a variety of strategic and macro-level policies and frameworks to promote TEL, which may not be effective in certain contexts. An example is the implementation of a particular week as 'e-learning week' where students will engage in learning online for a week, regardless of the learning outcomes, faculty's familiarity and resources in designing the experience, and students' prior knowledge.

This paper explores the on-going university-wide approach taken by the Singapore Institute of Technology (SIT) to ensure faculty are prepared for TEL, which includes developing a framework or levels of competence, assessing faculty's competencies and providing professional development. A competency is defined as "a knowledge, skill, or attitude that enables one to effectively perform the activities of a given occupation or function to the standards expected in employment" (Richey, Fields & Foxon, 2001, p. 26). As a competency-based approach may accept the minimum level of performance rather than achieving higher standards, so looking holistically when determining competence will be recommended, though attitude will be difficult to measure.

There is a diverse range of tasks for the university instructor in online learning environments (such as creation of online interactive content, managing online interactions of learners, administration of the online classroom), and depending on the tasks taken on by the instructor and on the technological teaching environment (Alvarez, Guasch, & Espasa, 2009; Williams, 2003), specific competencies may be required. For example, the competencies of an online course instructor may be different from that of another who just want to be able to continue teaching in the event of a disruption to normal face-to-face teaching activities. Hence, there is a need to investigate the competencies needed for accrediting faculty in the context of teaching in SIT.

At the time of writing, adaptations to the strategy are still being made based on lessons learnt through the implementation of the framework. This paper elaborates on the development process, preliminary observations, challenges faced, feedback gathered, and improvements made so far.

The TEL Framework

In 2018, the university began designing a TEL framework to clarify the competencies that all faculty should have to teach with technology. The framework is designed with 3 tiers as shown in Figure 1. The first tier of the TEL framework is based on 4 baseline competencies that the university has identified as the minimum requirement of faculty teaching in SIT to conduct remote teaching. The second tier builds on the basic (first tier's) competencies by focusing on the use of more advanced technology and sound underlying pedagogical principles to enhance students' learning. The third tier of the framework is related to competencies on the use of new and innovative technology or method in using technology as well as the more sophisticated and elaborated evaluation of TEL practice.

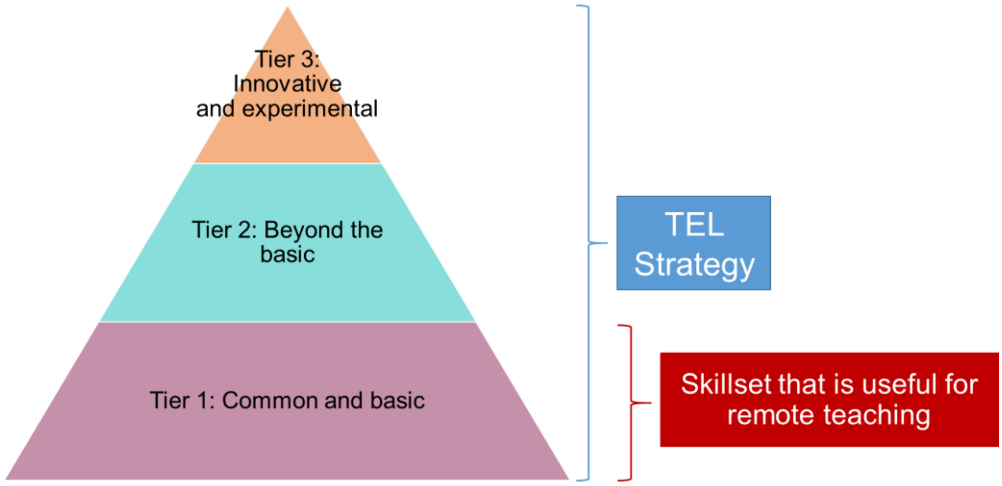

Figure 1: TEL framework

Perspectives on the framework were gathered from faculty through a dialogic process in 2018. By mid-January 2019, the TEL framework was officially launched in the institute. The framework (especially tiers 2 and 3) is a work in progress with its usefulness and effectiveness still being determined.

Competency for Online and Remote Teaching (CORT) Project

Started in end April 2019, CORT is a competence assurance initiative to ensure faculty members are pedagogically and technically ready for online teaching and learning based on Tier 1 of the TEL framework. All faculty are required to demonstrate four basic competencies in using technology to teach:

- Create an online video lesson
- Conduct an online lesson synchronously
- Conduct an online discussion asynchronously
- Create online assessment (quizzes and assignments) and give feedback

Literature of competencies for online instructors

Many researches have been done to study competencies required for online instructors. For example, Bigatel, Ragan, Kennan, May and Redmond (2012) surveyed experienced online faculty and staff members and identified 64 teaching tasks. Smith (2005) identified 51 competencies for online instructors, categorising the competency based on their primary importance before, during, and/or after the course. Darabi, Sikorski, and Harvey (2006) applied the International Board of standards for Training, Performance and Instruction (IBSTPI) methodology to identify and validate distance education instructor competencies. The researchers identified a list of 20 competencies and found that the most commonly used competencies in distance education include employing appropriate types of interaction, employing appropriate presentation strategies to ensure learning, facilitating productive discussions, and providing timely and informative feedback. Martin, Budhrani, Kumar, and Ritzhaupt

(2019) interviewed eight award-winning online faculty members on their perspectives of key competencies for online teaching which include technical competencies and the general competencies, such as the willingness to learn, knowledge of how people learn, content expertise, course design skills, and student learning assessment skills.

Selecting competencies for online instructors in SIT context

The list of competencies in the literature were considered during the selection process. At SIT, faculty use technology to enhance the learning experience or outcome or when there is a disruption to the traditional face-to-face learning. So, the selected competencies need to complement the core aspects of face-to-face instruction (i.e. creating/delivering content, conducting learning activities, facilitating discussions, and carrying out assessment with feedback). General competencies such as attitudes, content expertise, as well as basic pedagogical and technical skills (e.g. applying constructive alignment, uploading of files to the learning management system (LMS), using technology efficiently) are subsumed under CORT but will not be a focus of evaluation as they are covered in compulsory training sessions that faculty have attended. Other competencies that are more relevant for a fully online course (e.g. setting up a well-organised course site) were omitted.

Competence assurance process

Faculty will submit their artefacts that demonstrate the four Tier 1 competencies (i.e. pre-recorded video lesson, live online lesson, online discussion forum, and online quiz/assignment). Learning designers from the Centre for Learning Environment & Assessment Development (CoLEAD) are tasked to assess whether the artefacts meet the stipulated criteria for each competency. The artefacts must be created or set up by the faculty, and not inherited from another colleague or through someone’s help. A summary of other key criteria is provided in Table 1. Each competency is assessed by one learning designer to ensure consistency in evaluation.

Table 1: A summary of the key criteria of each Tier 1 competency

Competency	Criteria
Create an online video lesson	The online video lesson should • Be created using a screen recording tool, elearning authoring tool, or camera • Be published or delivered on a platform that can be accessed remotely by others • Not be a class recording where the faculty is talking to the students in class • Have clear narration
Conduct an online lesson synchronously	The live online session should • Be conducted using a tool that allows live video calls and sharing of presentation • Be delivered on a platform that can be accessed remotely by others • Not just be the presentation of content, but it should also include engagement of the participants using tools like chat (audio/text) or poll • Have clear audio
Conduct an online discussion asynchronously	The online discussion should • Be conducted using a discussion board or forum • Be delivered on a platform that can be accessed remotely by others • Include at least a topic, and a faculty’s reply to a post by another participant • Not be done via email or messaging apps
Create online assessment (quizzes and assignments) and give feedback	The submission should include (i) an online quiz, (ii) an online assignment, and (iii) evidence of qualitative feedback given online. It should • Be published or delivered on a platform that can be accessed remotely by others • Be created within the last one year • Feedback must be qualitative, not just marks and grades

Technology 4 Teaching (T4T)

Technology 4 Teaching is a professional development programme to prepare faculty for CORT. Hands-on workshops and learning resources are provided to build their skills to teach online. It was emphasised that faculty who already have a certain competency need not attend the workshop. In addition, mere attendance of the workshop does not indicate competency. Faculty can submit evidence or artefacts that were produced during or after the workshop, which includes the following sessions:

- Create an online video lesson (using Microsoft PowerPoint and Echo360 Universal Capture)
- Conduct an online lesson synchronously (using Microsoft Teams and Bongo Virtual Classroom)
- Conduct an online discussion asynchronously (using Teams and LMS)
- Create online assessment (quizzes and assignments) and give feedback (using Microsoft Forms and LMS)

These tools were chosen based on availability within the institute and ease of use. Faculty were also consulted to suggest other tools for training based on their needs and preferences.

Beyond Basic Competencies

In order to make a positive difference in students' learning, faculty are encouraged to go beyond the basic skills and engage students in meaningful ways. Faculty are also invited to embark on TEL projects, some of which involve interdisciplinary teams of faculty working together, supported by expertise and funding from CoLEAD.

Findings and discussion

Change management strategies

Sharing common vision and working closely with the management

The scientific management theory (Kezar, 2014) involved the setting up of a new framework through seeking stakeholders' input as well as communicating the vision across various communication channels. The Assistant Provost (Applied Learning) presented to faculty the rationale of this framework in relation to the university's vision of applied learning and digital learning. The university's faculty are grouped into clusters, where the directors and deputy directors continued to encourage faculty to embrace this common vision.

Providing motivation

As an incentive to participate in CORT early, monthly draws are conducted with prizes given out to the winners. Some faculty are also encouraged when they received positive responses from their students, which led to them wanting to do more online teaching.

Increasing risk appetite
Faculty can be very reluctant to make changes in instruction that constitute a risk to student satisfaction (Smith & Herckis, 2018). Thus, it is of utmost importance to build a trusting institutional environment where faculty are acknowledged for the effort to make changes and not severely penalised for trying something new which is not be well-received by students. For this to happen, working with the management team to build a nurturing culture, as well as communicating that "it is not unexpected that things may go wrong when new things are tried, and it is ok" need to be done.

Promptly responding to feedback and queries

Before and following the launch, various conversations were held with the clusters and individual faculty to provide more details, and to hear and address their suggestions, queries and concerns (see the following section).

Responses and Suggestions

Going beyond technical skills and minimum standards

Initial reactions to the TEL framework and CORT initiative have been positive, with several faculty members emphasising that high standards on pedagogy and technology should be set. Below were some comments:

> If we focus just on the technical aspects, faculty may just do the bare minimum (e.g. very simple videos). It is wonderful that the workshops also cover the pedagogical aspects.

> To provide a well-rounded learning framework, it would be of benefit if accompanying the skill development, the initiative also included literature on the latest or future directions in e-learning/remote learning pedagogy and tips/guidance on best practice.

We realised it was important to underscore the need for best practices and how having certain competency can lead to improvement in students' learning outcomes. As pedagogy aspects have already been covered under other compulsory training, these workshops were targeted more on teaching the selected competencies. Furthermore, by highlighting that it is basic competencies that were focused on in this process, we motivate faculty to do more beyond the basic and offer face-to-face consultations and collaborations.

Usefulness of selected competencies

Some faculty commented that certain competencies may not be useful in their contexts, and a handful of them clarified the rationale for the criteria and the minimum they need to do to fulfil the requirements.

> Every discipline or teaching program has different teaching philosophy and uses different pedagogy, it may not be suitable for us to use all of them.

> The nature of my module doesn't suit a virtual classroom. Every student has a different research project topic. The students wouldn't participate as well in a virtual classroom.

It was not uncommon for faculty to resort to a more familiar way and time saving way such as sharing previous lecture recording or use of WhatsApp for discussion. We acquired the help from faculty champions within the clusters or programmes to share how certain competency can be helpful. By having conversations on used cases and trying out new tools, faculty can learn about the benefits of learning and developing new competencies.

Progress in CORT and participation in T4T

At the time of writing (which is about five months from the launch of CORT), faculty have submitted 45% of the total expected artefacts. Participation in the T4T workshops resulted in around two-thirds of the total submissions. While the participants were able to perform during the workshop, a handful of them still required help after the session. This is in agreement with studies that show learning (or long-term retention and transfer) and performance (short-term changes) are distinct and can be inversely related (Soderstrom & Bjork, 2015).

Conclusion

This preliminary investigation into a university's strategy to prepare their faculty in TEL has revealed some of the complexity that underlies the challenge to conceptualise and assess competencies. The study selected four competencies in online teaching out of a broad range of competencies in literature. This approach has allowed faculty to measure their current skills and take steps to address skill deficiency. Using change management strategies, participation in CORT has been encouraging so far, though various challenges in ensuring the entire faculty population is prepared for online teaching still exist. Further study can be done to capture why some faculty have not been taking part, and how short-term performance via a once-off competence assurance process could affect the development of faculty in online teaching. Another area to investigate is the impact of this TEL framework on teaching practices, including tracking changes to the actual use of technology in the modules.

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Back to Basics: combining analytics and early assessment with personalised contact to improve student progress

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Student progression, attrition and completion are key metrics for all Universities. Subject level progress rates can be a useful lead indicator of these metrics; thus allowing quality improvement activities to be piloted and evaluated in shorter timeframes. The aim of this pilot study was to examine the effect of a series of pre-census interventions on subject progress rates. In 2018, twenty five subjects from the Faculty of Science at Charles Sturt University were selected to participate in the pilot based on a history of poor subject progress rates. Approximately 700 disengaged students were identified via learning analytics and emailed in week 2. In weeks 3 and 4 a range of "triggers" were used to identify 425 students who remained disengaged and contact was made via phone and/or email. Overall average subject progress rates increased from 66% in 2017 to 80% in 2018 ($p<0.05$) with a significant reduction in the average number of fail and fail withdrawn grades (from 42 to 26 per subject, $p<0.05$). Overall, we demonstrated that significant improvements in subject progress rates can be achieved when academics and Divisional support staff work collaboratively to identify, contact and support disengaged students prior to the HECS census date.

Keywords: Subject progress, Learning analytics, Early assessment item

Introduction

There is no doubt that student progression, attrition and completion rates have concerned Universities, the government and the broader community for many years. Recent announcements from the Federal Government regarding the introduction of performance-based funding in 2020 have cemented the fact that these metrics will continue to be front of mind for academics and senior university management for years to come! "The Department of Education and Training counts as attrition a commencing student who reached their first census date (which is at least 20 percent of the way through the semester) but is not enrolled the next year without completing" (Grattan, 2018b). Although attrition is the measure on which most importance is often placed; this measure is significantly lagged because by definition the latest attrition data is not known for at least 12 months after the student enrols. Due to the lag in attrition data, a useful surrogate or lead-indicator of attrition is subject-level progress rates. However, it is acknowledged that the relationship between progress rates and attrition is not perfect; and indeed the strength of this relationship can differ depending on the discipline of study.

The first HECS Census date for a commencing student represents a critical juncture in the academic journey; for both the institution and the student. Once a student passes this first census date and then withdraws from study they are deemed attrition. There is a short "window of opportunity" between students accepting their offer through to the first census date for Universities to support students in their transition to Higher Education and guide the student in making a decision as to whether University study is the right choice for them. Both the Higher Education Standards Panel (2018) and the Grattan Institute (2018a) reports include specific recommendations about monitoring student engagement and taking action before the census date.

There are a multitude of published studies describing complex algorithms and models that predict (with variable levels of accuracy) the likelihood of a student failing their subjects or leaving University (Jayaprakash et al 2014; Wolff et al 2013; Lacave, Molina & Cruz-Lemus 2018; Lu et al 2018; Tempelaar et al 2018). However, in this pilot project we took a "back to basics" approach through building solid relationships with teaching academics and divisional support staff to devise a program of proactive, pre-census support and contact at the subject level. The aim of this pilot program was to improve subject progress rates through the identification of disengaged students before the census date and offer targeted support.

Methods

Pilot Phase 1: In 2017 a single large enrolment, multi-campus, online and on-campus subject was selected to pilot different mechanisms of pre-census contact. The subject had an early assessment item (online mini-test) due in

Week 4. Of the 227 students enrolled, 58 did not submit the early assessment item. These 58 students were randomly divided into 2 groups, which compared two contact strategies:

- Group 1 were phoned by Divisional support staff from the Charles Sturt Outreach team. This team of trained callers can provide over the phone assistance with managing administrative processes and the availability of other University support services (e.g. disability, counselling, academic skills etc). Following 3 failed call attempts a brief email was sent directing students to contact their Subject Coordinator.

- Group 2 were phoned by the Subject Coordinator. No script was provided to the Subject Coordinator. Following 3 failed call attempts an email was sent that provided instructions on how to contact the subject coordinator if an extension was required, as well as links to manage their enrolment and firmly worded text about the financial implications of remaining in the subject after the HECS census date.

Overall, this small test case indicated that the Outreach Team provided far more effective support for students over the phone compared to the academic; however, the more firmly worded email from the academic was more effective in prompting the Group 2 students to update their enrolment.

Pilot Phase 2: In 2018, twenty five subjects from across the Faculty of Science at Charles Sturt University were selected to participate in Phase 2. Subjects were selected based on a history of poor subject progress, with all subjects having progress rates less than 80%. Subject progress is calculated as the percentage of students that receive passing grades for a subject. Non-passing, substantive grades that reduce progress rates include: Fail (FL; scoring less than 50%), Fail Withdrawn (FW; not submitting any assessment items) and Approved Withdrawal (AW). All subjects had a large number of commencing students, and 20 of the 25 subjects were offered across multiple internal and online offerings. The number of students enrolled in each subject varied from 20-740 (average 153). Disengaged students were identified at two time points, firstly in weeks 2 and again in weeks 3/4.

Week 2 Contact: Disengaged students were identified in all subjects using the learning analytics tool, retention centre in Blackboard. Retention centre uses site access analytics and a site access rule was created to contact students that had not accessed their online learning resources since the beginning of session. These students were sent a friendly email as a reminder that the resources are ready and to contact their subject coordinator if there were any problems. Subject coordinators were sent clear instructions (PDF and video) of how to do this quick task themselves and were provided with a template email and additional support from the project team.

Week 3/4 Contact: Disengaged students were identified in all subjects using a range of "triggers". Where possible students were identified via non submission of a pre-census early assessment item. However, in subjects without a pre-census assessment task, nonattendance at compulsory classes or learning analytics were used as a substitute. Learning analytics such as date of last site access, the number of site accesses and access to the subject outline were used. The Charles Sturt Outreach team then attempted to contact all disengaged students via phone and an email was sent following 3 failed attempts. The email template was provided to the Outreach Team and was based on the successful email devised in Phase 1.

Data are expressed as mean ± standard deviation. Group means were compared using a paired student t-test (2017 v 2018) or one way analysis of variance (ANOVA; for comparison of 3 years of data) using a Tukey Post Hoc and were analysed using the statistical package GraphPad Prism (version 7.04). The significance level was set at $p<0.05$.

Findings

Approximately 700 students were identified and contacted in retention centre in week 2 due to not accessing their subject sites since the commencement of session. Unfortunately, a number of students were contacted with the same email multiple times for not accessing each of the subjects they were enrolled in and in the future a course based approach to contact would be more appropriate.
Overall, 425 students from the 25 subjects were identified as disengaged in Week 3/4 and 3 attempts at phone contact were made, with follow-up emails sent to all students who did not answer. Unfortunately, the reporting did not allow for simple extraction of data on the number of students who answered the phone, but a rough estimate from the Outreach Team was 10-20%. In the future SMS communication may increase the call success rate.

Figure 1 illustrates the significant increase in progress rates across the 25 subjects from 2017 to 2018. Average progress rates increased from 66% in 2017 to 80% in 2018 ($p<0.0001$). Comparison of progress rate improvements in subjects with and without a pre-census early assessment item also revealed a significant difference (Figure 2).

Subjects which included a pre-census assessment task (n=16) improved progress rates from 70% in 2017 to 83% in 2018 (p<0.05), while those without an early assessment (subjects n=9), despite targeted intervention strategies in 2018 had a non-significant increase from 69% to 73%. Indeed, it is very difficult to accurately identify disengaged students with learning analytics alone. Interestingly, in 2017 without targeted feedback there was no difference in subject progress with or without an early assessment, indicating that to have a significant impact on subject progress, both an early assessment and targeted contact and support are required.

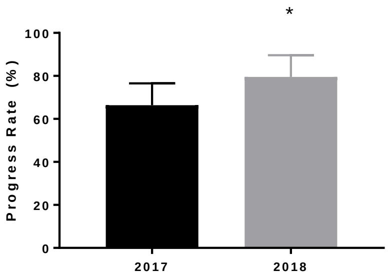

Figure 1. Significant increase in the average progress rate in 2018 following targeted student contact pre HECS census, *p<0.0001.

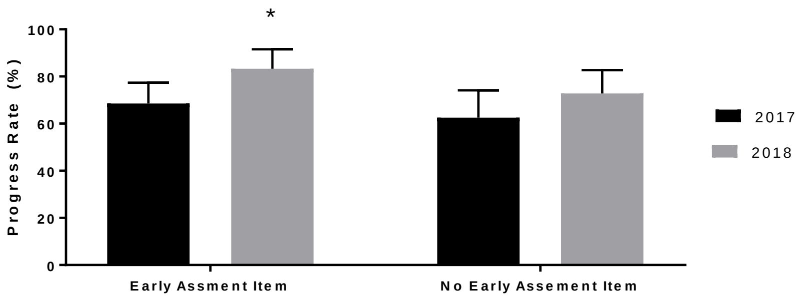

Figure 2. Subject progress rates in subjects with and without a pre- census early assessment item.
*** Progress rates in 2018 with an EAI were significantly higher an all other progress rates, p<0.05.**

This increase in progress rates occurred concurrently with a significant decrease in the number of FW grades, reducing on average from 6 per subject in 2017 to 3 per subject in 2018 (p<0.05) and a reduction in the average number of FL grades from 36 to 22 per subject (Figure 3). Importantly, this increase in subject progress, and decrease in non-passing grades did not affect the number of passing grades, or average student load (Table 1).

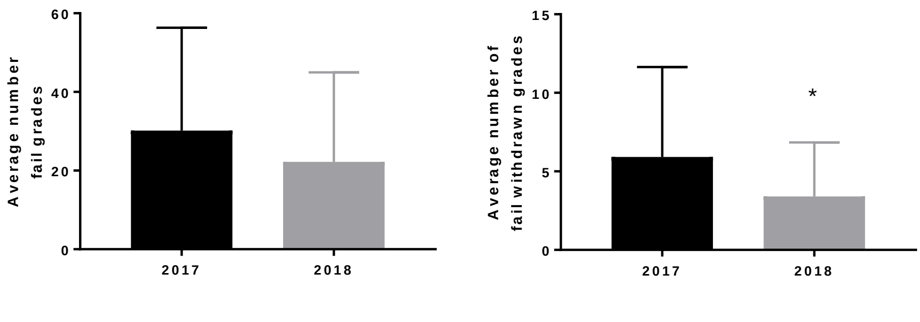

Figure 3. The average number of FL and FW grades per subject. *Significantly lower than 2017 p<0.05.
Table 1: Subject progress rates, cohort size and the total number of FL and FW grades for each of the 25 subjects in 2016, 2017 and 2018. Subjects 1-16 had a pre census assessment task and subjects 17-25 did not.
*** Significantly different to 2016 and 2017, p<0.05**

Conclusion

Overall, this pilot project demonstrated that significant improvements in subject progress rates can be achieved when academics and Divisional support staff work collaboratively to identify, contact and support disengaged students prior to the HECS census date. The authors acknowledge that there are many variables which can influence subject progress rates from one year to the next; however, in most subjects the assessment regimen was unchanged and few changes were made to the teaching staff.

There is no doubt that a key finding from this pilot is the critical importance of a pre-census assessment item. The use of learning analytics alone as a “trigger” to identify and contact disengaged students simply did not perform as well in terms of progress rate improvements. In Kift’s (2009) Program coordinator: First year curriculum principles checklist the importance of an early, low-stakes assessment item is explicitly mentioned. However, the checklist states “is there early, ‘low stakes’, formative assessment due and returned to students before Week 4-5…..” (Kift, 2009). A key recommendation from this work is that if an early, low-stakes assessment task is to be utilised to contact disengaged students then it must be scheduled between 3-7 days before the HECS census date to allow time to contact students that have not submitted.

The Higher Education Standards Panel (2018) report made a strong recommendation that “institutions should automatically review the enrolment of all students who have not engaged in their studies to an agreed level by the census date”. As a result of this pilot project we would recommend caution when determining the “agreed level” of pre-census engagement; especially where learning analytics tends to be the “go-to” approach. Charles Sturt University is proud to have a significantly high proportion of low SES and first-in-family students enrolled and this pilot has again highlighted that personalised contact and support for these students can result in really positive outcomes. This pilot forms a solid foundation for future expansion of this work across all Faculties and an increased number of subjects in 2019. In particular, future work will take a much closer look at the timing and design of all pre-census assessment tasks to ensure maximum benefit for students and the institution alike.

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Augmenting learning of immunology through an online learning package and a digital game – what's next?

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Immunology, the study of the immune system, is a subject taken by tertiary life sciences students. It is perceived as difficult due to its technical terminologies and abstract concepts that are interlinked. To address these learning challenges, learning technologies were embedded into the curriculum of an immunology module. This paper describes the design, development and deployment of a digital game as well as an online learning package to enhance the learning of immunology. Key considerations in the incorporation of technology-enhanced learning into the curriculum are described. Student learning was enhanced, mainly through the animations and quizzes for the learning package, and the interaction and visuals for the game. However, not all students found the game engaging. Reflections on the effect of the learning technologies on student learning, sustainability and possible future directions will be discussed.

Keywords: immunology, technology, digital game, online learning

Introduction

Learning technologies are widely used in biological education, in the form of animations, visualisations, simulations, and so on as they can help to elucidate processes or phenomena that are otherwise invisible; e.g. DNA replication and techniques such as polymerase chain reaction (Lee & Tsai, 2013). Video games have also been shown to improve learning outcomes in education (Gee, 2003) and promote a positive attitude towards learning and school (Annetta, Minogue & Cheng, 2009).

Immunology is the study of the immune system and its response to infections. It is challenging to learn due to difficult terminology and complicated concepts that are interlinked. Moreover, the immune system responds differently to various pathogens and students require deep understanding to apply their knowledge to specific contexts. Digital games for learning immunology have been reported in the literature (Kelly, et al., 2007; Nankervis et al., 2012; Cheng et al., 2013). However, these games are either not available for public access, not in the English language or do not meet our intended learning outcomes. This paper outlines a technology-enhanced approach to augment the learning of immunology for students at Ngee Ann Polytechnic, Singapore. It comprises two complementary parts: an interactive digital game, "Mission: Immunity!" as well as an online learning package for explicit teaching.

Embedding technology in the learning of immunology

Development of a digital game, Mission: Immunity!

Rationale for development of digital game
A digital game was developed to provide an interactive and engaging learning experience to enable students to visualise and the processes and interactions of the immune system components and how they contribute to the 'big picture'. The game and its impact on learning has been reported (Low & Lim, 2017) and is briefly described below.

Immersive game-based learning
The game presents two game scenarios depicting infection by a virus (Influenza!) and a bacterium, (Pneumonia!). The student controls immune system components to accomplish game challenges. On completion of all challenges, the student unlocks a battle mode which opens a 'command centre' coordinating all immune responses to the infection concurrently (Figure 1).

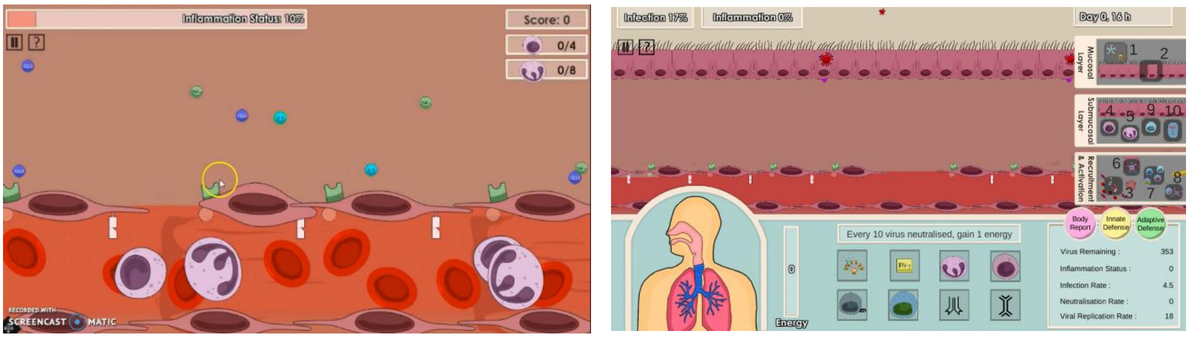

Figure 1. Gameplay mode (left) & battle mode (right) (https://bit.ly/30MUZPb)

Design of game to incorporate content learning

Content learning is embedded in the background information at the start of each challenge as well as the interactive game tutorial which provides step-by-step guidance for the challenges. Quizzes are incorporated after each challenge to make learning outcomes explicit and to provide feedback to students (Figure 2).

Figure 2. Background information (left), interactive game tutorial (middle) and quiz (right)

Development of an online learning package

Rationale for the development of an online learning package

As part of a push towards the development of online learning at the institutional and national level, part of the immunology module was selected to be developed as a 5-hour online learning package and made available on PolyMall, a learning management system shared by Singapore's 5 polytechnics, available to all polytechnic students. As PolyMall is intended to be self-accessed by any student, the online learning package was designed to be self-paced with no interactions with facilitators or other students.

Using online scenarios to facilitate learning

In conventional lectures, the immune system is taught in isolated parts from cells, proteins and organs, to processes. In the online learning package, the content learning is presented through scenarios, such as infection by the influenza virus (Figure 3) connects the different components. Students learn about the immune response through the analogy of a battlefield.

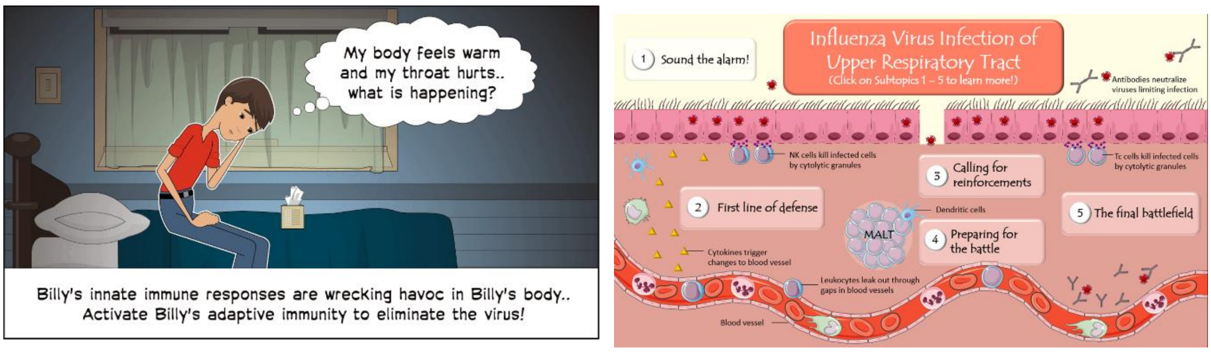

Figure 3. A comic illustration for Billy has the flu (left) and content selection page (right).

Enhancing the learning experience through incorporation of animations, illustrations and quizzes
Each topic commences with an animation that illustrates the stage of infection that will be covered in the topic; (https://bit.ly/2JISrMp). This allows students visualise the role of the immune system during an infection. Content knowledge was also explained through voiceovers and illustrations. Embedded quizzes help reinforce learning and clarify misconceptions.

Integration of online learning package and Mission: Immunity! into the curriculum

The online learning package was spread out over 3 weeks and students were given instructions regarding their online tasks on a weekly basis. A flipped learning approach was adopted, allowing students to discuss key concepts learnt the week before to deepen their learning. *Mission: Immunity!* was introduced after content knowledge was taught as our earlier study indicated a greater impact on learning after, as opposed to before formal teaching. To reduce the barrier of using a new educational tool, students were introduced to the game mechanisms and were tasked to complete 3 game challenges during a 1-hour classroom session. This also allowed for technical issues to be resolved. In addition, there was also social learning as students helped one another as they played side by side. Subsequently, students were required to complete the remaining challenges on their own in the next 2 weeks. A debrief session was carried out to reinforce the learning and clarify misconceptions.

Findings following implementation of online learning package and digital game

This two-pronged technology-enhanced learning approach for immunology has been carried out for 2 years. A learning experience survey was conducted upon completion of the online module (Table 1) and Mission: Immunity! (Table 2). A 5 point Likert scale was used. Up to 83% of the students had positive perceptions (score of 4 or 5) of the online module, while up to 72.7% of students in AY17/18 and 86.7% of students in AY18/19 had positive perceptions of the game.

Table 1: Results of online learning package (PolyMall) experience survey

PolyMall experience survey (48 responses)	*% Agree or Strongly agree*
1) The animation has helped me better visualise the immune system processes	74.5
2) The quizzes have helped reinforced the concepts learnt	83.0
3) Overall, the PolyMall module benefits my learning of immunology	72.4
4) I find the PolyMall module interesting	68.1
5) The PolyMall module has increased my interest in learning immunology	53.2
6) I would like to recommend this module to others	55.3

Table 2: Results of game experience survey

Game experience survey	*% Agree or Strongly agree*	
	AY 17/18 (n = 66)	AY18/19 (n = 30)
1) Playing the game has helped me to learn immunology terminology	59.1	73.3
2) Playing the game has helped me to better understand how the different immune system components work together	59.1	73.3
3) Playing the game has helped me to better visualise the immune system processes	72.7	86.7
4) Overall, the game benefits my learning of immunology	60.6	76.7
5) Playing the game has increased my interest in learning immunology	47.0	56.7
6) I find the game interesting to play	51.5	56.7
7) I would play the game again on my own	40.9	40.0

For the online learning package, students found the quizzes most useful for learning. This was also reflected in their qualitative comments; *"The quiz forced me to understand the concepts and that is good"* and *"The quiz after each subsection (helped me to learn)"*. This is in agreement with studies that show quizzes have a positive and long-lasting effect on learning (McDaniel, 2011), through immediate feedback (Peat, 2002).

Visualisations were also perceived to be beneficial when students are learning via the online learning package as well as *Mission: Immunity!*, which also accords with the literature (Lee, 2013). Visualisations facilitate the understanding of biological processes and abstract concepts, thus enabling learners to gain a deeper understanding of the subject.

Reflections

Integration of online package and game with face-to-face sessions for enhanced learning

In the first semester that the online package was used, the online learning was carried out within a 2-week period without face-to-face contact, which led to a lack of connection between the students and the lecturer. Hence subsequently, a flipped learning design has been used. The online package is coupled with face-to-face tutorials, where students apply the concepts learnt and clarify doubts, and the lecturer is able to build rapport with students. As shown in Table 2, the game was not terribly engaging in itself, but it served its purpose of helping students to visualise the processes in an interactive manner. During the subsequent face-to-face teaching, explicit connections are made to the online package and game scenarios to illustrate key concepts.

Enhancement of learning: beyond engagement to improved learning outcomes

It is difficult to attribute improvement in attainment of learning outcomes specifically to the online package and game as there are many factors affecting the students' performance. However, there are qualitative indicators, one of which is the quality of questions asked by students. Prior to the implementation of the game and online package, students would ask questions that were more microscopic and atomised in nature, which showed lack of big-picture understanding. However, after the implementation, the questions were deeper in nature, showing greater appreciation of how the immune system works in an interdependent manner.

One concern with moving a portion of the learning online and having less face-to-face teaching was whether learning would be compromised, particularly for the weaker learners. Due to a change in the curriculum at that time, we were unable to compare performance across the cohorts. However, it was encouraging to observe that student performance remained healthy, despite a reduction in curriculum hours.

Technology considerations for the game Mission: Immunity!

The learning package will need to be updated or refreshed from time to time. This is not an issue as it was created entirely by the lecturers, using mainly Powerpoint and the iSpring authoring toolkit. The game, however, is a different matter. As the lecturers do not have expertise in game design and development, a vendor was engaged to develop the game. There was close collaboration to develop a game to bring across the learning objectives accurately, yet have game objectives. Maintenance of the game is required due to browser updates and security vulnerabilities over time. However, the 3-year maintenance period of the game has ended, and the vendor has changed the focus of its core business. Although the source code is owned by the institution, it will be difficult to find another vendor that would continue to maintain the programme. In future, when the game becomes obsolete, it may be more feasible to redevelop the game than to patch it. However, this would incur significant cost and hence, for a greater returns on investment, the user base should be expanded.

Scaling and sustainability; collaboration with other institutions

Currently only the online learning package is available to students and lecturers from the other polytechnics. However, usage by other students is very low. To encourage adoption, it may be necessary to reach out to lecturers and include a resource pack such as accompanying slides and lesson plan and guide for lecturers.

The game would complement the learning package very well. However, it is currently not deployable on the PolyMall platform for sharing across the polytechnics. While the game is browser-based, it has to be launched from an in-house server and database, as student access and progress is tracked. This presents challenges as it can only be used within the campus or via a virtual private network. One possible solution is to host it on the cloud, but there is a running cost to be borne. Another possibility is to open the game for public access and not track individual progress. However, the issue of administration of accounts, maintenance and cost would be a limiting factor, as the risks of hacking and vandalism would also be increased.

What's next? A different paradigm?

During the development of this game, another game for learning immunology aimed at college-age students, *ImmuneQuest* was developed (http://immunequest.com/). The game was conceived by scientists and technologists, with support from the National Science Foundation. As at this point in time, Part 1, which covers innate immunity, is free to play, while Part 2 requires payment, to fund the development of the remaining Parts 3 to 5, which are yet to be developed. The game has an educator's portal which allows the lecturer to provide students with a course code and track their progress. A study carried out with undergraduates found that the game aided learning of immunology (Raimondi, 2016). Once *Mission: Immunity!* reaches its end-of-life, it may not make sense to redevelop it, if high quality games that meet the leaning outcomes such as *ImmuneQuest* are available.

However, there may be a potential for developing a game in which teachers and students can create challenge scenarios. The concept would be similar to visual programming software such as Scratch and other drag and drop programming tools. Immune system components have certain behaviours and characteristics, and there are a limited number of arenas (parts of the human body) in which they act. By developing a sandbox for the immune system where lecturers could programme the parameters of a particular pathogen, sites of action and their interactions of the immune system, would allow lecturers to develop their competencies in game-based pedagogy (Nousiainen, 2018). If this is open on the web, the immunology community could contribute different scenarios, as seen on the Scratch website (https://scratch.mit.edu/)

Taking this further, the next step forward would be student-authored games. Beyond playing games to learn, creating games based on the learning or research sets the stage for deeper learning as students extend their learning from the learning packages to create their own scenarios. Apart from deeper learning, students could also develop critical thinking skills (Yang & Chang, 2013) and computational skills. While Mission: Immunity! is a single-player game, game authoring involves groups and is a social constructivist approach to learning through collaboration (Kafai, 2015). Students could create games based on actual pathogens on which they carry out research. This also opens up possibilities for assessment of learning as students demonstrate learning through game creation. Peer assessment could also occur through playing games created by other students and providing feedback on the games. We propose that this would be a future direction for deeper learning of the immune system.

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Educational Technologists, Universal Design and Transforming Higher Education

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The field of educational technology continues to develop and grow in an era of unprecedented demand for the fruits of the higher education orchard. However, the persistent inequalities in relation to access and transfer opportunities remain. In parallel the field of universal design has evolved as a framework that allows us to reframe the ambition of enabling full participation for all citizens by adopting a whole systems approach. Educational technologists have articulated their desire to have an impact on all aspects of the higher education system – however current HE structures often relegate their work to marginalised or subsidiary roles with the HE hierarchy. Previous research capturing the values and beliefs of educational technologists resonates strongly with the emerging universal design for learning agenda. This paper will propose that personal and collective ambitions of educational technologists can be further realised by adopting the principles of universal design.

Keywords: Educational technologist, universal design, digital transformation, values and beliefs

Introduction

The purpose of this paper is to propose that the future development of the practices, capital and doxa associated with the field of educational technology should be premised on the underpinning values and beliefs that each social agent embodies. Bourdieu has demonstrated that to understand our practices we need to understand both the evolving fields within which we are situated and the evolving habitus which social agent brings to that field. In this sense a field *"...is a social arena within which struggles or manoeuvres take place over specific resources or stakes and access to them.*" (Jenkins R. 2002, p.84)

The path proposed is aligned to developments in an allied field also struggling to re-position itself in the wider context of education reform i.e. the field of universal design. A community whose identity has been shaped by decades of advocating for the rights of students with disabilities. It is at the nexus of these intersecting fields that I believe a future evolution of the field of educational technology can emerge. Universal Design is firmly linked to how services and processes can become more inclusive and open, how the design and composition of an environment can be accessed, understood and used to the greatest extent possible, by all people regardless of their age, size, ability or disability. These ambitions are shared in many respects by educational technologists (McNutt,2018) who describe their main motivation as driven by the needs of the learner. The Seven Principles of Universal Design (Table 1) define the overarching requirements in delivering a quality inclusive educational environment for all learners and staff[5].

Table 1: The Seven Principles of Universal Design

1. Equitable **use.** 2. **Flexibility in use.** 3. **Simple and intuitive use**. 4. **Perceptible information.**	5. **Tolerance for error.** 6. **Low physical effort.** 7. **Size and space for approach and use**.

However, the field of Universal Design has recognised that it must move from the periphery to mainstream and one key strategy in this endeavour has been the emergence of UDL – Universal Design for Learning.

The Universal Design graphic (Craddock & McNutt,2017) presents all users of ICT equipment and services on a pyramid with human abilities along the vertical axis, with a wide base representing those who can access all services and devices directly. At the apex of the pyramid are users who can only access services and devices with the assistance of another person. The goal of Universal design is to extend the boundary between end-users "*who*

[5] http://universaldesign.ie/what-is-universal-design/the-7-principles/the-7-principles.html

can use all" and those only "*with adaptation*". Technology has transformed the lives of many people and now represents one of the few areas in which the interests of people with disabilities and able-bodied people intersect.

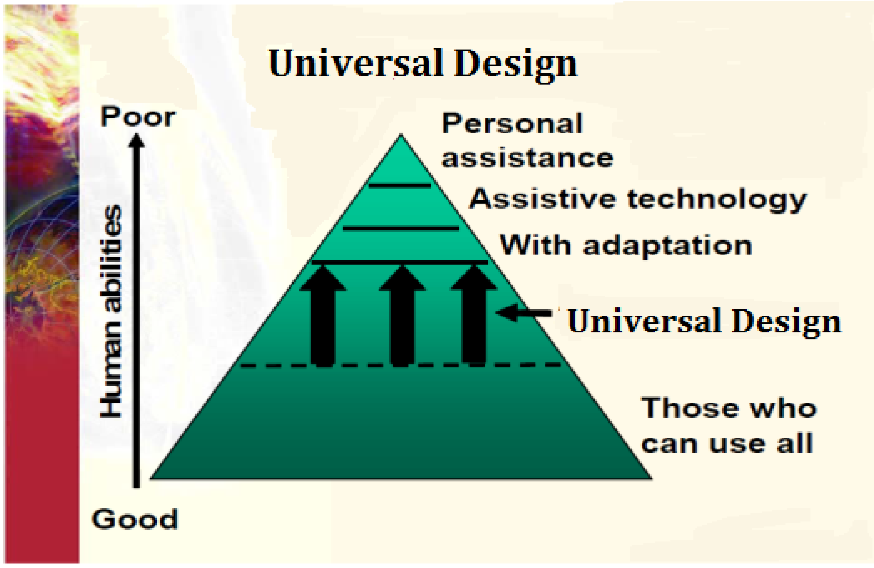

Figure 1: Universal Design Pyramid

However, there is often an assumption within the field of educational technology – that technology is inherently good design. A presumption that also presents in other professions for example it has been argued that conventional architectural education allows students to disengage from intensive understanding of diverse human experiences. To counteract this scenario, it has been suggested that consideration must extend beyond generalized notions of the "user" and emphatically engage specific embodiments in the design process. (Gunawan and Jamrozik, 2018). This is also echoed by Edyburn who offers an interesting insight into how we as educational technologist can address this challenge:

> I believe that there must be a priori evidence that the instructional designer understands academic diversity and is proactively building supports that will ensure that individual differences do not mitigate access and engagement. Otherwise, the result is simply a happy coincidence between the use of technology and new tools that students enjoy. UDL is more than simply integrating the latest technology tools into the curriculum.

Burgstahler (2015) (see Table 2) provides a useful illustration of how the seven principles of universal design can be applied but also advises that "UD is a goal that puts a high value on both diversity and inclusiveness. It is also a process." (p.9)

Table 2: Example of application of the principles of universal design

Equitable use	The design is useful and marketable to people with diverse abilities. A website that is designed so that it is accessible to everyone, including people who are blind, employs this principle
Flexibility in use.	The design accommodates a wide range of individual preferences and abilities. A museum that allows a visitor to choose to read or listen to a description of the contents of a display case employs this principle.
Simple and intuitive	Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level. Science lab equipment with control buttons that are clear and intuitive employs this principle.
Perceptible information.	The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities. Video captioning employs this principle.
Tolerance for error.	The design minimizes hazards and the adverse consequences of accidental or unintended actions. An educational software program that provides guidance when the user makes an inappropriate selection employs this principle

Low physical effort.	The design can be used efficiently and comfortably, and with a minimum of fatigue. Doors that open automatically employ this principle.
Size and space for approach and use.	The design provides appropriate size and space for approach, reach, manipulation, and use, regardless of the user's body size, posture, or mobility. A science lab with adjustable tables employs this principle.

It must always be remembered that at the heart of universal design is the opportunity to mainstream accessibility for people with disabilities. Bringa (2018) reminds us that "universal design is a wanted but demanding concept" – however in the Norwegian context there are clear indications that the concept when used supports social and economic sustainability.

> The major implications resulting from this study were teachers' perceptions of the impact on students with exceptionalities and the effect that these teaching methods have on the classroom learning environment.

This challenge has been addressed in relation to ICT Professionals and emerged from a CEN workshop in 2011 that there was an urgent need to promote Universal Design amongst ICT professionals (Rice et al, 2011). There is also significant research that demonstrates that accessibility barriers in learning platforms and associated learning materials has an impact on students fully participating in higher education (Seale, 2013). Chen et al (2018) undertook a qualitative study to determine the attitudes of faculty members towards students with disabilities and universal design in education. They have reported that *"The faculty members had generally positive attitudes towards accommodating diverse students in their teaching and making digital learning materials accessible if necessary. Most were aware of the laws and regulations related to accessibility. However, many lacked experience with student diversity and utilised inadequate terminology when discussing diverse students."* This scenario is also described by Rydeman et al (2018) who claims that the importance of attitudes, from both teachers, students and the organisation as a whole, was a key component, recognising that it will not be easy to change existing attitudes and will require new approaches as well as patience and time (p.104). One promising solution is co-operation between units at different parts and levels at the university and joining forces with each other in a more efficient way. (p.105). Also adopting more innovative approaches as suggested by Hughes et. Al (2018) where "maker pedagogies encourage students to take ownership of their learning in a way that is both supported by the curriculum as well as the classroom teacher."

To embrace universal design as a unifying framework to transform higher education I will argue that the unique skills, experiences and attitudes of educational technologists is the optimal combination required to lead this endeavour.

Educational technologists as universal design champions

In a recent discussion paper published by the Irish Higher Education Authority titled "*Digital Transformation and Empowering Technologies in Higher Education*"[6] they refer to Orr (2018) who contends that

> Better use of digital tools in learning environments can offer personalised education options according to diverse prior knowledge and personal needs.

This is seen as a game-changer for students with different learning styles, special needs and students who prefer to learn at their own pace. The expectation is that the educational technology centres in each higher education institution will be charged with realising this agenda. However, what is not recognised is that the scenario presented *"personalised learning"* can only be realised if the principles of universal design are adopted.

Bringolf (2018) describes this symbiotic relationship between universal design and digital transformation when she states that

> Universal design of itself does not target a specific disadvantaged group even though its outcomes do. Rather, it targets those who have the power to change their design processes to be more inclusive.

[6] https://hea.ie/assets/uploads/2017/04/190212_FutureFocus_Digital-Transformation_Discussion-Paper.pdf

An earlier study (McNutt, 2010) to explore the habitus of educational technologists provided a useful insight into values and beliefs that underpinned their work. It could be seen from the data that the participants *own personal motivation* was very much learner centered.

> I think it's the match and that you use technology based on what you think the learner gets out of it or gets most out of it.
>
> it would be the learner I would be most focused on
>
> For me it's the learner. Otherwise the technology does nothing. The learner has to be the starting point.

But the main consensus was that for all the flaws that may exist a key assumption was that educational technology has the potential to radically change higher education:

> It does have the potential of the radically change the way we deliver and manage education
>
> Yeah, my assumption is that it's got potential, I suppose I'm still at the point where I'd say it's got potential, and we haven't seen its full potential

The data illustrated that educational technologists have a broad and varied range of views and opinions on the current profile of the higher education sector. The main topics that dominated the discussion were the changing profile of students and their associated behaviours; the dominant economic drivers in relation to course development and provision; the priority of the research agenda and the impact of quality assurance. Educational technologists may be viewed as "technies" operating in an educational domain, but the data captured and presented here offered a very different perspective. Educational technologists have the knowledge, skills, motivation and beliefs to influence the design processes that define the educational environmental and experiences of all our learners.

This process can be transformative for the designer and the learner - Edyburn & Edyburn (2011) have described how anticipating differences can reduce or eliminate the need for accommodations and modifications. Whilst Poore-Pariseau (2011) describe a changed perspective (2011, p.54)

> I learned that the more one knows about the principles of universal design, the more one tends to proactively consider the needs of students

Conclusion

It is these shared beliefs on the potential of technology to deliver real change and the personal motivation to ensure that the learner is central to all initiatives that underpins my proposal that the community best suited to seize the opportunity afforded by the adoption of the principles of universal design reside within the field of educational technology. UD is not a euphemism for accessibility, as access features such as ramps and lifts are "potent symbols of separateness" (Welch, 1995, p. 2). Rather, UD is a "process of exploring how a politically mandated and socially desirable value can be embodied by the design disciplines" (Welch,1995, p. 262).

So, what are we waiting for? I am reminded of Seneca's observation 2000 years ago:

> Putting things off is the biggest waste of life – it denies the present by promising the future

Time to grasp the opportunity to re-define the field of educational technology by applying the concept Universal Design to our endeavours as Meyer and Rose (2000) defines it

> where all students' needs are taken into account during the curriculum planning stages, to design an egalitarian and accessible content delivery system for all learners

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Study Progression, Success and Program Component Selection

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This article evaluates some of the underlying assumptions of a data analytics initiative being undertaken at an Australian university, which provide student support staff with lists of students who have enrolled in program components (classes) different from the plan prescribed in the curriculum (e.g., out of sequence, not on the plan). This study was undertaken with the assumption that these 'inappropriate' enrolments might negatively impact student progression and success. The analysis suggests that student progression is significant negatively affected; in particular, students can be prevented from studying full-time, extending the time needed to complete their program. However, the impact on student success was found to be minimal. The findings help to demonstrate the impact of the data initiative, and the value of continuing and expanding its use into the future.

Keywords: Study success; course completion; data analytics; study support

Introduction

The role of universities, and of higher education in a global society is changing. Students are increasingly seeking higher education, and selecting programs of study as pathways to employment (Bhardwa, 2018). More and more students from a wide social economic spectrum are choosing to attend postsecondary education to prepare themselves for the global workforce. The growth in access and uptake of university education specifically, has conferred many benefits to growing numbers of students from a wide social spectrum, with data indicating that in Australia completion of a university degree increases the prospects of employability regardless of gender and level of achievement at entry to university (Marks, 2018). Students in greater diversity and numbers than ever before are seeking to enhance their global mobility, and to find and experience hands-on, authentic work placements integrated with their undergraduate study. They want to join an institution with a strong reputation and attendant opportunities to meet and work with creative business leaders, especially those who are the founders and executives of innovative companies and organisations that deliver positive social impacts via knowledge and innovation.

Students enter higher education institutions with a range of perceptions and expectations concerning university life, for example in terms of social aspects as well as in an institutional and educational context, including workload, access to academic staff, feedback, and support (Bailey, Gosper, Ifenthaler, Ware, & Kretzschmar, 2018). However, research shows a mismatch between students' perceptions and reality (Smith & Wertlieb, 2005). Furthermore, research indicates that many students do not know what is expected of them at university and that they are often academically unprepared (Mah & Ifenthaler, 2017; McCarthy & Kuh, 2006). Students' preparedness is particularly relevant with regard to generic skills such as academic competencies (e.g., time management, learning skills, technology proficiency, self-monitoring, and research skills), which they are supposed to already possess when entering university (Barrie, 2007). Students are also expected to follow a specific pathway in a program (i.e., degree) at a university. They will often have an amount of flexibility of what, when, and how to complete the courses (i.e., components, units, or subjects) that comprise the program. However, this freedom and flexibility of choice can also result in dropout (Tinto, 2005).

This paper aims to examine the impact of student choices of course enrolment on their success in the program (measured in terms of pass rate, grades/marks, and program retention/drop-out rate). Specifically, this study examined a selection of programs at an Australian university, for students who, in their first semester of study, selected courses which were not recommended to be studied until a subsequent semester.

Background

Literature Review

Research on study success has produced a broad conceptual understanding of the construct and related terms such as retention, persistence or graduation (Mah, 2016; Tinto, 1997). According to Sarrico (2018), study success can be conceptualized as the successful completion of a program. Opposing terms for a lack of success include withdrawal, dropout, non-completion, attrition and failure. Hence, the essence of the construct ‘study success’ is to capture any positive learning satisfaction, improvement or experience during learning.

Educational data mining and analytics show promise to enhance study success in higher education (Berland, Baker, & Bilkstein, 2014; Pistilli & Arnold, 2010). For example, students often enter higher education academically unprepared and with unrealistic perceptions and expectations of academic competencies for their studies (Ifenthaler & Mah, 2017). Both, the inability to cope with academic requirements as well as unrealistic perceptions and expectations of university life, in particular with regard to academic competencies and management of following a specific study pathway, are important factors for leaving the institution prior to degree completion (Mah, 2016).

Context

Compared to many other institutions, most programs at the University typically have a relatively fixed structure, with not much choice between which courses students can select. Programs generally have only a handful of ‘elective’ courses (selected any course from the University they meet the pre-requisites for), or ‘optional’ or ‘alternate core’ courses (selected from a pre-defined list) available for selection in each program. The courses in each program are also typically designed to be done in a specified order, and where there are elective, optional, or alternate core courses available, these are generally intended to be selected at particular points in the program. Other institutions, with a less structured, or more flexible programs, may find less value in an initiative such as this one.

The Learning and Teaching Analytics team at the university have operationalised a dataset which includes a list of students with ‘inappropriate enrolments’, that is, students with at least one enrolled course that is not intended to be studied until a subsequent semester of study. This dataset is provided to directors of student engagement, program coordinators, and student services staff for review who contact students as appropriate, where there are concerns. The dataset was well received in the initial pilot in Semester 1, 2019, with several cases where, based on this list, students were advised to change their enrolments prior to the start of classes. One program coordinator stated that the dataset was “Very useful for identifying students incorrectly enrolled” and “all were incorrectly enrolled (so what a neat report that is!!)”.

Due to the success of the initiative in 2019 Semester 1, it is being continued and expanded into 2019 Semester 2 and onwards. However, at present, there is only anecdotal evidence that students having ‘inappropriate enrolments’ negatively impacts their progress and success. This paper aimed to find empirical evidence of this claim, to help encourage the uptake and expansion in the initiative.

Inappropriate Enrolments

There are several reasons to suspect that students having ‘inappropriate’ enrolments at the university may negatively impact their success. Some of issues it can cause (which varies depending on individual circumstances) are:

- Students may not have the intended ‘scaffolding’ intended by the program designers, i.e. they may study a course without having the intended background knowledge on a subject.
- Students will be more likely to have class timetable clashes (tutorials, lecture, laboratories, workshops etc.) preventing them from attending all their classes.
- Students may require more time complete to their program, as not all courses are available every semester.

Methodology

Research questions

For this analysis, an ‘inappropriate’ enrolment is defined as occurring when a student in their first semester of study, attempts a course (unit) two or more semesters earlier than prescribed in their program’s curriculum.

To formalise the objective of this paper, the following research questions have been formulated:

- **Research Question 1:** Are students with an inappropriate enrolment in their first semester of study, less likely to pass courses studied in their subsequent two semesters, compared to students with no inappropriate enrolments?

- **Research Question 2:** Do students with an inappropriate enrolment in their first semester of study, have lower marks on average, for courses studied in their subsequent two semesters of study, compared to students with no inappropriate enrolments?
- **Research Question 3:** Do students with an inappropriate enrolment in their first semester of study, attempt fewer credit points in their subsequent two semesters, compared to students with no inappropriate enrolments?

To summarise, research question 1 aims to determine whether inappropriate enrolments impacts pass rate, research question 2 to aims to determine whether inappropriate enrolments impact average marks, and research question 3 aims to determine whether inappropriate enrolments impact the number of credits attempted. For the purpose of this analysis, an 'early withdrawal' from a course counts as the student having not attempted it.

Scope

To control for potential confounding factors, the research questions were investigated only for students who met all the criteria in Table 1.

Table 1: Student Inclusion Criteria

Student Criteria	Rationale
Started their program attempt in semester one of: 2015, 2016, 2017, or 2018.	Four years of data increases the sample size. Students who start their program are more likely to have non-standard study plans, which could complicate the analysis.
Studied a full-time load (100 credit points) in their first semester of study.	Focusing on students who studied full-time, excludes students who might have withdrawn early from some of their subjects, which the researchers do not have data for at present.
Passed all courses attempted in their first semester of study.	Limiting to students who passed all their courses in their first semester of study, controls for the expectation that students who did not pass all their courses, may choose to study fewer courses in their subsequent semesters, not as a result of an inappropriate enrolment.
Studied one of four specific undergraduate programs known to have a relatively large number of students with inappropriate enrolments.	Programs can be very different from each other, and the impact of inappropriate enrolments could be very different in different programs. Focusing on four large programs which were found to have large numbers of inappropriate enrolments, helps to control for this.
Were new to program and have not been granted any exemptions from studying courses.	Students with exemption will have fewer credits to complete, which would skew the results.
Were only studying one program at the university in their first semester of study.	In the usual cases where students study more than one program, the number of credits studied in each program in each semester are likely to be non-standard and would skew results.

A total of 3930* students met the above criteria. Of these, 3713* had no inappropriate enrolment (control group) and 217* had at least one inappropriate enrolment. *Students who started multiple programs during 2015-2018 and met the criteria in Table for each program, can be counted multiple times.

Results

Research Question 1: Are students with an inappropriate enrolment in their first semester of study, less likely to pass courses studied in their subsequent two semesters, compared to students with no inappropriate enrolments?

An independent samples *t*-test was performed comparing the mean course pass rate of the control group students and the inappropriate enrolment students. As predicted, the inappropriate enrolment students (M = 86.1%, SD = 22.6, N = 180*) had a lower pass rate than the control group students (M = 89.0%, SD = 21.8, N = 3439*), $t(3617)$ = 1.668, p = 0.0841, two tailed.

The difference in the mean pass rate of 2.9pp is not quite significant enough (at a 5% significance threshold) to support the prediction that students with an inappropriate enrolment are less likely to pass the courses they attempt.

*274 control group students and 37 inappropriate enrolment students did not attempt any credits in the subsequent two semesters and hence, were excluded from the calculation, as no pass rate can be determined.

Research Question 2: Do students with an inappropriate enrolment in their first semester of study, have lower marks on average, for courses studied in their subsequent two semesters of study, compared to students with no inappropriate enrolments?

An independent samples *t*-test was performed comparing the mean weighted mark of the control group students and the inappropriate enrolment students. Contrary to expectations, the inappropriate students (M = 65.5, SD = 11.7, N = 179*) had roughly the same average mark as the control group students (M = 65.5, SD = 11.4, N = 3405*), $t(3582) = 0.0024$, $p = 0.9980$, two tailed. The difference of 0.0 marks was not significant.

*308 control group students and 38 inappropriate enrolment students did not subsequently get any mark, hence are excluded from the analysis. An average mark cannot be calculated for these students.

Research Question 3: Do students with an inappropriate enrolment in their first semester of study, attempt fewer credit points in their subsequent two semesters, compared to students with no inappropriate enrolments?

An independent samples *t*-test was performed comparing the mean number of credits attempted by the control group students and the inappropriate enrolment students. As predicted, the inappropriate enrolment students (M = 135.8, SD = 75.2, N = 217) attempted fewer credits than the inappropriate students (M = 168.2, SD = 58.8, N = 3713), $t(3928) = 7.7418$, $p < 0.0001$, two tailed.

The difference of 32.4 credit points studied is highly statistically significant ($p <= 0.0001$) and supports the prediction that students with an inappropriate enrolment, attempt fewer credits in subsequent semesters. A typical course at the University is worth 25 credit points, meaning on average, students attempt at least one less unit. 32.4 credit points is 16.2% of the typical maximum number of credits that can be studied over two semesters (200 credits) and represents a significant negative impact to student progression and potential loss to the University.

Discussion and Conclusion

Student retention in higher education has been a global concern for years, as withdrawals from higher education remain at about 30% in the member countries of the Organisation for Economic Cooperation and Development (OECD, 2013). The first year of higher education is considered particularly crucial, as students often decide within this period to leave the institution, prior to degree completion (Mah & Ifenthaler, 2018). Recently, higher education institutions have gained interest in educational technologies, which have the potential to enhance student retention. Educational data mining and learning analytics show promise to support students throughout their higher education journey (Berland et al., 2014).

The most significant finding from this analysis is the fact that although there was not a significant difference in average marks, and only a small difference in pass rate, there was a highly significant difference in the number of credits that students attempted in subsequent semesters. This analysis does not conclude a causal link; however, it does suggest that inappropriate enrolments are preventing students from being able to study full-time and hence requiring them to take longer to complete their program. This is even more notable given the two groups of students performed similarly well in the courses they did attempt. This finding helps to demonstrate the value of the dataset provided by the analytics team to the university and quantifying it (avg. ~32 fewer credits studied in the subsequent two semesters), helps to measure its impact. The possible actions that could be taken on this this issue include providing clearer information/counselling to students in selecting courses, so they can make better informed choices about their learning pathways (Bailey et al., 2018).

Clearly, the current data analytics strategy can be considered as an advanced offering of academic support services. In addition to other study support, for example summer bridge programs, first-year seminars, or mentoring programs (Padgett, Keup, & Pascarella, 2013), the data analytic strategy can be expanded as an (semi-) automated student self-service feature and can be expanded into a larger data analytics initiative at the university.

One major aspect missing from this analysis is the rate of early withdrawals (students withdrawing before the cutoff date for fees). Due to limitations of the current data, this was not able to be investigated. Inclusion of early withdrawal data is planned for future analyses and is expected to further increase the significance of the findings.

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Personalising medical education: ePortfolios for workplace-based assessment

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There is much literature on the challenges of designing for and implementing ePortfolios. Issues include technology management and overcoming barriers to acceptance and usability. Yet as higher education practitioners we find ourselves continually stumbling over these issues. Through discussion of a work-in progress case study at a large Australian medical school, we raise some of the design and implementation issues that impacted integration and facilitation of an ePortfolio system. The system was created to support students' personal learning, and evidencing and assessment of clinical competence. Recognising the importance of context, we focus on a Workplace Learning Portfolio (WLP) course, in which an ePortfolio system was adopted to support and deliver workplace-based assessments for students in Years 3 and 4 of a Doctor of Medicine (MD) program. Discussion centres around the promise and reality of concurrently implementing curriculum and technological change with a large cohort of domestic and international students. The complexity of using an ePortfolio system to identify students at risk of academic failure is raised, as is an example of unexpected student engagement with personalised learning.

Keywords: ePortfolios, medicine, workplace-based assessment, personalised learning

Introduction and background

In recent years there has been increased interest in higher education in the use of ePortfolios to demonstrate student competence, showcase student achievement, and aid personal reflection (Coffey & Ashford-Rowe, 2014; Driessen & Tartwijk, 2019; Hallam & Creagh, 2010; Holt et al., 2014). As a space for the curation of digital artefacts evidencing a learner's personal experiences and achievements, ePortfolios (electronic portfolios) may be considered a product (Hallam & Creagh, 2010). As a means for helping learners 'move beyond *what* they have learned to consider *how* they have learned, and to understand the connections inherent in the creative process of learning' they may be considered a process (Hallam & Creagh, 2010, p.181).

In the context of medical education, Driessen and Tartwijk (2019) identify three main goals for the use of portfolios, namely 'monitoring and planning learner development, assessing performance, and stimulating reflection' (p.255). While the 'scope, structure and content' (p.255) of portfolios may differ significantly in medical education, Driessen and Tartwijk maintain they are typically promoted as catalysts for meaningful dialogue between clinicians and learners. Through the process of managing and curating a portfolio, proactively seeking out learning opportunities to document clinical assessments, and reflecting on these experiences, students can be encouraged to become increasingly conscious of their 'personal and professional strengths and weaknesses' (Hallam & Creagh, 2010, 2008, p.179; see also O'Sullivan, Carraccio, & Holmboe, 2018). However, where ePortfolios are assessed, there can be a tension between the goals of accountability and the goals of reflection. Driessen (2017), for example, warns that key stakeholders (students, residents, teachers and scholars) may 'condemn the bureaucracy surrounding portfolio implementation' (p.221).

Assessment requirements in the clinical setting

A requirement of medical education is that students are assessed on their performance of clinical competencies and interactions with clinical teams. This may be in hospital wards, general practice clinics, and a range of clinical practice settings. These workplace-based assessments (WBAs) represent skills essential for internship, and include, for example, taking a patient's medical history, undertaking a physical examination, conducting a procedural skill such as a cannulation, or educating a patient about their medical treatment. In this way students are observed and evaluated by medical experts in real workplace settings, not merely during simulated clinical sessions. At our university an accreditation report and external review of assessment design highlighted the need for greater consistency across medical disciplines where WBAs were carried out. This included reducing the number of high stakes hurdle assessments, and aligning assessments with a national clinical competency framework that sets out common diagnostic and procedural standards for medical graduates (MDANZ, 2014). Also, internal curriculum reviews confirmed the need to increase opportunities for students to be observed performing clinical skills and receiving feedback on those performances. By moving to a more integrated, whole of program, longitudinal assessment strategy (Schuwirth & Van der Vleuten, 2011) for WBAs, it was expected that students could better demonstrate their achievement, and collect, document and reflect on feedback received throughout their medical program.

Consequently, a year-long workplace learning portfolio (WLP) course was introduced. An ePortfolio system, as product and process, was expected to contribute to a longitudinal assessment strategy in the following ways, by: (1) helping make visible student learning in the clinical workplace over the life of a student's medical program; (2) encouraging personalised learning, by expecting students to assume responsibility for their own learning and seek out opportunities for practice, feedback and assessment in the clinical environment; (3) encouraging more feedback from assessors; (4) creating opportunities for, and capturing, students' reflections – contributing to professional growth; and (5) taking the pressure off individual assessments, instead focusing on a collected body of achievements, i.e. facilitating longitudinal assessment. Also, it was anticipated that a paper-based logbook to capture clinical activities used previously in different courses (subjects or modules) could be replaced with a new ePortfolio system to integrate WBAs into the one course. Hence ePortfolios were expected to provide pedagogical and technological support for change, encouraging a holistic and meaningful approach to WBAs.

Technology to support learning and teaching

Underpinning learning and teaching needs and curriculum change there was a need for a reliable and effective ePortfolio platform. We were mindful of earlier research that warned of barriers to successful implementation brought about by conflicts between pedagogical goals and technological issues (Holt et al., 2014; Mason, Langendyk, & Wang, 2014). Prior to our plans for introduction of new WBAs, the central university elearning centre undertook broad stakeholder consultation, selecting Chalk and Wire (https://www.campuslabs.com/chalk-and-wire/) as the enterprise-wide ePortfolio tool. It was seen as a sustainable solution that could support a range of learning and assessment needs, and replace bespoke systems in use around the university (UQ, 2015). Following usability testing, piloting and evaluation, the system was adopted by the central elearning centre. The elearning centre provided technical and educational design support, and the Faculty of Medicine provided additional local support for staff and students, and conducted its own usability and use case scenario testing with staff and students. In 2017 WBAs using the ePortfolio system were introduced in two Year 3 courses (student numbers N = 385). Additional ePortfolio WBA templates were then created and populated with rubrics, details of placement, assessment processes (tick-the-box grading options and qualitative feedback boxes), and spaces for student reflection. Access to Chalk and Wire was successfully enabled via single sign-on through the course website on Blackboard (https://aus.blackboard.com/index.html). Full deployment of the scaled-up system was achieved in 2019 in the WLP course with a large and diverse student cohort (N = 931; domestic students 58%; international students 42%). In addition, students were assessed by over 2000 external practising clinicians at clinical placements across urban, rural and international clinical schools.

ePortfolio records were collected by students, either by uploading their observed assessment records or initiating an electronic request to their supervising clinician to complete an end of clinical placement assessment. A set number of clinical encounters were required for assessment over the two-semester length WLP course. The WBAs were not graded, students were required only to complete a specific number and meet competency levels for some clinical procedures, with students encouraged to reflect on their performance. Reflection was only mandated if a clinical task was not completed to a satisfactory level or if a student was identified as being at risk of not meeting overall requirements. In this case, students were also required to create a learning plan for their future development and achievement of clinical competence. Overall, the ePortfolio system was designed to accommodate significant variation in the clinical experiences of a large cohort of students, widely distributed across numerous clinical units, and including students in our partner program in the USA.

Issues of implementation

Table 1 provides a summary of a selection of key issues evident during the first iteration of the ePortfolio system and WLP courses. It identifies expectations regarding learning and teaching processes, technological and workflow issues, stakeholder engagement, and a selection of consequent challenges, outcomes and implications (see Table 1). Evidence for the table was collected from faculty planning documents, written student and clinician feedback, and analysis of data in the ePortfolio system. The team business analyst systematically reviewed data collected from the system and, using methods of constant comparison, the authors distilled themes and issues from the data set. While there is insufficient room to discuss at length all the issues raised here, two are addressed: a technical problem identifying students at risk of failing the WLP course, and an unexpected outcome indicating positive evidence of stakeholder engagement.

Table 1: Expectations, challenges and outcomes of the ePortfolio implementation

Expected functionality & 'designed for' processes	**Challenges and Outcomes**
Learning and teaching processes	
A space for students to collect, view, share, manage and evidence clinical practice. A tool for formative and summative assessment and reflection.	Partially achieved. In semester 1 2019 a total of 13,744 WBAs were captured in the ePortfolio system. However, students needed further training to be able to confidently complete formative and summative assessment processes.
Educational design: ePortfolios well integrated into the curriculum – embedded as a whole of course approach, with mandated requirements.	Adopted by most disciplines, although some disciplines defaulted to a mixture of legacy assessment processes in addition to the new ePortfolio processes and product.
Timely entry of assessments into online space making visible growing competence over time.	Assessments captured, but frequent misunderstandings of submission process, or process performed incorrectly.
Opportunities for reflection: voluntary entries encouraged, but if student did not achieve clinical competence, mandatory entries and an action plan for remediation required.	Reflections were added, but the extent to which this promoted further student actions to improve clinical performance is unclear (further evaluation required). More mentoring required to deepen student responses and overcome workload issues.
Stakeholder engagement and mentoring	
Mentoring and training: Information sessions for staff and students, guidebooks, online tips, and ongoing support.	Training and mentoring well received, but busy clinicians external to university still struggled with the new technology alongside curriculum change, as did students.
Student to manage personal learning process – their responsibility to request assessment from clinician, and manage technology.	Students reported confidence issues approaching clinicians for assessment while on placement, and workload issues around double handling of data.
Unexpected process request: A positive outcome.	Students requested extra online space to upload non-mandated records. Evidence of proactive management of own learning.
Technical and workflow issues	
Ease of use, with mobile access to support documentation of assessments in any clinical setting, and allowing for timely clinician feedback.	Interface not optimised for mobile devices. Novice users (staff and students) needed much support to navigate the interface. Resource intense workarounds implemented, including paper-based logbook system in tandem with online system, and some manual data management.
Removal of need for paper-based assessment forms for clinical assessments. Supervisors previously signed hardcopy assessments and students did not always receive feedback on their performance.	Paper-based logbook required due to technical limitations of ePortfolio system. Students transcribed logbook entries into online system. Consequence – time-consuming double handling of information, risk of error, and manual checking.
Interoperability between university services – single sign-on with Blackboard learning management system, student information system and student placement system.	Interoperability with Blackboard achieved. However, delays transferring data from student information system meant delayed reporting of student withdrawals in ePortfolio system. Linkage with clinical placement system identified as being required.
Reporting functions – mapping from ePortfolios to course curriculum outcomes, and identification of students at risk.	Reporting functions trialled successfully during pilot but in practice, at scale, capacity issues experienced, and functions limited. Time-consuming manual calculations required and some data could not be extracted accurately (system limitation).
Notifications system to alert clinicians of assessment requests and when assessments needed grading.	Email alert not always recognised by clinicians as coming from the Faculty of Medicine ePortfolio system, so prompt assessment of student tasks did not always ensue. Manual alerts required to supplement system.

Expected functionality & 'designed for' processes	Challenges and Outcomes
Sustainability and portability of content – ability to export and evidence clinical practice after the course.	PDF files as a record of clinical competence could be exported.

Technology and workflow issues: Identifying students at risk

Implementation of ePorfolios at scale is a known issue (Posey et al., 2015), and even the best designed pilot testing may not alert managers and users to potential problems. This was evident in our project. As well as issues navigating the interface, increased workload because of the dual paper/online system, failure to recognise system email alerts to clinicians requesting grading of assessments, one of the key technical issues that interfered with reporting and workflows was identification of students at risk in the WLP course (i.e. failure due to non-completion of WBA requirements). It was hoped that the ePortfolio system would provide valuable and timely learning analytics about students at risk, and while we could determine who had not met the minimum course requirements at the mid-year portfolio review (N = 93, 10%), the extracted data needed further detailed analysis. The result was that from the system reports alone we were unable to differentiate between students at risk from non-completion of submission (due to user or system error), versus students at risk due to academic under-performance (not able to achieve their assessment requirements, or not clinically competent to the required level). Manual analysis was required to identify the students who were *not* struggling academically (N = 52; 5.5%), but who had technical issues uploading results correctly from their logbooks to the ePortfolio system. This was further complicated if students delayed uploading their WBAs (N = 3535 in the last two weeks prior to the deadline), so technical errors could not be remedied prior to reporting of student results.

The problem with at risk students became a mixture of system design issues, and users' inability to navigate the system. This affected our ability to report accurately, and alert staff and students when risks presented. Around 4% of all students who met all WLP course requirements (and were not identified as being at risk) also had difficulty with technical aspects of the ePortfolio – with ePortfolio entries containing submission errors. Manual manipulation of this critical exported data became a resource issue, as did personal support and mentoring of stakeholders. These issues affected the actual and perceived sustainability of the intervention. Clinicians now expected additional data about students at risk, for example, as an affordance of the new system, and were frustrated when it was delayed. Nonetheless, requests by clinicians for additional data about students at risk indicated a raised level of staff awareness about how data could be used to better support student learning.

Stakeholder engagement: students personalising and managing their learning

Perceptions about ease of use, usefulness and surrounding pedagogical and technical support all affect users' acceptance of innovation, and their willingness to engage meaningfully with curriculum change (Posey et al., 2015). This was evident in our project. While anecdotal evidence from emails and an internal student report on the efficacy of the system suggested that students struggled with the workload of a dual paper-based/online system, and overcoming issues of confidence approaching their clinical supervisors for assessment and feedback during placement, there was evidence of the success of the new WLP course to support personalised learning. This came from an unexpected student request. Students asked for a space to store evidence of additional, non-mandated procedural skills that they had completed while on clinical placement (evidence provided via emails to staff, and posts to the course discussion board). Consequently, an additional space was provided in the ePortfolio system to accommodate this need, and 402 student entries were made over the semester. This allowed students to make their learning more visible, acted as a formative learning support, represented a record of achievement, and indicated self-management of learning.

Conclusion

Once again we stress the substantial impact of technological issues on ePortfolio implementation. Poor integration and limited functionality disrupt best laid plans, and demand workarounds and additional resources. Further, to engage students and teaching staff, the interface must be intuitive, seamlessly interoperable with other student systems, and provide the required reporting functions. All of this is critical where student assessment is at stake. In addition to technological barriers, as the literature, our experience, and this project confirm, we cannot overlook the impact of mentoring and user support (see also Driessen & Tartwijk, 2019), feedback – which has a key role in promoting successful uptake of ePortfolios (see Bleasel et al., 2016), and effective educational design of the system and curriculum (see Hallam & Creagh, 2010).

Introducing curriculum change (WBAs) and a new ePortfolio system in tandem was, as expected, a complex and challenging task (see also Driessen & Tartwijk, 2019; Mason et al., 2014). To overcome similar challenges, we recommend that design and implementation of ePortfolios be conceptualised as an ecological venture. This means viewing these activities as iterative and evolutionary, where underestimation of the impact of even one element risks poor outcomes for the whole project. To enable this, we maintain the value of sensitive and respectful dialogue and collaboration with stakeholders (Burge, 2007), acknowledging the differing perspectives brought to the project. We cannot plan for or anticipate all outcomes of curriculum and technological change. However, as Burge (2007) points out, while institutional planning is not always rational, and often political, we can lead and maintain momentum of the change process. This can be achieved by, for example, showcasing project successes, and explaining successes to learners and colleagues. It also makes sense to have a safety net – no matter how low-tech: ours was the humble paper-based logbook.

Following this first review, modifications to the WLP course are underway. They include adjustments to reporting functions and rubrics, and simplification of submission and workflow processes to reduce double handling of paper and online records. We have recommended ongoing dialogue with the vendor to accommodate on-the-fly, just-in-time modifications during implementation. In addition, a new central advisory group is being established to investigate pedagogical needs across all faculties, recognising that one ePortfolio platform at the university may be insufficient. With regard to future research, we plan further investigation into the efficacy and impact of ePortfolios in the context of workplace-based assessment, and the differing goals and perceptions of teaching staff (clinicians) and students in this context.

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The Active Learning Platform a year after implementation: Lessons from the lake of hope

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This study investigated the uptake of the Echo360 Active Learning Platform (ALP) by academic staff at Griffith University. This research will inform future deployment prospects of this platform and seeks to discover the best ways to support staff in utilising its newer features to help students engage with their educational content. The study reports on the uptake one year after the implementation of the new features. It reports on data at two levels, firstly from the overall uptake of the new features in the tool and, more particularly, it reports on how a smaller number of staff have engaged with the tool over the last six months. Results suggest although the many new features in this tool have been welcomed by staff, the uptake is slower than had been predicted. Those who used the new features have reported student engagement with the tool in face to face classes and increased lecture attendance. However, some academics found the platform difficult to use and that it takes more time than expected to understand features. The paper reports reasons for this and provides some insights as to what can be done next to see a further increase in the level of engagement.

Keywords: Echo360ALP; active learning; higher education; implementation, polling

Introduction

For many years now, with the advent of more reliable technologies supporting the higher education (HE) sector in Australasia, and more particularly with the push towards providing more flexibility in how students access their learning resources, institutions have invested heavily in a range of online tools (Glasby, 2015) to augment the traditional learning management system (LMS). Tools such as lecture capture systems, ePortfolios, online assessment tools, and virtual classrooms, etc., as seen in Figure 1, that depicts the Griffith virtual learning environment (VLE). However, more recently, these technologies have started to introduce features designed to actively engage students in their learning. These new tools not only provide static or passive resources for those studying at a distance, in blended modes and in newer style physical learning spaces (Glasby, 2015), but now have more interactive features. If we take, for example, the lecture capture tool that Griffith University uses, Echo360 ALP, and look across the Australasian sector, we find that this one tool is used by over 31,000 academics and with half a million students using the lecture captures these academics provide (statistics provided by vendor).

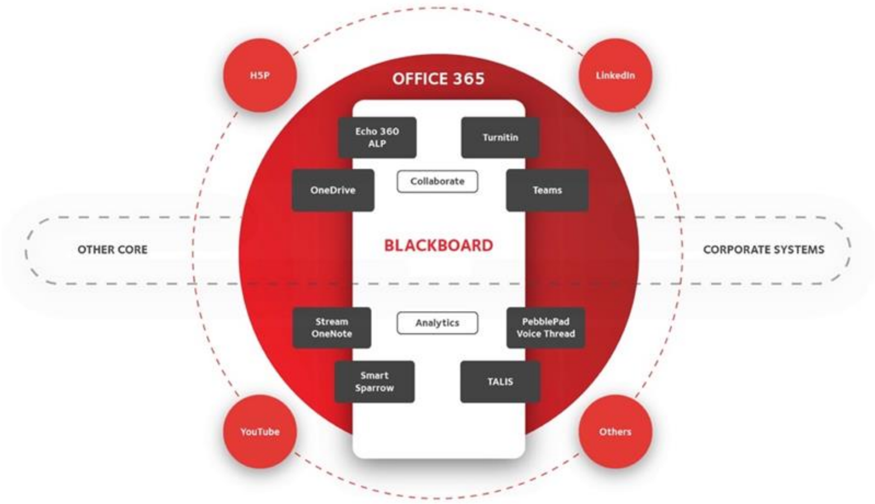

Figure 1. Griffith virtual learning environment (VLE)

Griffith, like many universities in Australasia, has used Echo360 lecture capture in face-to-face teaching for some time. Lecture capture enables students who are unable or unwilling to physically attend the lecture, to engage with the course lectures after the physical lecture has taken place. In 2016, when the previous version of Echo360 was coming to end-of-life, the University updated to the Echo360 Active Learning Platform (ALP). This newer version includes more interactive tools than its predecessor and allows students to engage in questions and polls, participate in question and answer (Q&A) discussions, flag course materials that need clarification, and take notes corresponding to presentation slides or videos. The platform also provides academic staff with the opportunity to review analytics data, providing valuable insights into the level of student engagement. However, the use of these tools, in the case of Griffith, is based on a conscious effort to engage students in more active, collaborative and authentic learning experiences. To that end, as the lecture tool that Griffith had used for some time started to develop these more active learning features, it was a natural decision to engage as much as possible in adopting the affordances of this new tool.

In 2016, a small pilot of Echo360 ALP was undertaken with seven courses involved as early adopters with the key success factors being previously reported (Duffy, James, Campbell, & Williams, 2017). After a break which involved analysing the data collected during the small pilot, a larger more inclusive pilot was developed using an early adopter project methodology. Expressions of Interest forms were sent out with twelve respondents from two academic groups. Two staff were from the Griffith Business School and 10 staff were from Griffith Health. However, of these 12 staff only six staff attended the training and used the platform. The formal training involved one session with the vendor as well as two other sessions conducted by the central teaching unit. The university Learning and Teaching Consultants (previously called educational designers and blended learning advisors) that reside in each of the four Academic Groups (Faculties) were also invited to each of the training sessions. A SharePoint site was set up for resources to be shared with the Learning and Teaching Consultants to help provide a level of consistency across the institution. One of the initial setbacks in the early adopter program was that the links within the Learning Management System, Blackboard, were not automatically populated and needed to be manually implemented. To support this, a very thorough set of instructions were posted on the project site, as well as a video on how to complete these steps manually.

From the initial training sessions there was some effort to provide resource creation and further training. At the time, two Griffith Faculty Sparks (short video presentations with supporting resources) were provided. For example, see https://app.secure.griffith.edu.au/exlnt/search#q=echo360&o=most-recent&et=faculty-spark as well as several blog posts and six generic training classes conducted (two per trimester) with two being supported by the vendor's Learning Technologist. Also provided was School-based training run by the central unit for the Griffith Health Academic Group (two sessions to 49 staff) and the Sciences Academic Group (two sessions to 17 staff). There was also a show and tell session run for the Griffith Business School, with 18 attending. During the training sessions, the first part of the training was conducted from a student perspective showing how the tools could be used in the classroom for students. This demonstrated how one could provide opportunities for increased engagement and active learning in class. The second half of the training sessions were hands-on with attendees adding in their links to the LMS, uploading activity slides, and looking at how they can structure their courses within the platform. Overall the training was considered successful based on positive evaluations.

Literature review

One commonly used higher education digital technology is lecture capture. Its purpose is to increase flexibility for students in terms of when and where they study. While there were concerns that using lecture capture would affect lecture attendance (Young, 2008) and student learning this does not appear to have eventuated. Toppin's (2011) research suggests that attendance at lectures was not negatively affected through using lecture capture, with students perceiving it to be a useful tool in helping them understand concepts taught. This is consistent with that of Chandra (2007), who concluded that reviewing videos of class lectures has a positive impact on student learning. A study into the use of Echo360 as a lecture capture platform (Mark, Vogel & Wong, 2010), concluded that students "instead of developing an intention to skip classes … believe that Echo360 plays greater value in helping students to revise" (p.1732). However, research on this latest version of Echo360 lecture capture, called Echo360 ALP is quite limited. There is early evidence that Echo360 ALP engages students who use it (Campbell & Centre for Learning Futures, 2017), with Campbell and Blair (2018) suggesting that students engaged with various tools that were available and uptake in the course was good with 76% of students accessing and using the platform.

As this is a new technology, it is important to discuss adoption of new and emerging technologies. The rate of adoption of any new technology usually starts low, accelerates until about 50 percent of users have adopted and then decelerates as the new technology becomes more widespread and reaches everyone in the community (Butler

& Sellbom, 2002). Moser (2007) found the following were all factors instrumental in how technology was adopted; time, competence (support resources), course design, teaching/learning experience, reliability of the technology, and reflection. In adopting new educational technology and to address these issues, Abrahams (2010) suggests the focus should be on how to successfully adopt the technology for increasing or improving the ability to educate using the new technology. Moser (2007) suggests that a successful program for supporting educational technology adoption must encompass and foster a community involving faculty and support groups.

Methodology

Phase one of this project involved an analysis of institutional data associated with the overall uptake of the new features in the tool, while phase two involved survey data that was collected online through an anonymous survey which was placed in Qualtrics for the academics to complete. The survey took approximately ten minutes to complete and asked questions such as demographic questions, ease of use, how often using it, changing lecture preparation, as well as the advantages and disadvantages of using the platform.

While 53 staff began the survey, only 33 staff completed the survey. Some staff emailed and reported that as they had not been using Echo360 ALP, they couldn't finish or participate in the survey. From the 33 staff who completed the survey, only 22 had used it in the previous six months. Results are reported only from those participants active in the past six months. Data has also been gained and thus reported from the analytics available in the system.

Results and Discussion

Below the results have been broken into two sections, one showing university statistics and the other the results from the survey.

Phase one: Institutional data

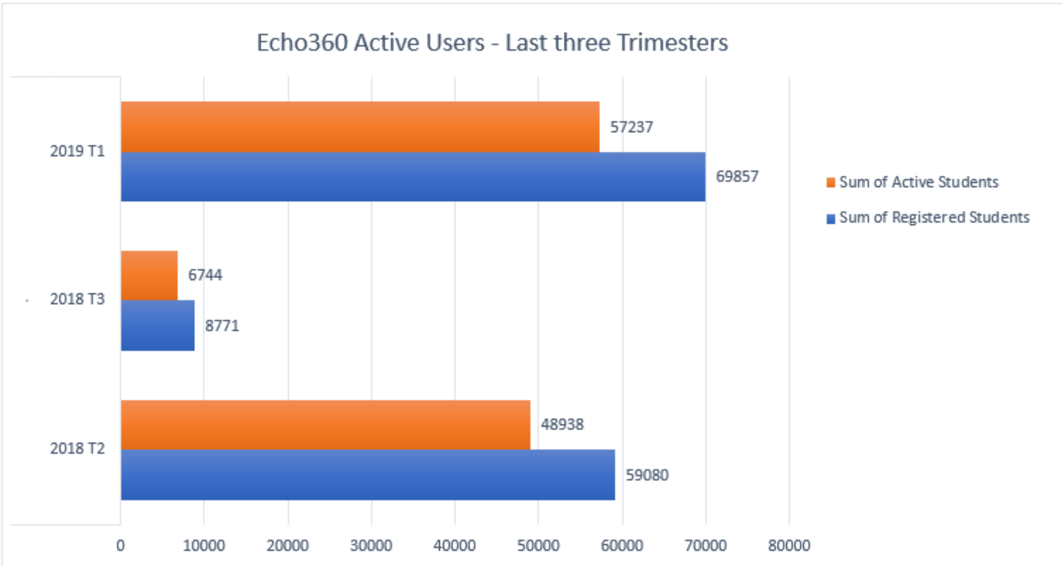

Figure 2. Active and registered students for the past three trimesters.

Since the implementation of Echo360 ALP in Trimester 2, 2018, usage has improved. This is evident in Figure 2 which shows increased usage since trimester 2, 2018. As Trimester 3 is over summer, only a small number of students' study which is why usage was lower at this time. Figure 3 reports the types of usage and the total of that usage as compared with the number of active students (n=57,237) which is lower than the number of registered students (n=69,869), this is any student who has a class that is using Echo360 ALP. This means that 82% of the registered students are active, which seems quite high. As expected, students most often used the slide deck view (n=36,831) and then also used the note taking facility with 21339 note events counted. Polling was also used (n=9127) to a good extent.

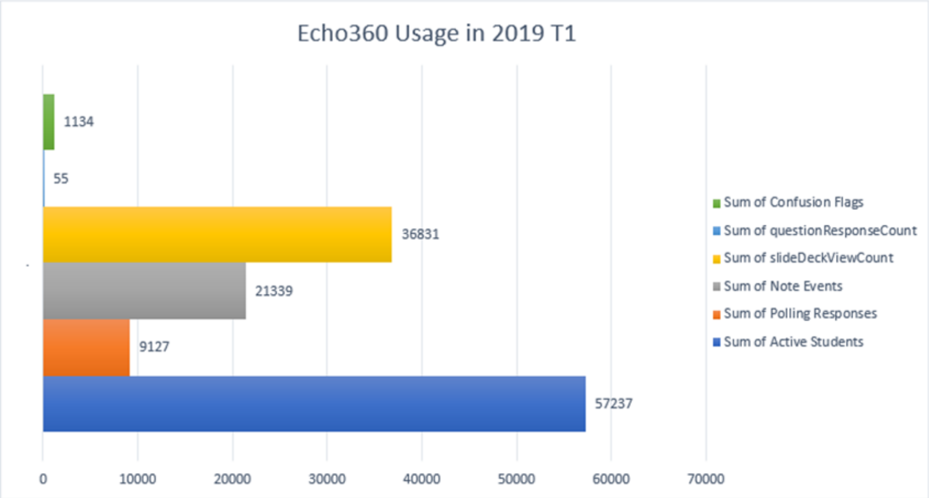

Figure 3. Types of usage across the university.

Phase two: Academic survey results

From the academic survey that was implemented, 22 respondents, who identified as Lecturers or Course Conveners, had used the active learning features in the last six months with a strong 82% of respondents either using it weekly or multiple times a week. Of these, 86% had found the platform easy to use. Of those not finding it easy to use indicated that it was difficult to locate the tool within the suite of options available to them within the LMS environment, and not due to the tool itself. Fifteen (68%) reported changing the way they presented their materials based on the new tools being available. When asked which features of the new tool-set they were using (they could choose multiple answers) to get students engaging in class, most it appeared were providing either multiple choice questions for their student (n=15), or short answer questions (n=12). Three (n=3) were using image quizzes and ordered lists (n=2) and numerical response questions (n=1).

When asked about how they use the tools in the system to engage their students, there was a 62% agreement that the tools helped them feel that the lecture itself was more interactive, with 28% not sure and 10% not agreeing with this. However, when asked if they felt their students were more involved in learning in the class the sentiment was not as strong with only 33% agreeing with this and 38% disagreeing, while the remaining 29% were not sure. Although this is not surprising given engagement does not necessarily equate to learning, at least without data, or evidence to suggest this is the case, it is difficult to make that call. It became clear in the responses that many of these lecturers experienced some (different forms of) technical difficulties that prevented a full engagement with the platform, with students not always having the right devices with them, to problems with the network, to not setting it up properly. It was seen that some of these problems could be remediated as they became more familiar with the product, while others they felt they had no control over. Despite this, 68% believed that they would use more features in the future. A feature that was seen to be valued by half the participants (n=11) was that of allowing students to provide opinions back to the teaching staff during class. Those who disagreed with this (n=6) had very limited exposure to the new tools set.

Staff were asked about their experiences with the platform with several staff commenting in the positive. One staff member commented "I was pleasantly surprised by the level of student engagement", while another suggested "It engaged students far more than I expected and the more I use it, the more students coming into my classes are familiar with it. I am also growing in confidence and starting to use Q and A and a flipped classroom approach". One advantage to using Echo360 ALP is that "students can access lecture[s] any time on [sic] their own pace". One academic suggested it was a learning process as s/he "had to learn to identify the type of questions that were adaptable to the platform. One advantage that was commented on is that it makes a "difficult course easy and students can understand the content easily" which is possibly due to the active learning nature of Echo360 ALP. This is reinforced by another academic who stated, "the main advantage is student engagement and the ability to gauge the level of student understanding during class rather than after an assessment item". Some of the barriers previously identified in the literature (Moser, 2007) were also evident with one academic reporting that it took "more time than expected," while another one stated one "Disadvantage is extra time to prepare presentations in Echo from previous PowerPoint slides".

Although student uptake is quite high, a staff member did comment on the lack of student uptake in a course by stating “Lack of student uptake; not knowing how to show the students how to use it” which suggests greater training for the students may be beneficial. More training may also be helpful to students in the course where the academic stated “I expect[ed] students to interact more” or perhaps they could change the way it is being used in that course slightly. Another problem was that there were “problems with connectivity of students using mobile phones or tablets, some features of PPT are not supported by Echo360”. While another staff member suggested while it was mostly positive “some students don’t have a laptop or phone and struggle to engage”. One staff member did report they weren’t sure how to use it due to “no appropriate training” and “not knowing how to show the students to use it”. The staff were asked if there was a need to change their lecture preparation when using the platform with 68% (n=15) stating yes, which suggests that most did change the way they created and undertook their lectures.

Further Research

This preliminary research shows that further research is required to fully understand the issues facing academic staff on the adoption of this platform. In the future we plan to conduct in-depth interviews with staff who are using the tool as well as surveying those who attended the training but are not currently using the platform. Interviews with university faculty-based Learning and Teaching Consultants would also be beneficial and work around university support in the Schools would be beneficial to increasing use across the university. Further resources could be made available and an investigation into how they are being used and how they could be improved would also be helpful to staff. Providing greater support to staff could be acted upon and then conducting a student survey around usage and engagement in the future may also move the research forward on motivators to academics using the platform.

Conclusion

While Echo360 is just one of the many tools that is used for active learning, it forms an important part of the entire VLE learning suite. Griffith University is committed to providing high quality education to students and has now developed an Active Learning Website for staff who are able to use it to increase their use of the suite of tools provided to help them engage with their students in on-campus and blended forms of delivery. Echo360 ALP forms part of this suite and has been shown to be under utilised to-date. Now that the central teaching support unit is aware of this, it will be able to make training sessions more accessible to staff. The next phase of this project will be to then see if this drives increased usage in the future and to what extent this will facilitate a greater level of student engagement.

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Understanding pre-service teachers' experiences of a mixed reality simulation environment: An analysis of pre-service teachers’ perspectives on communicating with a simulated parent avatar

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The integration of simulation platforms in the Initial Teacher Education (ITE) programs enables pre-service teachers (PSTs) to experience a range of teaching scenarios that they might not otherwise encounter in real-world practicum contexts. Understanding PSTs’ perspectives of their experiences of these new learning spaces is critical in determining the role played by simulation platforms in the preparation for placements, their specific affordances for learning and how these platforms can be effectively integrated to support PSTs’ practices. This paper reports on a pilot study of PSTs’ participation in a simulated parent conference session with a parent avatar in SIMLab™, a mixed reality simulation environment. SIMLab™ allows the facilitation of synchronous responses by a human interactor playing a virtual reality avatar to enhance the authenticity of the experience for PSTs. Based on data drawn from a cross-sectional survey design, the paper provides an analysis of PSTs’ perspectives on six possible affordances of SIMLab™ and describes emergent themes gleaned from PSTs’ comments on their learning experiences within and in relation to SIMLab™. The findings inform the design and implementation of the simulation experience in ITE programs.

Keywords: mixed reality, simulation, initial teacher education

Introduction

In mixed reality settings, real-world and virtual objects are juxtaposed within an environment where a real-world setting is virtually augmented or a virtual setting is augmented by real-world interactions (Milgram & Kishino, 1994). At present, there are no clearly defined configurations of real and virtual elements, but the intention is for these elements to be integrated in ways that present users with the best possible simulated or enhanced experience of a real-world context. With advances in this field, mixed reality simulation platforms such as Teachlive™, Mursion™ and SimLab™ (Dawson & Lignugaris/Kraft, 2017; Dieker, Hughes, Hynes, Straub, 2017; Ledger, Ersozlu, & Fischetti, 2019) have made some headway in the Initial Teacher Education (ITE) programs. These mixed reality simulation platforms allow the facilitation of synchronous responses by human interactors playing virtual reality avatars within the virtual space as they interact with users; a functionality referred to as “human in the loop” (Dieker, Lignugaris-Kraft, Hynes & Hughes, 2016). A key affordance of these simulations in ITE is that pre-service teachers (PSTs) are able to experience a range of teaching scenarios that they might not otherwise encounter in real-world practicum contexts (Ledger & Fishchetti, 2019) and the “human in the loop” functionality enhances the authenticity of the experience. This paper reports on a pilot study of PSTs’ perspectives on their experience of conducting a simulated parent conference session with a parent avatar controlled by a human interactor. It provides an overview of significant effects in relation to PSTs’ perspectives on six possible affordances of a mixed reality simulation platform known as SIMLab™ and describes emergent themes gleaned from PSTs’ comments on their learning experiences within and in relation to SIMLab™. The findings inform the design and implementation of the simulation experience in ITE programs.

Methodology

The aim of the study was to explore the affordances of mixed reality simulation environments for learning and practice in the ITE context. The simulation experience involved Year 4 PSTs in the ITE program at a university in Western Australia. The simulation experience was embedded within an experiential learning cycle (Kolb, 1984) which included PSTs interacting with an avatar playing the role of a parent of one of their students, followed by a coaching session with a tutor to help them reflect on their words and actions during the simulation experience and consider strategies for managing discussions with a parent. This was then followed by with a second interaction with the parent avatar for PSTs to enact the strategies discussed with the tutor. The study employed a cross-sectional survey design. The questionnaire was issued immediately before the first simulation experience to establish a baseline and immediately after the second simulation experience in order (i) to compare the attitudes of the group towards the simulation experience pre- and post-intervention and (ii) to evaluate the program (Creswell, 2012). There were 101 respondents in the pre-intervention survey and 57 in the post-intervention survey. The online survey was voluntary and anonymous. Quantitative analysis of the data was based on the component of the questionnaire comprising a 4-point Likert scale related to possible affordances of mixed reality simulation platforms, that is, building self-confidence, planning for diverse parents/families, handling difficult situations, asking good questions, accepting critical feedback and self-reflecting. Qualitative analysis of the data was based on the participants' comments in open-ended sections on their experience of the simulation platform. Constant comparative analysis was employed to generate categories reflecting participants' attitudes towards the simulation experience through systematic comparison of specific incidents in the data (Strauss & Corbin, 1990).

Findings

Survey data results

To test the hypothesis that the post-intervention group (n=57) would be associated with significantly different perspectives on the affordances of SIMLab™ for learning how to interact with a parent compared to the pre-intervention group (n=101), an independent samples t-test was performed. The test compared the scores for six possible affordances of SimLab™ for the pre-intervention and post-intervention group. Scores for four of the six affordances showed a statistically significant difference between the pre- and post-intervention groups.

- Building self-confidence for the pre-intervention group *($M=3.03$, $SD=.467$)* and post-intervention group *($M=3.38$, $SD=.491$); $t(112) = 1.98$, $p = 0.000032$*
- Handling difficult situations for the pre-intervention group *($M=3.06$, $SD=.552$)* and post-intervention group *($M=3.56$, $SD=.501$); $t(126)= 1.97$, $p=0.000000075$*
- Accepting critical feedback for the pre-intervention group *($M=3.12$, $SD=0.503$)* and post-intervention group *($M=3.42$, $SD=0.565$); $t(105) = 1.98$, $p=0.0015$*
- Self-reflecting for the pre-intervention group *($M=3.21$, $SD=0.593$)* and post-intervention group *($M=3.49$, $SD=0.504$); $t(132) = 1.97$, $p=0.0026$*.

The results indicate that the SIMLab™ experience surpassed PSTs' initial expectations before they participated in the intervention. PSTs found that the learning process situated within and around the simulation experience productive in terms of shaping their perceptions of their own capacity and building their capacity to manage and to reflect on challenging scenarios during parent-teacher meetings.

The two affordances which showed no significant difference for the pre- and post-intervention groups were asking good questions and planning for diverse parents/ families difference.

- Planning for diverse parents/ families difference for the pre-intervention group *($M=3.06$, $SD=.552$)* and post-intervention group *($M=3.19$, $SD=.666$); $t(99) = 1.98$, $p=0.237$*.
- Asking good questions for the pre-intervention group *($M=3.10$, $SD=.488$)* and post-intervention group *($M=3.28$, $SD=.559$); $t(104) = 1.98$, $p=0.055$*.

The results for asking good questions might be due to PSTs not considering the practice of asking good questions a strategy to better understand parents' concerns or not having the skills to ask good questions of the parent avatar and, hence, finding that the simulation experience did not support the practice of asking good questions. With regard to engaging with parents/ families from diverse backgrounds, it is plausible that the number of scenarios PSTs experienced being limited to two was the reason for this result or there was possibly a lack of shared understanding of what "diversity" in relation to parents and families encompasses.

Emergent themes

This section describes the emergent themes identified from PSTs' comments about their experience with the SIMLab™. The perspectives reflected in these themes were consistent with findings yielded by quantitative analysis of the survey data in the previous section.

Developing greater awareness of initial actions and reactions. Acknowledging the difficulty they had coping with a given scenario was a good starting point for some PSTs during their initial experience within the SIMLab™.

They accounted for their response in terms of cause-effect interactions, realised specific aspects about themselves or their responses that they needed to work on or found wisdom in their initial actions.

> I found it hard to think on the spot. The parent was rude and I needed to take control of the situation, outline the actions in place.
>
> The first time round I stuttered and stammered, and didn’t know where to lead the conversation.
>
> I think I need more practice on handling difficult situations. Because this was my first time and I did not know what to expect, I was really stressed. Although I had planned the way I was going to introduce myself and thank the parent for coming, I started the interview by trying to solve the problem straight away.
>
> In the first interview, I was unable to speak very much but I think that was a good thing. It allowed me to realise the importance of initially, letting parents say what they want and be heard. That way, when you try to work with them to come up with a solution, they are more likely to be calm and want to work with you.

Building confidence within a safe environment. PSTs observed that the process of managing challenging scenarios helped to build their confidence in their ability to engage with parents. That confidence was tied to their awareness that there were no real-world repercussions for failure which made the simulation environment a safe space for them.

> You are able to build your confidence with handling difficult situations and trial de-escalation strategies in a safe learning environment.
>
> Building confidence in myself to ask questions and help parents.
>
> It was very overwhelming at first, but toward the end I became more confident and managed the situation to the best of my abilities.
>
> To respond and acquire feedback in a safe space, rather than the first time we are expected to speak to parents as teachers about a students[sic] progress.

Trialing strategies. Following the initial simulation experience, PSTs had a feedback cum coaching session with a lecturer/tutor before their second simulation experience. PSTs found that they benefitted from this session as they were armed with a structured approach such as Situation Action Outcome (SAO) or Inform/Inspire, Show/Share, Try/Transfer, Apply/Action, Review/Revise (iStar) that they could then deploy during their second simulation experience. This structured approach enabled students to plan their responses and stay focused on the task at hand rather than react to the parent avatar’s words and behavior.

> I had a debrief with [lecturer/tutor] and we discussed the Situation Action Outcome framework for my next attempt. I thought about Max’s perspective as a parent and what information I could provide him about his child Ethan and how to reassure him that I am monitoring his child’s academic and social development and will maintain communication with him in regards to this.
>
> It was really noticeable to me how my responses differed between reactive initially and proactive when armed with some strategies to address yhe[sic] parenr[sic] character.
>
> It allows you to trial your ability to respond in real life situations with parents and also helped me to compare the scenario when a more structured approach to the parent was used through implementing the istar model. Highly recommend this experience to all students.

Learning through the coaching, reflection and practice cycle. The learning process within which the simulation experience was embedded ensured that PSTs received coaching and feedback that was relevant and timely and that they had the opportunity to reflect on the advice and feedback they received to improve their practice during the second simulation experience.

> This experience allowed me to make mistakes the first time, be coached and to practice again a second time to practice immediately what I just learned - it was great.

> I think its[sic] really wonderful to have [lecturer/tutor] there to provide some pointers for how to handle the situation. The advise[sic] she gave was really useful and then being able to implement it straight away was also really helpful.
>
> [D]oing the simlab twice was really good for reflection and implementing new strategies that could assist the outcome of the meeting.
>
> The initial interview was quite confronting, however on pausing to reflect on different strategies to use when engaging with irate parents/carers the second interview went a lot smoother.

Discussion

The findings shed light on PSTs' perspectives regarding the affordances of SIMLab™ in relation to how it helps to build their confidence in their capacity to conduct the conference sessions with parents and manage challenging scenarios. They also highlight how much PSTs value the opportunity to practise their strategies in an environment free of real-world repercussions and on the multiple opportunities to trial and practise different strategies with parents of different students with different learning needs in order to build a knowledge bank of situation-specific strategies that would be of use to them in future. While the simulation itself did not afford opportunity for feedback, coaching and reflection, it provided students with a hitherto unexperienced scenario which they could draw on to consider possible strategies for effectively engaging parents in conversations about their children.

The findings also revealed the importance of strategic integration of a simulation within the learning process. It was the immediate follow-up in terms of feedback and coaching by the lecturer/tutor and reflection on the PSTs' part between their enactments within the simulated environment and the opportunity to immediately put into practice what they had just learnt through coaching and reflection that PSTs found most beneficial to their professional growth. PSTs also observed that just-in-time information from a knowledgeable other (Vygotsky, 1978) in the form of a structured approach or strategies such as Situation Action Outcome (SAO) or Inform/Inspire, Show/Share, Try/Transfer, Apply/Action, Review/Revise (iStar) helped guide their development and application of strategies for communicating with parents.

Implications

The survey data illustrates PSTs' favourable perceptions of their SIMLab™ experience and the affordances of the SIMLab™ for learning how best to interact with parents during parent-teacher conference sessions. While there are limitations to this study in that the data are drawn from PSTs' experience of one simulation platform, the goal of this pilot study is not for PSTs to place their faith in a specific technology or in simulated experiences in general but for them to build their capacity to manage a range of scenarios revolving around parent-teacher interactions. To this end, the most pertinent implications for integrating mixed reality simulation platforms in ITE relate to the extent to which it supports practice and reflections on practice.

For practice within SIMLab™ to inform PSTs' learning, a degree of verisimilitude is required. Given that anthropomorphized avatars are better able to establish social presence (Blascovich, Loomis, Beall, Swinth, Hoyt & Bailenson (2002), the "human-in-the-loop" functionality affords anthropomorphizing of avatars through human interactors, who control the avatars, ensuring that the dialogue is consistent with real-world interactions and portraying human-like traits. However, more in-depth studies on the nature of verisimilitude that facilitates PSTs' immersion in practice needs to be examined. Beyond interactional verisimilitude, other contextual aspects which usually inform parent-teacher conference sessions need to be considered as these help enhance the authenticity of the simulation experience. For example, some PSTs suggested that more details on the scenario such as time of the year, the child's grades and background information on child and family would help them prepare for the simulation experience in the same way that teachers prepare for their meetings with parents. Ultimately, the aim is to delineate clearly the configurations of virtual and real elements that would support effective enactment of and engagement in practice.

Rodgers (2002) distilled four criteria characterising John Dewey's concept of reflection that can inform the use of the SIMLab™ as a means to support reflections on practice. The SIMLab™ experience aligns with these four criteria to varying degrees. First, PSTs were engaged in a meaning-making process about their actions and reactions (which over time become habitual practices) in parent-teacher interactions. More scaffolding in the reflection process is needed to guide PSTs towards using this greater awareness as a first step towards understanding their own motivations and how these are shaped by prior experiences and their own ideas or expectations about parent–teacher interactions. Second, PSTs were provided with models they could use to engage in reflection systematically. There is, nevertheless, room for more rigorous engagement in reflection as the quality of the reflections across the cohort varied. Third, PSTs' reflections were supported by their interactions with a more knowledgeable other. On top of that, opportunities to discuss their reflections with other PSTs could help PSTs view their experience through a different lens. Finally, PSTs acknowledged the professional growth they experienced from the SIMLab™ experience. A broadening of PSTs' reflection focus would facilitate considerations of personal and intellectual growth.

The current pilot study and its findings have shed light on PSTs' initial perspectives on their experience of using a mixed reality simulation platform and have highlighted important considerations in terms of how such platforms can be effectively integrated in the learning process to support practice and reflections on practice. Planned analyses in future will focus on the discourse of PSTs to provide insights into how the strategies that PSTs talk about are enacted in-situ.

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Fostering interdisciplinarity through blended learning

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Many of the complex problems we face in the 21st century necessitate an interdisciplinary approach. However, most university curricula still prioritize discipline-focused education. There is, therefore, an urgent need to train students to deal effectively with such real-world problems. To foster interdisciplinarity, we implemented blended learning in a mandatory PhD course which has so far relied on didactic modes of instruction. For one of the topics in the course, we included various online activities, e.g. micro-lectures, asynchronous forum discussions, instructor and peer feedback, which were designed to help prepare students for summative group presentations. When we analysed their presentation scores, we found that they had performed better on the topic supported by blended learning than the one that followed the traditional didactic format. The survey and interview responses suggested that the instructor feedback, peer feedback and micro-lectures promoted interdisciplinary thinking. Even though students did not like using the forum to discuss their projects, they agreed that the instructor's contributions to the forum discussions were helpful in guiding the interdisciplinary conversation. Overall, our findings suggest that blended learning helps to promote interdisciplinarity in the postgraduate classroom.

Keywords: PhD students, interdisciplinarity, blended learning, instructor feedback, peer feedback, micro-lectures, forum discussions

Introduction

A traditional Doctor of Philosophy (PhD) programme trains its students to become highly specialized and independent researchers, usually in a particular field or discipline. However, solutions to complex 21st-century problems require input from multiple disciplines. Examples of such complex problems include climate change, renewable energy, public health, and sustainability. To prepare students for careers that may call upon them to address such complex problems, they need to be trained to be bold enough to transcend disciplinary boundaries and situate their work in broader contexts. In other words, PhD students should be given opportunities to engage in interdisciplinary learning.

The ability to think innovatively and across interdisciplinary boundaries has been identified as a key skill by those calling for a reform of doctoral programmes, along with other skills that the authors identified as being essential for the 21st-century PhD holder, e.g. creativity and self-directedness, competence in epistemology and sound research conduct, commitment to high ethical standards and teamwork, and effective communication and leadership. The overall goal of such reform would be to train students to be thinkers rather than just specialists (Bosch & Casadevall, 2017). Simply put, the "Philosophy" needs to be put back into "Doctor of Philosophy" (Author, 2019). Further, it has been suggested that to create powerful learning experiences for PhD students in a revamped curriculum, the above elements need to be combined with passionate student engagement and genuine meaning-making in an active learning context (Bosch & Casadevall, 2017).

At the National University of Singapore's Graduate School for Integrative Sciences and Engineering (NGS), we endeavour to foster a spirit of interdisciplinarity in our students through our interdisciplinary curriculum. As part of their mandatory coursework, our students have to complete a course titled "Interface Sciences & Engineering", which is meant to expose them to various research areas, including some of the complex problems mentioned above, i.e. climate change, renewable energy, and sustainability. However, this course has traditionally relied upon didactic instruction and assessment modes that primarily test a student's content knowledge. As a result, the learning becomes more passive than active. This focus on content also makes it less likely that they will cultivate skills essential for interdisciplinarity, such as collaboration and communication. According to Repko and Szostak (2017, p.21), interdisciplinarity is defined as a "process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline, and draws on the disciplines with the goal of integrating their insights to construct a more comprehensive understanding". Moreover, our students' tendency to be reserved during face-to-face sessions (which seems to be a general observation in the Singapore context) will further inhibit collaborative discussions.

To promote interdisciplinarity in the above course, we decided to implement blended learning as an instructional mode to deepen students' learning both inside and outside the classroom. Blended learning is defined as the "organic integration of thoughtfully selected and complementary face-to-face and online approaches and technologies" (Garrison & Vaughan, 2008). We believed that this instructional mode would help us transcend the limitations of our traditional classroom setting (De George-Walker & Keeffe, 2010). In the new format, students would watch micro-lectures on interdisciplinarity and participate in an asynchronous discussion forum designed to promote collaborative dialogue between students. In addition, the online environment would permit the exchange of feedback between peers and between the instructor and the students. Feedback is defined as "information used by a learner to close the gap between the level of his performance and the reference level" (Ramaprasad, 1983). Students like peer feedback because it strengthens their learning and augments their understanding (Ertmer et al., 2007). When students share feedback with their peers, they grow and learn from each other, which in turn facilitates co-construction of knowledge (Roehler & Cantlon, 1997). As feedback is important to student learning (Hattie & Timperley, 2007), we felt that it would facilitate the interdisciplinary learning process and thus guide them towards attainment of the module's overall learning objectives. Collectively, we believe that blended learning will help to promote deeper learning and nurture the skills essential to interdisciplinarity.

Problem statement

To prepare our students for the needs of the real world, they need to be trained in the process of interdisciplinarity. However, our compulsory interdisciplinary module has so far not explicitly taught them how to be interdisciplinary because it has relied upon didactic instruction and prioritized content knowledge in its assessments. As a result, students fail to collaborate well on their assessment tasks. To create opportunities for interdisciplinary discussions in a "safe" environment outside the classroom, and thus promote more interdisciplinarity, we have introduced blended learning into the module. We expect that this intervention will help our students tackle their assigned problem at a deeper level. We also expect the intervention to help develop their confidence for subsequent face-to-face discussions with their peers and instructors.

Purpose of study

The purpose of this study was to investigate the effects of blended learning on our students' ability to engage in interdisciplinarity. In particular, we wanted to examine whether online micro-lectures, forum discussions, instructor feedback, and peer feedback helped to improve their performance on group presentations.

Research question

Would blended learning facilitate interdisciplinarity amongst students enrolled in a compulsory interdisciplinary module and help improve their performance on the summative assessment task? [Interdisciplinarity was assessed through (1) a customized grading rubric, and (2) an analysis of discussion forum posts.]

Methodology

Participants

This study was reviewed by the National University of Singapore Institutional Review Board and found to be exempt. All data used are anonymous and cannot be linked to individual students. All twenty-seven PhD students who participated in this study were enrolled in a core interdisciplinary module. The topic that followed the traditional format lacked any online activities, while the redesigned topic consisted of both online and face-to-face sessions. The online component was delivered through the university's learning management system.

Design and procedure

A mixed-method, quasi-experimental approach was used to assess the effectiveness of blended learning. Topic 1 of the module followed the traditional format in which a two-hour didactic lecture was followed by face-to-face group presentations one week later. In contrast, Topic 2 involved our students in various online activities during the intervening week, such as micro-lectures, asynchronous forum discussions, and instructional scaffolding in the form of instructor and peer feedback. The online tasks culminated in face-to-face group presentations. We compared students' presentation scores from the scaffolded topic with presentation scores from the un-scaffolded topic. To better understand students' perceptions about our interventions, we conducted a survey after completion of both topics and interviewed selected students. (The survey and interview guide included questions on the effectiveness of the blended learning environment, micro-lectures, forum discussions, instructor and peer feedback, in promoting interdisciplinarity). We designed the survey and interview guide ourselves, based on existing guides on research methodology (Kelley, Clark, & Brown, 2003; Rowley, 2013). Some questions were based on Repko and Szostak's definition of interdisciplinarity and corresponding model of the Interdisciplinary Research Process (ref), while others were based on key differences between the traditional and blended learning modes.

Data analysis

Students' presentation scores were analysed using the *R* software (RCoreTeam, 2018). A Welch two-sample t-test was performed to test for any significant difference between the mean score of the Topic 1 presentation and the mean score of the Topic 2 presentation. This t-test was also performed to compare scores that students had earned on individual components of the grading rubric. We tabulated the results of the survey. For each survey item, we calculated the percentage of responses for each answer choice. Interview notes were analysed for common themes. Interview responses were compared to the survey data to reveal correlations.

Results

Presentation scores

Since we wanted to find out the effect of our interventions on students' learning outcomes, we compared their presentation scores for Topic 1 (un-scaffolded) and Topic 2 (scaffolded). Students scored a mean of 75.50% on the first presentation and 80.34% on the second presentation. The t-test showed that students' scores on the scaffolded presentation were significantly higher than those for the un-scaffolded one ($p<0.001$). We also investigated which of the individual rubric components gave rise to such a difference by running t-tests on the five components. Students performed significantly better for *organisation* ($p<0.001$) and *interdisciplinarity* ($p<0.001$) for the scaffolded topic.

Survey and interview results

Micro-lectures vs. traditional lectures
Most students agreed that the micro-lectures prepared were clear and effective in explaining the topic content and they were able to list some important points of the lecture. However, they were ambivalent about whether they preferred micro-lectures to traditional lectures, with only 48.2% agreeing that they liked micro-lectures more than traditional ones. When interviewed, students revealed that they liked micro-lectures because they were convenient, and they could re-watch parts they did not understand. However, they were indifferent because they also liked the face-to-face interactions of traditional lectures where queries could be answered immediately.

Instructor and peer feedback
Almost all students agreed that the instructor's feedback on their presentation outlines was helpful and that it helped promote interdisciplinary thinking. Students overwhelmingly agreed that peer feedback was helpful in helping them improve their work. All the students agreed that they welcomed feedback from their peers. Most students felt that receiving feedback helped them think in a more interdisciplinary manner, and that they took these comments seriously. The majority made changes to their work in response to feedback. Most students also agreed that discussing feedback received with their own group members made them reflect more on their own work, and that the feedback given by their peers was helpful. [The traditional mode of Topic 1 did not feature instructor or peer feedback of the kind that was provided in Topic 2.]

Forum discussions
Generally, students did not like using the forum to discuss their projects. Only 29.6% agreed that the forum was a good platform for collaboration. Nonetheless, they agreed that guidance provided by the instructor helped to improve their discussions. 59.3% of them thought that the initial prompts provided by the instructor on the forum helped to scaffold their discussions. 63% of them agreed that the instructor's contributions to forum discussions was helpful in guiding their interdisciplinary conversations. The interviewed students revealed that the way forum posts were displayed by our learning management system (LMS) made it difficult to keep track of the discussion. They preferred more instant and user-friendly modes of communication such as instant messaging applications or the collaboration functions on Google Documents. Many revealed that they conducted discussions elsewhere and posted the most relevant posts from those external discussion platforms on the LMS forum merely to document their progress.

Blended learning
Most students agreed that blended learning was overall beneficial and said that they preferred it to traditional modes of learning. A majority of students thought that blended learning helped them learn better, with 63% agreeing that they learnt better through such a format. 59.3% agreed that it helped them take more ownership of their learning. Most students agreed that these activities were more effective at fostering interdisciplinarity than the traditional format. 66.7% of them believed that they were better prepared for their presentations as a result of blended learning. Most students agreed that a blended learning approach would ultimately be more suitable for this module than the traditional format. Most students agreed that they enjoyed the blended format more. Interestingly, during the interviews the students revealed that blended learning was a better instructional mode despite the heavier workload.

Discussion

We conclude that blended learning contributed to our students' improved overall performance on group presentations. Furthermore, it was the "interdisciplinarity" and "organisation" components of the grading rubric that accounted for the improved scores.

An analysis of survey and interview responses suggest that the interventions that enhanced interdisciplinarity were the instructor and peer feedback, forum discussions, and micro-lectures. The benefits of teacher feedback have been well-studied, especially in helping to improve student understanding (Kluger & DeNisi, 1998; Ponte, Paek, Braun, & Powers, 2009), but the effect of instructor feedback on online platforms has only recently been investigated. According to Guo, Chen, Lei and Wen (2014), good instructor feedback improves online cognitive engagement. In our case, blended learning helped elicit better responses and thinking by students. Providing online feedback to fellow team members as well as to other groups, accompanied by the improvements that they made based on such feedback, are examples of "social reflection" and "articulation" (Herrington & Herrington, 2006), recognised as being important ingredients for authentic learning and collaborative knowledge creation.

Even though the forum discussions were not as popular with the students as we had hoped, we found that the forums were constructive to some extent. The online forum allowed students to analyse and share information with their group mates in a more organised manner because through forum threads and headings, students could keep track of all the ongoing discussions. While they might not have liked using the forum, there was some evidence of this organisation from their forum headings. Even if students used other platforms to complement their work, they were also digital, rather than face-to-face, suggesting the effectiveness of integrating technology into learning. The online platform facilitated discussions as students could respond to their peers at their own convenience, and present evidence (e.g journal articles) to back up their assertions and make their points better. All this made their responses clearer and more effective than a face-to-face conversation. Moreover, the instructor could interject by asking probing questions, guiding them towards clearer thinking or drawing their attention to issues they may have neglected. Nevertheless, we are currently exploring ways to further enhance these forum discussions.

Due to timetabling constraints, we were not able to follow up comprehensively on the micro-lectures in class, and thus what we had was not a fully flipped classroom but merely a form of blended learning (Reidsema, Hadgraft, & Kavanagh, 2017). A flipped classroom format which combines the best of both worlds would appeal to more students, on option which we are considering for future iterations of the course.

Our study advances the field of interdisciplinary doctoral education by demonstrating that blended learning is more effective than traditional didactic lecturing in fostering interdisciplinarity. What we found most encouraging was the fact that learning gains were achieved even though students faced a heavier workload under blended learning. Apart from blended learning, we intend to further augment this interdisciplinary module by incorporating authentic learning elements (Herrington & Herrington, 2006) that will help students to cultivate the skills that are essential for interdisciplinarity. In addition, we believe that we should also teach students *how* to be interdisciplinary, in other words they need to be taught interdisciplinarity as a process. We thus intend to ground our teaching in interdisciplinary research theory (Author, 2019; Repko & Szostak, 2017).

In conclusion, we believe that our findings will be relevant to ongoing efforts to reform PhD programmes. The results of this study will guide us as we revamp the rest of this module as well as other modules within our curriculum. Even though these results are based on a single course, we believe that they can be generalized to other courses as long as the group composition and learning objectives are similar. Further studies will help to validate our findings and refine the pedagogy used so as to achieve more effective learning outcomes.

Thus, our findings may be useful to those who are keen to enhance their interdisciplinary curricula, at both the undergraduate and postgraduate levels.

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The semi-formal benchmarking of TEL practice: Helping the TEL community get its act together

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Over the last year, two major sector-wide events were held that have brought together technology enhanced learning (TEL) professionals from across the country to semi-formally benchmark their practices in the use of new and emerging technologies. These events have focused on major trends with technologies such as virtual and augmented reality and the use of the Office O365 suite of tools with a special focus on the use of the Teams application. This paper reports on the findings of these two national Summits hosted and facilitated by Griffith University. The motivating force for these free Summits was to provide an open forum for the sharing of practice across Australian and New Zealand universities. The data gained through the formal evaluations of these activities indicated that the collegial nature of these events has assisted in stimulating an openness and willingness to share examples of good practice seen across the sector. This form of semi-formal benchmarking is both appreciated and highly valued as TEL professionals seek to push in to new territories and provide opportunities for this community to further share their practices.

Keywords: Semi-formal benchmarking, TEL, Teams, O365, Virtual and augmented reality

Introduction

Benchmarking comes in many forms within higher education (HE) and has become a central instrument for improving the performance of institutions across the globe (Al-Khalifa, 2015). When used effectively, it can help institutions position themselves within the highly competitive higher education environment (Epper, 1999). The Australian Tertiary Education Quality and Standards Agency (TEQSA) defines Benchmarking as:

> A structured, collaborative learning process for comparing practices, processes or performance outcomes. Its purpose is to identify comparative strengths and weaknesses, as a basis for developing improvements in academic quality or performance. Benchmarking can also be defined as a quality process used to evaluate performance by comparing institutional practices with identified good practices across the sector (TEQSA, 2019).

Benchmarking was adapted more specifically for use in HE in the early 1990s in the USA, then in Australia, the UK and Europe by about 2000 (Jackson, 2001). From this point on, benchmarking has been used consistently in the Australasian HE sector as a continuous improvement tool, primarily in response to the government introducing a series of quality standards (Bridgland & Goodacre, 2005). However, benchmarking is not one common set of practices, rather Bhutta & Huq (1999) suggest that there are many models currently in use, including: Performance Benchmarking, Process Benchmarking, Strategic Benchmarking, Internal Benchmarking, Competitive Benchmarking, Functional Benchmarking and Generic Benchmarking. In addition to this list of benchmarking models, Collaborative Benchmarking is a newer model that has subsequently emerged and would share many of the features found in some of these models (Sankey & Padro, 2019).

Semi-formal Benchmarking is similar to, but simpler than Collaborative Benchmarking which is the structured comparison of a process or organisation with others engaged in similar activities relevant to the domain being measured (Sankey & Padró, 2016). It is used to create a shared understanding about the needs for improvement (Arnold, Rush, Bessant & Hobday, 1998), without having to use a formal instrument for the measurement of outcomes. For the two case studies described in this paper, Semi-formal Benchmarking involves people (representing their HE institutions) formally coming together from across Australasia, with the express purpose of both sharing their practice and to learn what others are doing around a specific topic. Unlike a conference or workshop, the intent is to improve 'institutional' understanding and practice.

The two events

In 2019, two higher education summits were hosted by Griffith University. The first Summit was held in February and was the 'AR + VR + MR + XR = #anewreality' Summit. This was a two day immersive learning event for colleagues who manage emerging technologies, and/or are leading institutional practitioners. This event was kindly sponsored by ACODE (the Australasian Council on Open, Distance and eLearning) with staff from 20 institutions attending. The second event was the 'Microsoft Office + Teams in Learning and Teaching Summit'. Its focus was on the use of a select suite of Microsoft tools including, Teams, OneNote, Sway, Forms, and Stream and was kindly sponsored by Microsoft. This event was attended by 16 universities. As both events where free for participants, institutions where asked to nominate up to two representatives who would be willing to share their practices, strengths and weaknesses. Information about these two Summits may be found at:

- #anewreality https://blogs.griffith.edu.au/learning-futures/learnings-from-the-anewreality-immersive-symposium/
- Microsoft Office + Teams in L&T Summit https://blogs.griffith.edu.au/learning-futures/lt-strategies-shine-at-the-griffith-microsoft-365-summit/

As these events were all about sharing current practice, we chose to limit the emphasis on 'Key Note' speakers, opting instead for a larger number of shorter, sharper presentations focusing on practice, not research. In other words, these were not academic research events, rather academic practice events focusing on pedagogy and what could be done with these tools to help fulfil the pedagogy being required.

Literature review

Noting this is an under theorised space prior to the Microsoft Summit, an environmental scan of the literature was conducted. Using Google Scholar, search terms included "Microsoft" AND "higher education" AND O365 which had 244 items listed. Table 1 shows the results of the search (with PowerPoint excluded due to the number of years it has been in use).

Table 1. Results of research articles on Office tools

O365 Tools	Articles total (n)	Journal (n)
O365	7	1
Teams	5	2
Sway	3	2
Forms	2	0
OneNote	7	1
Class Notebook	3	0
Stream	5	1
SharePoint	1	1

As can be seen from the above table, there are seven articles on O365, with six from conferences held in the past six years. Topics include moving staff to the cloud (Lyons & Parker, 2013), snapshots of software as a service (Akande & Van Bell, 2014; Stefanovic & Janjic, 2018) and security (Syynimaa, 2015). One paper was on learning and teaching (Ratnam, Sanghrajka, Su & Pawar, 2017). There were two journal articles about Microsoft Teams, one on using Teams with undergraduate law students (Martin & Tapp, 2019) and another general paper on social networking (Bello & Akpojaro, 2019) and four conference papers, all being from the past two years. Sway had two journal articles with OneNote having seven articles with just one journal article. The journal article was on a comparison of OneNote and Evernote (Dinesh, Sontakke and Tamgire, 2019), while another article was on using OneNote as an ePortfolio tool (Golz, 2018). This short literature review provides evidence to the gaps in the literature with evidence that the research in using these tools to enhance learning and teaching has promising possibilities, particularly using the tools for curriculum and integration, work integrated learning, reflective practice, employability and graduate attributes.

Methodology

Attendees of the #anewreality Symposium were provided a short five question evaluation survey that focused on intended practice after the event, rather than on 'was the morning tea nice', as we already knew it would be. The survey contained three closed response (scale based) and two open-ended response questions. It also provided participants with a way to possibly plan what they would do for their institution on their return. For example, question four asked: 'What are you thinking might be the next steps for you/your institution in relation to what you learned?' The open ended questions underwent a thematic analysis to understand the top emergent themes.

For the O365 Summit, the team was interested first in ascertaining how extensively the newer tools in O365 were being used prior to the event, which required running a pre and post evaluation. From the pre-survey, 53 participants submitted data, with 64.15% (n=34) Griffith staff and 35.85% (n=19) external to Griffith. There were 42 participants who completed the post-survey. Questions asked included Likert Scale questions about their experiences, as well as how they will apply an idea from the Summit into their work in the next three weeks, the most useful part/s of the Summit and what improvements could be included in the future.

Results and Discussion

The results are presented here in two sections, one with the first workshop of AR + VR + MR + XR = #anewreality and the second being the Microsoft Summit.

AR + VR + MR + XR = #anewreality

Of the 60 attendees across the two days, 32 responses were received (53%). Of these, when participants were asked 'To what extent did you find the event personally helpful to your practice' on a five point scale from 'Very Helpful', to 'Not At All Helpful', 84% responded 'Very Helpful' with the remaining 16% responding 'Somewhat Helpful'. There were no responses in the negative. Participants were then asked, 'Would you be interested in attending another event like this in the future?' to this 100% responded 'Yes'. The clear reason for this is seen in the responses to the next question, 'To what extent was the information shared applicable to your institution and its direction?', to which 78% felt that it had been 'Very Applicable', with the remaining 22% stating it was 'Somewhat Applicable'. No respondent chose 'Not Applicable'.

The next part of the evaluation asked participants to explain possible next steps for their institution, based on what they had learned. The responses can be categorized into five main areas:

- A desire to gain a greater technical appreciation and the formal trialing of what can be done.
- Wanting to see more institution support and buy-in from management.
- Creating a minimal viable presence within their institutions.
- Wanting to extend this network of practitioners and continue to share through some form of community of practice.
- Formalise a plan for their institution against some form of technology enhanced learning framework.

As a result of the extremely positive response it was decided that ACODE and Griffith would run a similar event in 2020. The analysis of the qualitative data has also provided key themes that will help to focus the 2020 agenda.

Note: A range of extremely useful resources were collated from this event, along with recordings of the main presentations. These resources are openly available for attendees or for others who might find them useful. They are available on the ACODE website and accessible from: https://www.acode.edu.au/mod/page/view.php?id=1663

Microsoft Office + Teams in L&T Summit

From the Summit pre-survey results, participants had been working in higher education from 0-2 years (n=6) through to 21+ years (n=5) with 6-10 years (n=15) being the largest cohort and 11-15 years (n=13) the second largest cohort. 85% (n=45) of the participants had been using Microsoft O365 prior to attending the Summit, with only 15% (n=8) not using it previously. From the eight not using it currently, five said they would be using it in future. Participants were asked what tools they currently use in O365 for learning and teaching, with more than one answer able to be checked (see Table 2).

Microsoft Teams was used the most with 88.8% of Summit participants using it and 73.3% of participants using PowerPoint. Other tools being used included OneDrive, SharePoint, Word and Excel, Minecraft and Planner.

Table 2. Number of uses of each tool with % of the participants

Tool	Number	% of tool	% of 45 participants
Forms	19	13.1	42.2
OneNote	21	14.48	46.6
ClassNote	8	5.52	17.7
PowerPoint	33	22.76	73.3

Sway	9	6.21	20
Stream	8	5.52	17.7
Teams	40	27.59	88.8
Other	7	4.83	N/A (Several reasons listed)

Participants were also asked what they would like to get out of the two day Summit with 88.7% of participants checking they would like to "learn about what others are doing". This is interesting as there was a lack of volunteers to present with many feeling it was early days and not comfortable presenting at the time. 75.4% wanted "to hear what's new and possible". Results are in Table 3 below.

Table 3. Reasons participants wanted to attend the Summit and percentage

	Number	**Percentage**	**Percent of 53**
Learn about what others are doing	47	20.35	88.7
Information on governance	14	6.06	26.4
Use case examples	35	15.15	66
Networking	29	12.55	54.7
To hear what's new and possible	40	17.32	75.4
To hear what Microsoft have to present	31	13.42	58.4
To see David Kellerman present	14	6.06	26.4
To find out how to start using O365 for learning and teaching	21	9.09	39.6

Of particular note here is the high percentage response rates associated with the value proposition associated with what one could call semi-formal benchmarking practice, that is 88.7% (Learn about what others are doing) and 75.4 (To hear what's new and possible). From the post Summit survey, participants were asked about their experiences (see Table 4) with participants "likely to apply this learning in my work" with a mean of 4.79. The Summit was hands on and "facilitators encouraged participant input" with a mean of 4.48.

Table 4. Post Summit survey results

	Mean	**Std Deviation**	**Number of responses**
I am likely to apply this learning in my work.	4.79	0.46	42
The Teams channel assisted me in this Summit.	4.33	0.75	42
The Summit included effective learning activities.	4.15	0.84	41
The facilitators encouraged participant input.	4.48	0.70	42
The facilitators knew their content well.	4.90	0.29	42
Did you get sufficient information to know what the other participating institutions were doing in this space?	4.39	0.76	41

The post summit survey had very high means, across all five items, which suggested that Summit participants gained a lot from attending the Summit. It was evident that more research into learning and teaching through the use of Microsoft is needed. Summit participants were really interested in keeping the community moving forward and another university offered a Sway webinar to improve group understanding of Sway. Other participants are also setting up other communities of practice around the tools provided. Further, a Teams space remains active, even though tenancy requires changing for externals.

The above results demonstrate the value of both events to the participants and a clear desire to participate in future events of this nature. Importantly, the lessons learned from these events are captured for others to continue to access and learn from.

Note: Resources from this symposium are still available on the Griffith website and accessible from: https://teledvisors.net/blog/2019/07/14/office365-and-the-griffith-summit https://blogs.griffith.edu.au/learning-futures/lt-strategies-shine-at-the-griffith-microsoft-365-summit/

Conclusion

The value of running semi-formal benchmarking events is ultimately seen in the worth placed on these by the participants, as seen in the above evaluations. It is not often in the sector that we have the opportunity to share practice at this level. The two events demonstrated that there is both a desire and willingness to share common practices and lessons learned with colleagues from other institutions. Although Griffith facilitated these events as part of their sector wide engagement, it is important that other institutions look to host similar activities in the future, as we are all in this together and the more we can share the pluses and minuses of our practices, the more we can improve practice and limit remaking mistakes. Here in lies the beauty of semi-formal benchmarking.

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The evolution of a micro-credential

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In 2017, key representatives from the University microcredentials team and the Library collaborated to develop, deliver and embed into curriculum, digital literacy micro-credentials in multiple course shells via the University's new learning management system. The first microcredential delivered was Information Literacy. This credential aimed to address student needs to recognise when information was needed and strengthen their ability to locate, evaluate, and use information effectively (ALA Clearing House, 2017). Students who earned the microcredential were rewarded with a digital badge that outlined the achieved learning outcomes and recognition of this award was reflected on their official academic transcript. In addition, the badges were shared on social media platforms like LinkedIn as a way to demonstrate new skills and engage prospective employers. In 2019, the original credential was reviewed to ensure relevancy. A subsequent eight-week sprint process was initiated. The review process sought feedback from various stakeholders that included the RMIT Creds team learning designer, the subject matter experts (SMEs) from the Library and student reviewers. Results from the review process for the Information Literacy credential highlighted key changes to content and learning outcomes to reduce confusion for students and ensure learning outcomes addressed the module content directly. In addition, a shift away from a traditional educational context of information literacy to a broader professional context was also recommended to ensure relevancy to industry.

Keywords: Information Literacy, digital badges, microcredentials, Higher education, Australia

Background

Figure 1: Digital badge 2018

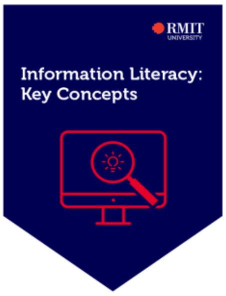

Figure 2: Digital badge 2019

The labour market is recognizing two types of skills that are important in the future of work. They include "soft skills" such as communication and team work, the other relates to the increasing importance of digital skills (OECD, 2017 p. 19). To support this notion, the Australian workforce also identifies transferable skills such as collaboration, digital dexterity, and critical thinking as essential elements. (Bentley, 2018). The OECD estimates that 14% of existing jobs will disappear over the next 15 to 20 years with over 30% undergoing radical change (Centre for the New Workforce, 2019). Educational institutions are fast realising that they must respond to this current disruption and produce work-ready graduates in order to stay relevant.

The RMIT credentialing program was developed due to various industry, university and government reports, recommending certification of skills gained through formal and informal learning in workplaces or other alternatives to traditional university study. As noted: "Employers are issuing a clear call to action for universities to integrate their offerings more tightly into the fabric of the world of work" (Gallagher, 2019). To emphasize this point, the Deloitte Access Economics report (2017), states that employers want graduates with both education and evidence of skills for employment. A report by Emeritus Professor Beverley Oliver, reinforces the notion that rapid innovation will displace the current workforce and the demand for higher cognitive skills such as creativity, critical thinking and complex information processing will be paramount for new and emerging roles (Oliver, 2019). In addition, the author outlines that microcredentials operate at the intersection of academia and industry and are seen as the bridge to achieve “better work-integrated learning and better learning-integrated work”. The author also emphasises the need for policy makers to provide strategic leadership in this space by supplying the resources needed for educational bodies and industry to capitalise on the opportunities that microcredentials present for upskilling (Oliver, 2019).

The newly formed RMIT Creds team have collaborated with key groups within the University and industry partners to develop multiple micro-credentials that address identified skills gaps. Ideation workshops and regular development meetings ensured both University and industry voices were heard and the content that was used was current and relevant. RMIT sees micro-credentials as an industry validated way for students to demonstrate skills and achievements that are transferable across sectors and careers. The badges and their associated metadata become evidence of competencies gained through life-long learning.

The following infographic represents what digital credentials mean to RMIT University.

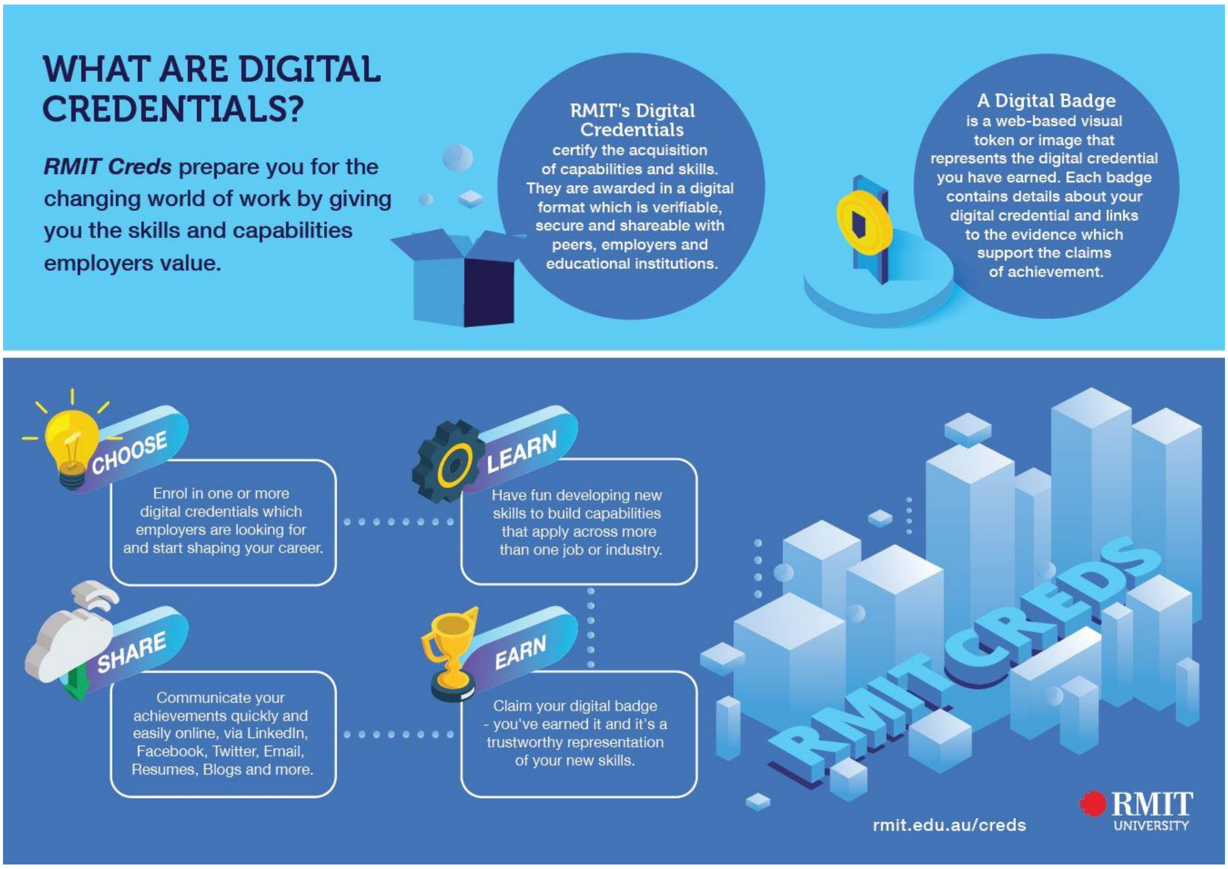

Figure 3: Infographic: What are digital credentials

One of the first partners of the RMIT Creds team and early adopters of the credentialing model was the RMIT Library. In 2017, the Library worked with the Creds team to develop a series of credentials that aligned with current Library resources for students. One of the products that resulted from this collaboration was the Information Literacy credential. This credential eventually became a foundational piece for a stack of digital literacy credentials. The Digital Literacy Stack evidenced skills in planning, writing, using data, understanding and identifying emerging technologies, repurposing and sharing digital content, creating digital artefacts and writing for digital environments.

The Information Literacy credential was selected to be developed first, on the premise that Librarians clearly recognise information literacy as a key set of abilities that require individuals to distinguish when information is needed and subsequently strengthen their ability to locate, evaluate, and use information effectively (ALA Clearing House, 2017). In parallel with a strong connection to the subject matter, the library developed original content, and sourced existing and additional resources for inclusion. Ultimately it was decided that the process of developing a microcredential was a smoother pursuit because of the convergence of these factors.

In a case study approach, we outline the process that was undertaken to deliver this microcredential to the University community.

The creation of a Cred: The design and development process

As an early adopter of the RMIT credentialing program, RMIT Library was one of the first divisions of the University to take part in the newly formed credential initiation, development and delivery process. The process began with the submission of a concept brief, followed by a product proposal outlining the skills, learning outcomes, target audience and industry partner, based on the initial idea. The proposal was then submitted to a central governance body that approved its development. This central governance body includes RMIT's Deputy Vice Chancellor - Education.

The RMIT Library developed a product proposal for a Digital Literacy stack/cluster that would focus on all aspects and skills associated with digital literacy. The proposed structure was based on the library's knowledge and understanding of the JISC Digital Literacy Framework (JISC, n.d.) which defines digital literacies as the capabilities which prepare someone for living, learning and working in a digital society.

As stated earlier, the Library's first development sprint began with Information Literacy. The reason for the selection was based on a pre-existing digital tool called iSearch, which delivered information literacy skills to students. This tool provided students with the capacity to find, evaluate, manage, curate, organise and share digital information. An important aspect for students was to interpret digital information for academic and professional/vocational purposes, and to review, analyse and represent digital information in different settings. The other aspect of skill development also included taking a critical approach to evaluating information in terms of its provenance, relevance, value and credibility, enabling students with the knowledge of information literacy to be equipped to find the information they need for any decision making process.

The University creds team allocated a learning designer who drove the discussion and creation of the credential over an eight-week sprint. Library staff self-nominated to be part of the development team and consequently engaged with elements of content writing, resourcing, design and referencing. All team members met once a week to discuss the framework and structure of the microcredential. Consequently, tasks would be allocated for completion by the following meeting. The execution of this work was very much an agile process, where the pace was rapid and the process was iterative for quick release.

The target audience for Information Literacy was RMIT students because it was considered an important foundational skill. The focus was aimed at commencing students, whether enrolled in higher education, post graduate or vocational education courses. The second focus group centred on those transitioning into the world of work. The anticipated learning outcomes were understandably centered in an educational context.

As at the end of Semester 1 2019, over 1,200 Information literacy digital credentials had been issued to enrolled students.

The Credential review process

In order to ensure that credentials remain relevant in the changing world of work, RMIT Creds, in collaboration with industry partners and the internal product owner (in this case RMIT Library), undertake a review of each cred every twelve to eighteen months. The cred is evaluated from a pedagogical and functional perspective. Automarked quizzes, moderated submissions and rubrics are all reviewed so that they align effectively with the credential's learning outcomes. Design features and the scaffolded content elements within a credential are also unpacked and critiqued to ensure flow and clarity. Student feedback is collated, and its analytics assessed to find potential indicators of the success or failure of the cred. The evaluation process is performed in collaboration with the learning designer allocated by RMIT Creds and conducted in an iterative and agile sprint cycle.

The Library recommended several reasons for the review of the Information Literacy Cred. The Library wanted to increase the skill point level from five to ten points to better reflect the complexity of the content. It also became evident to library staff that some learning outcomes did not effectively match the course content, which also created confusion for some students.

Information literacy emerges from the fundamental understanding in libraries that to critically engage with information, or to be "information literate" is to know when information is required and then be able to identify, locate, evaluate, organise and effectively use the information to resolve a need (Bundy, 2004). Bundy (2004) also alludes to the information literate person being one who uses these skills in workplace learning, independent learning and lifelong learning. The "common denominator" for all students when commencing University studies is the need to successfully access, organise, analyse, interpret, and reference information (Wright & McGurk, 1995).

The 2018 learning outcomes of the microcredential were based on this premise and had a focus on information skill acquisition in an educational context. The final four learning outcomes were only partially covered in the module and it became evident that other contexts would need to be included, such as personal or professional to address the true meaning of information literacy, support the learner from university into the world of work, and fulfil the impremada of microcredentials creating work-ready graduates (RMIT University, 2015).
(see Table 1.)

Table 1: Information Literacy 2018 Learning Outcomes

Articulate information needs
Search for data, information and content in digital environments
Create and update personal search strategies
Analyse, compare and critically evaluate the credibility and reliability of sources of data, information and digital content
Analyse, interpret and critically evaluate the data, information and digital content
Organise, store and retrieve data, information and content in digital environments
Organise and process data, information and content in a structured environment.

Information Literacy was reviewed in the last quarter of 2018 with a view to completing all updates before Semester 2, 2019. The newly revised and updated cred would then be embedded into the traditional curriculum through the Learning Management System as part of a program to insert information literacy skills-based learning into eighty-two programs. Academic staff were empowered to determine how they embedded the credential. Some made it compulsory, requiring evidence of completion from students by presentation of their digital badge. Some made it optional, some wrapped the credential with other pieces of assessment, and some allocated marks for completion. The embed process is currently undergoing review with a view of standardising the process and ensuring greater clarity for all parties involved.

Information Literacy: Key Concepts 2019

It is evident in literature that information literacy is a functional skill set that is helpful throughout a person's life, (Maass and Engeln, 2019) and an essential skill set with most jobs requiring some degree of research and an ability to access and use information. Studies have also suggested that a high degree of self-efficacy
equips individuals with the confidence and ability to drive lifelong learning. Information literacy is a clear underpinning skill that drives this type of enquiry within individuals (Demirel & Akkoyunlu, 2017).
People who understand information literacy are better able to search and locate information to solve problems with precision and accuracy. In today's workplace, employees must be able to conduct research to make smart choices about work tasks, finances, health or other significant decisions related to their jobs, education, families and roles in the community (CILIP, 2018).

A competitor analysis in the form of a review of similar offerings at Australian universities and their current approach to information literacy was performed as part of the research into how to improve the product and make it more relevant. The data that informed this analysis was collected through a literature and website review. It revealed that Universities generally took the educational/ academic approach when teaching information literacy and the majority of content was focused on library services, catalogues, information searching and referencing. A learning gap of information literacy outside an educational environment was identified - especially across health, lifestyle and workplace.

Student survey results also supported the view that students were looking for a learning product that would give them skills they could use outside university and in their future careers. As the review determined that approximately 60% of the content needed to be updated, the changes were treated like a new build and an entirely new credential was developed.

To disrupt the traditional academic approach, authentic learning that students could use and apply in the everyday context were introduced. Topics around Google search hacks, algorithms, filter bubbles and digital file management, were identified as relevant for today's students and tomorrow's workers. Additionally, learning how to interpret a task, identify keywords for searching, using online search platforms such as Wikipedia and Google Scholar, and developing a successful search strategy were included. Evaluating online websites for legitimacy using the CRAAP technique was also introduced (Wikipedia, 2019).

This approach aligned with the new learning outcomes developed to support the increase in points value of the credential and to reflect the shift away from the traditional educational context of information literacy to a broader professional context. (see Table 2)

Table 2: Information Literacy: Key Concepts 2019 Learning Outcomes

Identify and articulate your information needs for academic or professional purposes.
Develop, use and refine appropriate search strategies to locate relevant information.
Critically evaluate information for relevance, credibility and accuracy.
Retrieve, organise and store information and references in a digital environment.

The new microcredential, renamed "Information Literacy: Key Concepts" to differentiate it from its predecessor, was launched in June 2019. (see Table 2)

To date over 4000 students have enrolled in Information Literacy: Key Concepts. Though it is still too early to determine what the changes may mean for learners, student feedback sought during the development process of Information Literacy: Key Concepts was positive. "This will definitely be useful!" Since its release in June, 77% of 291 students surveyed said that what they learnt in Information Literacy: Key Concepts would be important for their future employment and 70% said they would be confident using the course to seek future life and work opportunities.

Conclusion

The experience of building, delivering, and reviewing a microcredential has been an absorbing learning experience from a collaborative point of view. Understanding student needs and synthesizing those needs with the needs of industry has broadened the scope and nature of what librarians and other university stakeholders deliver to their student cohorts. The involvement of institutional and industry partners has magnified the significance of the librarians' role in the digital literacy landscape, by casting a broader lens over the way digital literacy is delivered to our student cohorts. It is anticipated that moving from the educational context and illustrating the broader context of work and life will make the microcredential more meaningful to the recipient of the Information Literacy digital badge and create a more genuine experience for the participant.

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Integrating digital literacies through blended learning in a first-year undergraduate course

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The use of digital learning in New Zealand's tertiary and higher education opens up new opportunities but simultaneously raises concerns about students' digital literacies. In collaboration with two teachers, the researcher responded to digital information literacy demands in relation to the students' capabilities. The paper considers how integrated online resources were used to develop students' digital information literacy (DIL) in a first-year undergraduate course in Education and to enhance the blended learning in the course. Educational Design Research with three research phases as methodological approach supported the collaboration. Research instruments with students included questionnaires and focus groups; staff shared their experiences through interviews, meetings, emails and reflections.

Keywords: blended learning, digital literacies development, first year undergraduate study.

Situating DIL and blended learning in tertiary and higher education

As New Zealand tertiary institutions increasingly offer online learning in face-to-face courses (blended learning), one of the purposes of the research was to find out how to harness digital affordances for a blended learning design that encourages digital information literacy (DIL) development. With growing diversity and larger numbers of enrolled students in classes, online learning can open up possibilities to enhance students' learning (Mendieta Aguilar, 2015). However, the way blended learning (BL) is designed impacts on the implementation of learning and teaching and on the student experience. Although discipline-specific literacies development is essential for all tertiary students (Feekery, 2013; Gunn, 2013), little research exists about literacies development to address undergraduate course demands with blended learning. This study responded to the research gap.

With the growth of online learning, in general, there is a move towards independent study (Hughes, 2006). It implies that students now even more than before need to find and use digital information independently and critically as Lavoie, Rosman and Sharma (2011) point out. This research investigated how literacy development can be integrated to enhance students BL experience (Bernard et al., 2009; Gunn, 2013) by moving from posting information to include active learning online. Aspects relevant in tertiary learning and teaching were considered, including how teachers design for and integrate online with face-to-face learning and DIL development for studies and work (Schwenger, 2016a; Schwenger, 2016b). Students need to, for example, interpret and judge sources to then produce new information. They have to be aware of key information resources, identify the need for information, plan and search for appropriate sources, critically evaluate, organise, produce and present information (Gosling & Nix, 2011). As students engage with online information, digital information literacy (DIL) has become a standard demand (Hegarty et al., 2010; Hughes, 2006). This research understands DIL as one of six digital capabilities as defined by JISC, shown in figure 1 (2018), such as literacies, learning development, creating, problem solving, communication and collaboration. The JISC model recognises the interconnected nature of broader areas combined by an overarching focus on identity and wellbeing.

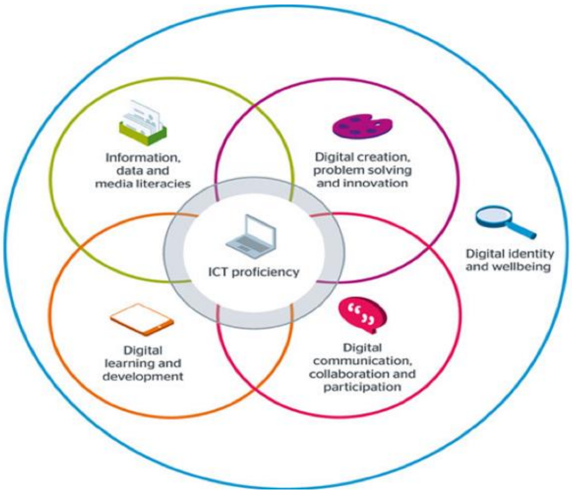

***Figure 1*: Six elements of digital capabilities (JISC, 2018).**

As digital information literacy (DIL) demands always emerge from a certain situation (Whitworth, Fishwick and McIndee, 2011), they result in a "socially situated set of meaning making practices" (Gourlay, 2009, p. 182). In this study, literacies development for students of Early Childhood Education is conceptualised as part of an explicit, situated experience that is integral for the learning process (Bent, 2013; Feekery, 2013; Secker & Coonan, 2013). It is based on the understanding that students new to tertiary study are in general unfamiliar with its standards and requirements (Cope and Kalantzis, 2010).

Background

The paper reports on one part of a doctoral study which investigated during 2016 how to design blended learning with digital information literacy (DIL) to support students' assessment in a first-year undergraduate course. The research questions relevant for this paper was "*How can teachers approach BL for undergraduate students to develop DIL?*". Learning support staff had identified that these students often presented with limited digital information literacy at the institutional learning centre when preparing assessments. The online resources addressed the quality and completion of the course assessment, an ePortfolio. The Bachelor of Teaching (ECE, Early Childhood Education) is offered at a New Zealand polytechnic and attracts a mix of students, including Māori, Pacific Islanders and Pākehā as the largest ethnic groups. The ages range from 17 to over 40 years old with many older students, often first-time and first-in-family to participate in formal tertiary education. The teachers involved in the research wanted to support their students with the institutional direction of offering more blended learning with increased online learning. The wider project team included library staff, Māori colleagues and ECE colleagues.

Research approach

Educational Design Research (EDR) invites iterative development with a phased, structured and reflective approach, is theory informed and aims at designing real-life interventions (Plomp, 2013). The research was conducted through a three phase model, informed by Plomp (2013) and included preliminary research, development and evaluation phase (Figure 2). Thirteen students and two teachers participated in the study during 2016. Students shared their thoughts through initial and final questionnaires and initial foci groups; teachers through initial questionnaire and interview, reflective prompts, emails and a final interview.

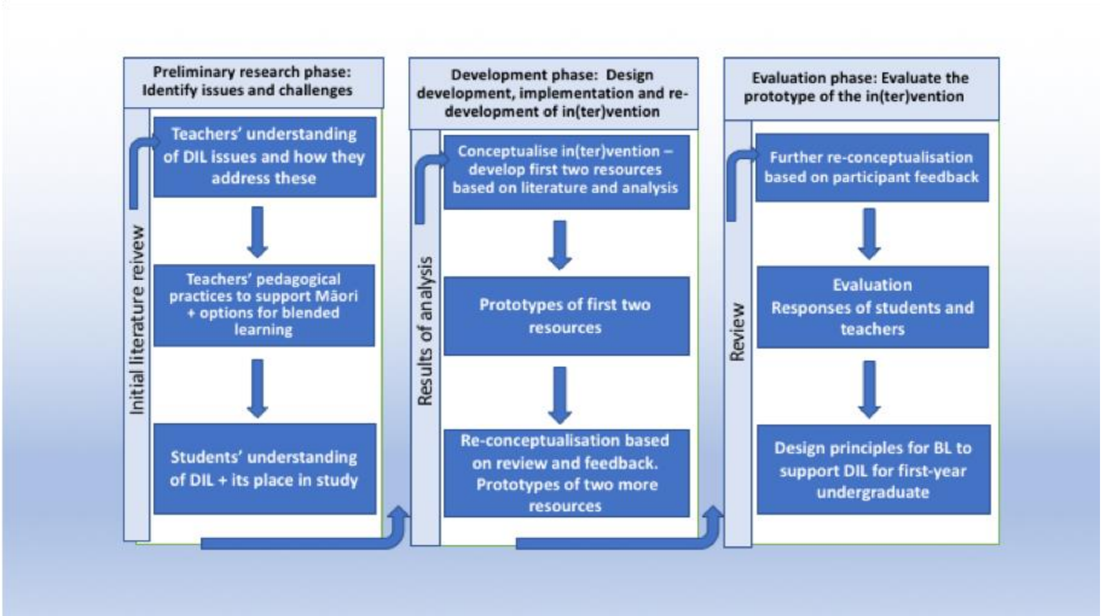

Figure 2: Overview of the three research phases in this study.

Students' DIL practices and assessment demands

The teachers reported that patterns from previous cohorts showed challenges related to the assessment such as inadequate literature. Teachers added after the research had started that many students seemed to consume information instead of adding new insights to existing knowledge. Findings from questionnaires and focus groups indicated that students struggled with evaluating, analyzing and synthesizing to create new information effectively in a digital learning space. Current research, for example by Gosling and Nix (2011), advises connecting any DIL development with the course content and particularly the assessment.

Discussion of findings

Embedding students' DIL through blended learning

Digital learning outcomes had been included in the course prior to the research as well as in Year 2 and 3 courses and provided an opportunity to address the DIL challenges of the ePortfolio assessment through integrating or embedding DIL. After I identified the DIL practices required for successful assessment and the teachers confirmed these, the online affordances of digital tools were considered to then design the student resources with practice and reflection opportunities. The resources were designed to encourage active learning by offering feedback and reflective questions with a focus on what students need to do to achieve the desired learning goals.

The content chosen for the DIL resources was based on the gap between the assessment demands and students' competencies. An initial literature review and first findings from students and conversations with ECE staff informed the first resource, the process of *How do I use information to develop my ePortfolio?* (Figure 3). The process underpins the portfolio compilation but had not been made explicit to students in the past. The process is non-linear and students might go through several iterations of certain actions. There are several occasions of evaluation, for example, students have to evaluate the sources and evaluate if the gained information is helpful to answer the query that underpins the assessment task in the ePortfolio.

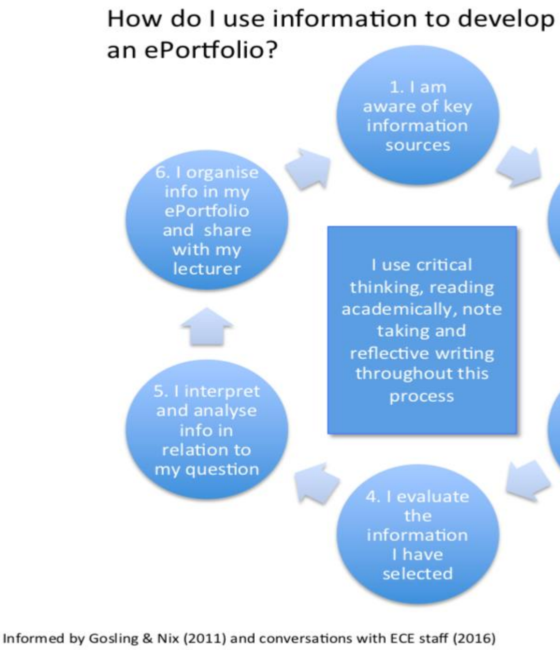

Figure 3: Process of using information for learning.

The first resource provided the information about the process and the actions required by the students combined with reflective questions to consider how to apply the information-handling practices and for what purpose. In the second resource, an ECE scenario with a Moodle Lesson, students could step through the actions to create an entry in their ePortfolio. They had to decide on an aspect related to each action and received feedback; in this way they could apply the complete process. A third and a fourth online resource were equally based on the process and included a quiz and an one-page overview with reflective pop-up questions and automated feedback. Combining these online resources effectively during the semester with the face-to-face learning and teaching emerged as one of the challenges for the teachers (Schwenger, 2017a; Schwenger, 2017b), however, the issues related to the blended learning design cannot be discussed further, due to the length of this article.

In the following, I discuss two areas of DIL challenges that have been important findings in the study.

Students' DIL challenges

Most students in the study seemed to plan and find information via the Internet and went to Google Search as their primary choice but did not mention difficulties in finding appropriate quality literature. Their preferences aligned with how Coonan (2011) describes students' behaviour to often first access the *"unordered, unverified, […] and seductively easy to use*" (p. 12) Internet instead of the library, the "cloistered garden of authorative, trustworthy sources carefully selected for their academic integrity" (Coonan, 2011, p. 12). Badke (2010) points out the required information might be outside the library catalogue. Whatever the exact reasons may be, students seemed more interested in finding the required information than in considering the tools for their search processes. The process and the resources therefore highlighted the importance of understanding the key sources and what information is needed as initial areas of work, based on the lack of quality literature as a key concern identified by the teachers.

Compared with the range of ideas of how students organised information in hard copy or digital, the students did not mention how they evaluate information. This seemed to indicate that they know less about strategies for evaluating as argued by Coonan (2011) and Feekery (2013). As a result of a gap in the existing library resources in terms of developing higher level practices of information handling such as evaluation and analysis, the resources considered how to scaffold students into these higher order functions of information handling. In a limited way, the resources aimed to contribute to this area by including the actions explicitly in the process and in the scenario. Questions were included for students to self-assess and reflect on the required actions, for example when paraphrasing the work of others. More needs to be done, though, to ensure students have the opportunity to improve these higher order functions of information handling in their courses. This raises the question of who is responsible for working with students so that they can enhance their DIL as they progress in the studies. Tertiary and higher education institutions have to work with their existing students, rather than the students we wish to have.

Contribution and limitations of the study

Although this article does not report the evaluation of the study, in the following some of the formative and summative feedback received are outlined. Teachers appreciated the explicitness of the resources and felt that connecting development with the assessment supported students' assessment success. The teachers reported anecdotal feedback from six students in the first semester who found the tools helpful. Feedback given on four ePortfolio assessments to students at the end of semester 1 showed a positive development in the use of literature in the ePortfolios. Feedback from seven students in a questionnaire at the end of the year indicated that the resources had been useful for their independent study, to develop the necessary actions of the process and successfully prepare the ePortfolio. The teachers confirmed several times explicitly how they valued the integrated online resources to foster students DIL capabilities. At the start of Semester 2, Teacher A reported that the literature in the assignments of the February intake in Semester 1 was of better quality. DIL was more explicitly discussed in the classroom in the first semester, including the introduction of the online resources, and it might have made students more aware of the importance to find quality information.

I recognise that the findings from students, in particular, are limited which is partially due to the small number of participants in each semester. The findings are from a particular situation; however, they can inform learning designers and teachers thinking about what influences learning design and what type of blended learning design can foster digital information literacy and support students' study success. It was an authentic experience, though, in a time of ongoing institutional change. The study contributed to our understanding of the complexity of change initiatives and collaboration and it touched on bigger issues related to digital literacies development that can be expected to surface similarly in other contexts.

Conclusion

The study was based on a holistic approach that recognises DIL development goes beyond skills to include attitudes, practices and behaviour and higher-order information handling practices. The students in the course benefited from DIL development to create new information for their ePortfolio assessment and add to knowledge rather than consuming information, which aligns with findings by Kennedy and Fox (2013). Although the study only seems to have scratched the surface of how students develop DIL through blended learning, it has identified that further work is required to find out more about developing students' digital information literacy effectively throughout their studies. Further work is needed to identify, for example, which areas to develop in the various years of study to staircase students' progression in DIL, who is responsible for developing literacies and how to combine online with face-to-face learning more strongly.

The DIL online resources, through their alignment with assessment demands, have supported the interconnectedness of learning and using information as described by Maybee, Bruce, Lupton, and Pang (2018). To develop DIL, generic one-off workshops, checklists for searching databases on the library website or bibliographic instruction might continue to be part of an institutional solution. Such stand-alone measures can fail, though, to actively engage students and are unlikely to address study specific DIL capabilities. The study findings highlight that integrating DIL within the content and assessment of a blended learning course can provide a vehicle to address DIL study challenges for all students. Furthermore, the study has shown that blended learning with increased online learning can offer new active learning opportunities to foster students' DIL situated in their field of study and at the same time is likely to enhance students' blended learning experience.

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Developing a DBR Model for Designing Authentic Healthcare Solutions: Mobile and Wearable Technologies

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This concise paper outlines the initial stages of a project involving a transdisciplinary team of educational researchers, practitioners, student designers, and the Auckland Hospital Design Lab in the design of innovative technology enhanced solutions to enhance patient and health care practitioner experiences. We outline the methodological design of the collaborative Design Based Research (DBR) approach. Using DBR, the project explores real world problems in health care with a team of student designers evaluating the application of mobile and wearable technologies to these problems. The goal of the project is the development of design principles for innovative learning environments that facilitate student-determined learning in real world scenarios.

Keywords: Design-Based Research, Authentic Learning, Heutagogy, Collaborative Assessment Design.

Introduction

Mobile and wearable technologies in healthcare have been identified as a significant research context driven by the almost ubiquitous ownership of mobile devices, and the predicted growth of social acceptance of wearable technologies (Rich & Miah, 2017). This is a real world context with problems that Universities can contribute towards authentic solutions. Initial explorations of the design of higher education courses in smart healthcare engineering indicate “positive impact on the learning process as well as a positive learning experience” (Rodić-Trmčić, Labus, Barać, Popović, & Radenković, 2018, p. 484) for students. This has led to establishing collaboration between hospital teams and university design teams to develop authentic health care solutions.

An example of the design problems that hospitals are ill-equipped to deal with is the identification of patients with restricted extremities. Restricted extremities refers to the restriction of access to upper limb(s) for drawing blood, obtaining intra-venous (IV) access or blood pressure (BP) monitoring. For example, patients with lymphoedema / AV fistula / thrombosis. Existing practice is to use a variety of colour coded wristbands, bracelets, compression sleeves and marking skin with either an indelible or surgical skin pen; each of these come with its own limitations and unanticipated adverse complications. Colour coding in particular presents a series of risks due to the lack of consistency in colours used to communicate specific clinical information across the different services in the hospital. Hence, the Health Quality & Safety Commission (HQSC) does not recommend the use of coloured wrist bands for any type of alert. An innovative solution providing an instant and effective visual alert is required to eliminate oversight of patients with restricted extremities in an environment that is over crowded with alerts of various shapes and forms. The end design solution should allow clinical staff to work and respond appropriately for these patients, providing better care and confidence for both patients and clinical staff.

The authors argue that Design Based Research is one approach to meeting the demands of these healthcare real world problems and designing authentic learning environments in higher education. Academics collaborating with students as designers in real world learning is a key element of educational design research (McKenney & Reeves, 2018), that is founded upon the principles of Design Based Research. Educational Design Research and Design Based Research are often used synonymously. These are the critical influences behind our project.

An Ecology of Wearable Technologies in Health Care

The project encompasses the exploration of several forms of visual (custom bands and watch faces), database-driven, multi-sensory input (such as voice, for example Siri) and feedback (visual, audio, proximity-based, and haptic) and biometric data (heart-rate sensing, fall detection, and ECG). Recent research validates the correlation between basic biometric data tracking and user/patient cognitive experiences (Aguayo et al., 2018).
Wearable technologies such as smart watches provide the basis for a customisable and unobtrusive approach to sharing patient information to a health care professional, via either the practitioners wearable device or their hand-held mobile device. A custom application will allow the health care practitioner to manage the notification data held upon a patient’s wearable device, and choose appropriate options to be activated on a patient’s wearable

device. This could include interactive patient notifications for; medications, directions, reminders, and alternative accessibility interaction from the patient via voice commands (for example Siri), and motion detection (for example the Apple Watch's built in fall detection). At a simple level, visual cues from the wearable device can take the form of custom designed and 3D printed colour-coded straps, and custom designed watch faces with select functionality for patient feedback and information. However, the use of wearable technologies opens up a wide variety of deeper and more flexible tracking of patient data. Some of the potential applications of wearable technologies in a health care context identified in an initial brainstorm include:

- Colour coded watch bands can easily identify the area of the patient's needs.
- Patients can be monitored either within the hospital or outside of the hospital thus reducing the needs of beds in hospital.
- If the patient has fallen over a wearable device can raise an automated alarm either within the hospital or away from the hospital.
- Blood pressure can be monitored automatically and sent to a nurse or central position.
- Notifications can be sent to the patient advising them of scheduled times for; medicating taking, exercise, appointments, location, navigation through unknown or unremembered environments (for example dementia or alzhiemers' patients).
- Family and friends can communicate with patients easily.

Research Questions

The problem of identifying restricted extremity patients is the first of many real world healthcare practice problems that the Hospital Design Lab have ear-marked for collaborative design with the University. As well as meeting the initial requirements of restricted mobility patients, the project aims to explore the wider potential of wearable and mobile technologies to enhance health care practice and the patient experience. The research questions underpinning the project are:

1. In what scenarios can wearable and mobile technologies most effectively enhance health care practice and the patient experience?
2. What are the design principles that can guide the development of authentic mobile learning collaborative student projects?

Methodology

The principal investigators (an academic advisor and an academic lecturer) bring a critical lens to the project team, and act as mentors and project managers to the student team. Through the Scholarship Of Technology Enhanced Learning (SOTEL) the project explores critical practitioner reflection on the design and implementation of technology enhanced learning environments founded upon learning theory. The project uses heutagogy (Hase & Kenyon, 2007) as a framework for designing learning environments that are student-centred and focused upon building student creativity, problem-solving, and life-long learning capabilities. Heutagogy builds upon the principles of constructivism (students build knowledge based upon prior experience), social constructivism (learning is a social process through which students build upon and extend their learning via learning from experts or more expert peers), and the importance of authentic problem based learning (real world projects), Heutagogy (a learning theory that focuses upon developing student capacity to navigate the unknown (Blaschke & Hase, 2015)) provides a theoretical framework for designing wearable and immersive learning environments that can impact student learning in a deeper way than traditional teacher-directed pedagogies. Heutagogy reframes teaching and learning as a collaborative endeavour between teachers or more experienced peers and learners, where learning is facilitated rather than mediated through teacher-directed content. The principles of heutagogy map closely to the core affordances of design based research (Blaschke & Hase, 2015), and provide initial principles for the design of authentic learning environments to facilitate student-determined learning that builds student capacity to problem solve and develop practical solutions to real world problems. Heutagogy can also be applied to patients' experiences. In this sense the project aims to empower patients through self-led action, within the ethical and safe practice limitations of the Health sector.

Design based research provides a structured, four-phase iterative framework (McKenney & Reeves, 2012) for designing interactive wearable and immersive reality (XR) learning environments for health education (Cochrane, Cook, et al., 2017). The four phases of the project are:

Phase 1: Analysis and exploration - Identification of the healthcare practice problem and the critical issues surrounding the application and design of authentic interactive wearable and XR learning environments, and exploration of supporting literature to identify initial design principles to address these issues.

Phase 2: Design and construction - Prototyping of the design of an interactive wearable and XR learning environment and healthcare practice intervention informed by the identified design principles.

Phase 3: Evaluation and reflection - Evaluation of the prototype interactive wearable and XR healthcare practice design through user feedback (Clinicians and volunteer patients), and refinement of the design principles.

Phase 2-3 Loop: Iterative redesign and re-evaluation of the prototype interactive wearable and XR healthcare intervention.

Phase 4: Theory building - Development of transferable design principles and dissemination of findings.

The project participants (outlined in the project team details table 1) comprise a collaborative transdisciplinary team of researchers, practitioners, student development team and the Auckland Hospital Design Lab. The project builds upon prior research in the application of mobile technologies for enhancing health care education (Aguayo, Cochrane, & Narayan, 2017; Aguayo et al., 2018; Cochrane, Cook, et al., 2017), particularly within the domains of critical care (Paramedicine) (Cochrane, Stretton, et al., 2018), nursing (Cochrane, Aiello, et al., 2018; Cochrane, Stretton, et al., 2017), and physiotherapy (Cochrane, Stretton, et al., 2018; Stretton, Cochrane, & Narayan, 2018). The project also builds upon prior research on the redesign of the visual design curriculum facilitating authentic student learning experiences through XR technologies (Sinfield, 2018; Sinfield & Cochrane, 2018).

Table 1: Project team details

Team Member	***Organisation***	***Role in research project***
Auckland Hospital Design Lab Manager	Auckland Hospital Design Lab	Overall project management
Auckland Hospital Clinical Staff	Auckland Hospital	Owners of the design intervention problem
Academic Advisor	Auckland University of Technology, Centre for Learning And Teaching	Principal investigator, educational technologist and student supervisor
Academic Lecturer	Auckland University of Technology, Art and Design	Co-Principal Investigator and academic/student supervisor
Research Fellow	Auckland University of Technology, App Lab	Coordinator of App Lab immersive reality application development team
Student 1	Auckland University of Technology, Art and Design	Student team leader
Student 2	Auckland University of Technology, Art and Design	Visual Design
Student 3	Auckland University of Technology, Colab	App Developer
Student 4	Auckland University of Technology, Art and Design	Prototyping Design

Establishing the Research and Design Team

The principle investigators have collaborated on several innovative curriculum design projects enhancing studio-based learning environments with mobile and immersive reality technologies (Sinfield & Cochrane, 2018). This led to the identification of health practice problems as real world design scenarios for student teams, and brokering of a potential design partnership between the University and the Auckland Hospital Design Lab. The project will be initially kick-started with the establishment of a team of 4 students funded by the University through 10-week 2019-2020 summer student scholarships. The recruitment of the initial student design team involves collaboration with several design-based departments across the University, including Visual Design, Colab, and Computer

Science. Managing these diverse relationships and providing appropriate access to working spaces and computers relies upon a model established by the Centre for Learning And Teaching (Frielick, Klein, & Probert, 2013). The key milestones in establishing the project are outlined in Table 2.

Table 2: Project timeline and milestones

Project Milestones	Project Timeline
Initial meeting of principle investigators and the Hospital Design Lab manager	February 2019
Scoping of a project MOU	July 2019
Fortnightly brainstorm/planning meetings of principle investigators and Hospital Design Lab manager	July 2019
Selection of first design problem	August 2019
Recruitment of student design team	Second Semester 2019
Initial project scoping and design team formation	10-week Summer 2019-2020 Student Scholarships
Analysis of first design problem	First Semester 2020
Prototyping of potential design solution	Mid First Semester 2020
Stake-holder evaluation	Second Semester 2020
Redesign of design solution and re-evaluation	Mid Second Semester 2020
Dissemination of first project outcomes	End of Second Semester 2020

As outlined in Table 2 the initial timeline for the setup stage of the project has taken significantly longer than anticipated. The process of building trust between the University research and project management team and the Hospital Design Lab team was complicated by prior experiences that the authors were initially unaware of. Rebuilding trust between the teams has been a critical step in the project. The next stage of the project involves the recruitment of the student team that will hopefully establish a longitudinal design team as students move from under-graduate to post graduate studies and potentially take the project as the basis of PhD research. Selection of a cross-disciplinary student team requires collaboration between several University Departments and academics, and negotiating roles, responsibilities, funding, and benefits to all. The availability of summer student scholarships from our Centre for Learning And Teaching for the University team to fund the initial scoping and prototyping of test design briefs has also been a key step to build confidence between the University and the Hospital design teams, to effectively kick-start the implementation of the project.

Conclusions

In this concise paper we have outlined a Design Based Research methodology for approaching real world problems as authentic learning environments for collaborative design teams that encompass real world stakeholders, academics as advisors and mentors, and students as designers. A significant first stage of the project establishment has been the building of trust between the principle investigator team and the key stakeholders of the real world problems – the Hospital Design Lab. Building this level of trust provides the foundation upon which the project will grow into a sustainable model of real world learning experiences for our students.

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The potential of Augmented Reality to amplify learning and achieve high performance in the flow of work

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The longevity of work skills and knowledge is constantly diminishing. This phenomenon provokes significant challenges for both employees and industries. There is a growing realization that we must all continue to 'learn to earn' (Bersin, 2015) in order to maintain employability to sustain the economic means to live life. This short conceptual paper proposes that there are increasing opportunities to learn new capabilities and practices and achieve high performance through learning in the flow of work. It explores the potential and constraints of Augmented Reality, as an emerging technology, to amplify workplace learning.

Keywords: performance support, learning in the flow of work, five moments of learning need, Augmented Reality

Introduction

> Human's ability to adapt to technological change is increasing, but it is not keeping pace with the speed of scientific & technological innovation. To overcome the resulting friction, humans can adapt by developing skills that enable faster learning and quicker iteration & experimentation.
>
> Mary Meeker, June 2019

Work and jobs as we knew them are changing rapidly. According to the World Economic Forum's (WEF, 2016) report on 'The Future of Jobs', the impact of technical and other changes is quickly reducing the shelf-life of workers' skill sets. With constant advances in automation, robotics, machine learning, globalisation and disruptive business models, the skills, behaviours and knowledge required of employees is quickly evolving and becoming more complex and multi-disciplinary. There is a growing realisation that continuous upskilling of workforce capabilities is key to the workforce agility and value. Consequently, the capabilities that determine employability are continuously changing over time.

This short conceptual paper explores the potential and constraints of Augmented Reality (AR) technologies to enable more rapid upskilling and reskilling of employees. It highlights the significance of the rapidly changing learning needs of worker-learners and their organisations and the need to learn in the flow of work. Using a number of case studies, the main focus is on the evolving potential of AR to provide the means to amplify learning in the flow of work.

The changing learning needs of employers and worker-learners

The need for people to continuously learn, unlearn, upskill and reskill has never been greater. The velocity of change means that the scope of what people need to learn to keep their knowledge and skills current for employability is ever-increasing. Equally, recruitment is expensive and so industries need their existing employees to develop in-demand capabilities and apply their learning quickly and efficiently in response to continuous change. In a study of over 600 learning and development (L & D) leaders (Jennings, Overton, & Dixon, 2016) representing 1,600 learners from 55 countries, 90% of L & D leaders expressed a strong desire to:

- Increase on-the-job productivity
- Respond faster to business change
- Improve employee engagement
- Reduce time to achieve competencies
- Improve the application of formal learning in the workplace

From a worker-learner perspective, there is also a growing realization that continuous upskilling is essential for continued employability. That is, you need to 'learn to earn' (Bersin, 2015). In turn, this awareness is positively influencing employees' motivation for, and investment in, learning. In fact, in the same study (Jennings, Overton, & Dixon, 2016), researchers asked L & D leaders about what motivates their staff to learn. Their findings suggest that:

- 76% would like to do their job 'faster and better'
- 75% want to learn for their own personal development
- 60% would like to increase their productivity
- 47% would like to keep up-to-date with new technologies
- 42% find working towards some kind of professional certification is motivating

However, the time required for continuous upskilling and reskilling is a concern for both industry leaders and employees. The tension is that there is both too much to learn and not enough time to learn. In formal courses, much of what has been taught is not remembered when the time comes to apply new knowledge to the task at hand. In the workplace, when an employee needs to solve a problem or complete a task, unproductive time can be spent on searching Google, YouTube or the company intranet to find relevant information to solve their challenge. There is a need to think about learning more strategically about how to support workers to improve or acquire new capabilities more quickly so they can do their job 'faster and better' in the flow of work.

Learning in the flow of work

'Learning in the flow of work', 'frictionless learning', and 'performance adjacent learning' (Herbert-Maccaro, 2018) are just a few terms that encapsulate the idea of learning in the context of the work you are performing. These approaches offer employees learning on-demand, point-of-need learning and/or short bursts of learning in concert with, or adjacent to, their workflows. The concept of learning in the flow of work is at the heart of the widely known 70-20-10 performance-oriented learning model and the popular Five Moment of Need model. The model is premised on the idea that you gain 10% of your learning from formal instruction, 20% from learning from others and 70% by learning from your on-the-job experiences.

While the 70-20-10 model shines light on the role of workplace learning, it does not really help us understand how and when people learn and become competent in the tasks they need to perform and how to best support their learning and performance. Some years ago, Gottfredson and Mosher (2012) argued that 'we turn our attention to the workflow and deliver the support employees need to not only be competent at their work, but to also sustain that competency in an ever-changing environment'. They further posited that in order to provide the support needed along the way we need to understand the learner journey, from the beginner stages of learning through to that challenges that can happen when learning is applied, and learners need to perform. Gottfredson and Mosher (2012) proposed Five Moments of Learning Need which are intended to 'comprise the full spectrum of performance support needs.'

1. NEW – learning something for the first time
2. MORE – expanding the breadth and depth of what has be learnt
3. APPLY – Acting upon what has been learnt (including planning what to do, remembering what they have learnt or adapting what they have learnt to transfer to a new context)
4. SOLVE – solving new problems when they arise, or when things don't work as expected
5. CHANGE – learning a new way of doing things that may require a skill or knowledge change that alters performance and practices

The evolving affordances of AR offer one way to support workers' learning and performance needs directly into the workflow. Using AR, it is possible to embed 'new' and 'more' into the workflow in real time, and to provide performance support tools that are immediately accessible and tailored to the situation of the user.

Augmented Reality

For those unfamiliar with AR, it is differentiated by other realities, such as Virtual Reality which is completely computer generated, because AR superimposes a digital overlay on a real-world environment in real-time. That means the user can simultaneously see their own reality as well as an Augmented (digital) Reality – so they don't lose sight of the real-world context around them. According to the Augmented Reality for Enterprise Alliance, a global member-based organisation for the widespread adoption of interoperable AR-enabled enterprise systems, augmented reality includes:

> Any technology that "augments" the user's visual (and in some case auditory) perception of their environment. Typically, digital information is superimposed over a natural, existing environment. Information is tailored to the user's physical position as well as the context of the task, thereby helping the user to solve the problem and complete the task.

The main types of Augmented Reality vary in complexity. Location and Marker-based AR are simpler in terms of implementation and connection to content, whilst Markerless and Projection-based are more complex and sophisticated and offer a more seamless immersion across the real and digital environment.

1. **Location-based AR**
   Utilizes GPS, accelerometers and digital compasses available in the device used to provide information overlays relevant to the location. That is, the learner's location triggers content.
2. **Marker-based AR**
   Utilizes a camera available on a device, such as a smart phone, tablet or webcam, to scan an image called a 'marker'. The marker may be any kind of visual such as a QR code, a barcode, a photo. In marker-based AR the maker triggers the overlay of content such as video, text, and animation.
3. **Markerless AR**
   Utilizes a camera to scan the actual surrounding physical world such as a piece of equipment that requires maintenance, for example a whole car engine. Content is then mapped to the visual environment and the user may also be able to zoom in, manipulate and interact with 3D models that assist them in their decision-making and performance.
4. **Projection-based AR**
   Utilizes advanced projection technology to projects light onto a real-world object or environment to create a light-based interface that can guide users in their completion of more complex tasks.

AR Use Case Examples

Social AR to improve performance in construction and facilities maintenance
This first use case uses an Android mobile app that was designed for social augmented reality in construction, and facilities maintenance service industries (Pejoska, Reponen, Virnes & Leinonen, 2017). The catalyst for the app development was a recognition that improved communication and remote collaboration practices could assist younger workers on site who needed to tap into the knowledge of the older, more senior workers. Given the younger workers typically used smart phones for communication, a mobile app was developed in an effort to change communication and collaboration practices for point of need, informal learning in the flow of work The Social Augmented Reality app (SoAR) uses video calling functionality to create a video stream of what the user was seeing (using the back camera view) as well as audio to discuss the work task context.

The ability to have a shared view of the objects and surrounds was critical to the industry context as 'it creates a common ground for collaboration, serves as a basis for situation mapping, supports the identification of issues and makes assumptions and beliefs visible' (Pejoska, Reponen, Virnes & Leinonen, 2017, p.12). Additionally, it provides situational awareness which provides the foundations for a thorough understanding of the task or problem that may be difficult to explain verbally. For collaborative purposes, there is considerable value in being able to point to objects and contextual information in the shared view. Using the app, the video stream could be paused to a static view whereby users could use their finger to create pointers and circles – thereby focusing their discussion. Three field studies were conducted in Finland and Germany concluded that the app was both usable and useful. Apprentices, in particular, could identify both efficiency and productivity gains. The directness of being able to call the right person at the right time and resolve the issue with immediacy and confidence was helpful. The major challenges were around harsh weather conditions, noise, screen visibility, and connectivity on-site.

Hololens™ for elevator maintenance
This second use case relates to improving point of need support in the workflow of elevator service engineers. The global engineering company Thyssenkrupp, recognised that over 1 billion people ride elevators every day. They provided support to service engineers using Microsoft Hololens AR technologies in order to improve the efficiency and effectiveness of their practices across the globe. When an elevator service engineer is dispatched to a job they put on their Hololens and see a 3D picture of the elevator they are going to work on and relevant information about the elevator. They can zoom into different parts of the elevator and within the digital AR layer, different training opportunities are available. These include video tutorials, checklists as well as historical notes on previous services on that particular elevator and safety alerts. Together, this information and knowledge can save time and prepare the technician, as never before, ahead of going to the job site.

At the elevator service site, the technician is handsfree while using Hololens to perform routine tests and examine parts to identify issues. For further support and expertise, technicians can trigger a remote call, using Microsoft Remote Assist. This means they can collaborate with a subject matter expert (who can see what the technician is seeing) to decide on the best course of action. Tests showed a huge potential to increase productivity as a result of this approach. Impressively, the time saved in conducting the maintenance was reduced from 1-2 hours to 20 minutes.

Light Guide and TrainAR™
Light Guide Systems offer projection-based AR to simplify complex manual tasks related to assembly or inspection in industries such as car and pacemaker assembly. Simplified text and other visual information is projected in front of the employee to support their performance as they complete tasks. In this way, employees can also learn to operate safely and collaboratively with robots in factory assembly plants. Chrysler reported an 80% improvement in quality and 40% improvement in productivity in their car manufacturing.

Using the Light Guide TrainAR™ System, a digital overlay can be projected onto any type of part or assembly providing step-by-step work instructions and visual and audio guidance. This is a customizable training environment with preloaded templates for fast and simple lessons. Employees can then take short tests to confirm understanding and learning progression before performing the tasks on the factory floor. This approach can significantly shorten the time lapse between training and application.

The potential of Augmented Reality

Studies reviewed for this paper, suggest AR has the following potential to amplify learning and achieve high performance in the flow of work in the following ways:

- *Reduce time to achieve tasks:* Recent reviews of industry and academic studies (e.g., Farrell, 2018, Akçayır & Akçayır, 2017), found strong indications that enabling AR in the workflow can mean employees achieve tasks more efficiently. For example, a collaboration between Boeing and Iowa State University found a 30% reduction in time to complete tasks as a result of AR training compared to groups who received traditional documentation or documentation on a tablet device nearby the assembly line (Richardson et al., 2014).
- *Reduce time to achieve competencies:* Many studies reviewed mentioned decreased time to achieve competence as an important affordance (e.g., Farrell, 2018, Lotring, 2005).
- *Enhance problem-solving and decision-making:* Using the affordances of AR can provide employee the most up-to-date information to make decisions and complete tasks in ways that are most optimal and efficient. Dunleavy, Dede and Mitchell (2009) identified the most important affordance of AR for learning is its 'unique ability to create immersive hybrid learning environments that combine digital and physical objects, thereby facilitating the development of processing skills such as critical thinking, problem solving, and communicating' (p.20).
- *Improve memory and understanding and reduce cognitive load:* Studies have found some evidence of improved memory recall when using AR systems to support performance (Tang, Owen, Biocca and Mou, 2003). Another benefit is improved understanding, particularly of complex concepts, when essential information is attached to the user's physical world view (Lotring, 2005, Squires, 2017). Furthermore, it has been hypothesized that with support from AR, cognitive load may be reduced when performing complex tasks (Squires, 2017).
- *Reduce error rates & improve health and safety:* Due to the nature of just-in-time performance support, a decrease in error rates and improvements in quality, and health and safety in equipment use have also been reported. Studies at Colombia University (Henderson & Feiner, 2011) found that participants using AR demonstrated more accuracy in task completion over 53% of the time.
- *Increase employee engagement and motivation:* Participants engaging in AR training have also reported experiencing AR training as more intuitive, motivating and engaging than other forms of training – although there may be a novelty affect influencing participant perceptions (Akçayır & Akçayır, 2017).

Constraints of Augmented Reality

Gartner research (Pettey, 2018) suggests that immersive technologies like AR will not reach maturity for another 5-10 years. There are still a range of constraints that challenge wide-scale take up, such as:

- *Interoperability:* According to the IEEE Computer Society (2016), 'the lack of AR interoperability and, consequently, AR content, stands in the way of rolling out such training to an emerging market in the numbers required' (p.96).

- *Design:* As Augmented Reality is still an emerging technology and a complex solution, a major constraint is in designing and implementing training solutions (Drljevic, 2017; Farrell, 2018). This includes considerations around whether AR will require a live internet connection to receive data and whether internet connectivity is reliable at the worksite.
- *Usability:* Usability is a key design consideration as AR solutions can be difficult or clunky to use in employees work environments (Akçayır & Akçayır, 2017). According to Dickson (2018), AR headsets and glasses also have some limitations. Some headsets are bulky and heavy which makes them uncomfortable to wear over extended periods of time. Motion sickness and headaches have also been reported. A limited field of view can also reduce the user's sense of immersion. Climatic events can affect usability in some work environments (Pejoska, Reponen, Virnes & Leinonen, 2017).
- *Adoption:* Resistance to change, fear of threat to jobs and issues associated with digital literacies of the target audience are key implementation considerations (Akçayır & Akçayır, 2017)
- *Interaction:* The user interaction afforded by glasses, headsets and other AR tools are still immature. Some have touchpads on the side of the frame that utilise swipes and taps to change and activate the menu while others have handheld controllers. Voice commands can be of limited use in noisy environments.
- *Safety:* The physical environment of the job at hand needs to be assessed as to whether it can safely support the use of AR (Farrell, 2018). Assessment needs to consider safety considerations while learners use AR. For example, could workers be more prone to trip hazards while looking at their devices in the work environment? Strategies, policies and procedures to manage safety are critical.
- *Governance frameworks, policies and security:* According to ISACA (2016), AR virtual graffiti attacks and the collection of information from social media and other sites pose a reputational risk. Privacy is yet another concern. Companies need strategies to proactively manage these risks and to update their governance frameworks and policies to incorporate AR as part of their business.

Final thoughts

AR, as an evolving technology, has strong potential to amplify workers' learning and performance needs in their flow of work. In relation to the 70-20-10 model, AR can offer the ability to learn more efficiently and effectively on-the-job in the context of real work tasks and to connect with other SME's across the company for mentoring, coaching, observation and feedback.

Thinking back to Gottfredson and Mosher (2012) Five Moments of Learning Need and the potential of AR:

1. NEW – tutorial content can be designed help workers learn something new. Because information is visually layered over the physical environment it may be easier, and quicker to understand and learning can be delivered in shorter focused chunks (Farrell, 2018)
2. MORE – because AR can deliver just-in-time performance support, learning is expanded in the context of the task at hand. Virtual coaches, mentors and SME's can contribute to the breadth and depth of learning experience. Content can be pushed in terms of prior achievement and employee readiness.
3. APPLY – using AR at point of need provides the performance support to help refresh prior knowledge, use real time data and information and tap into expertise that can support performance as knowledge is applied.
4. SOLVE – Information and coaching provided through the digital layer can help solve unexpected problems as they arise
5. CHANGE – New information and practices can be integrated into AR to re-skill or upskill workers as knowledge and practices change.

Certainly, in terms of reskilling, upskilling and maintaining employability in times of such rapid change, there is emerging potential to help worker-learners to maintain and amplify their capabilities in the flow of work.

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The Power of Podcasts – sharing stories to transform teaching practices, learning experiences and academic cultures

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In a constantly changing Higher Education environment, academic staff are under increasing pressure to improve their teaching practices to enhance the student learning experience. This requires them to engage with the scholarship of learning and teaching – not only do they need to keep abreast of recent educational developments, but also measure the successes of their teaching approaches and share their practice with others. This is no mean feat against a backdrop of increasing workloads and an evolving culture of performance.

The growing challenge for Academic Developers is to effectively support staff in their scholarly practice, through the provision of high quality resources and events/sessions. In all cases, the material must be accessible, relevant, inspiring and applied – translating across disciplines, at scale. Yet, too often, we know that resources end up under-used and events suffer chronically poor attendance (Hains-Wesson and Curran, 2014; Woodley, Funk and Curran, 2013).

The presentation will describe the process by which a College Academic Development Group (ADG) developed an innovative strategy to reach a wider audience for staff capacity building. Drawing on the literature on informal learning in the workplace (Boud 1999), we sought to use conversational storytelling as a mechanism for sharing, promoting and exploring teaching practices. We noted from the literature that an informal community of practice (CoP) that encouraged teaching staff to innovate and influence change via the sharing of teaching and learning stories among peers is a cost-effective sustainable model that could easily be adopted and promoted through social media such as, podcasts, blog posts, LinkedIn and Twitter micro-blogging on internet enabled devices (Lefoe and Myers, 2006; Hains-Wesson and Curran, 2014; Warr Pedersen, 2016).

In February 2019, we launched a podcast series called Open Classrooms. In each episode, a member of staff talks about something new or interesting they are doing in their curriculum or classroom. To date, there have been 14 episodes, each made available as free, open resources via Soundcloud and iTunes, and the series has become establish as one of the College's flagship Teaching and Learning resources. By capturing and publishing teachers' stories in podcast format, we have successfully used accessible technology to enhance individuals' teaching practice, professional profiles and catalyse social and cultural change in academic departments.

The presenters will tell the story of Open Classrooms, drawing on audio-visual resources to give the audience a multi-perspective understanding of the project and its impact. We will include a description of the practical approaches we have taken to recruiting interviewees, preparing them for the conversation, recording, publishing and marketing/advertising. Data from our on-going evaluation work will be used to tell our emergent impact story, including formal intended outcomes as well as some of the more surprising benefits to individuals and school cultures. Finally, we will reflect on the experience from our own perspective as academic developers with no previous experience of podcasting.

Keywords: Professional development, podcasting, storytelling, OERs

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Client's digital stories: Using the lived experience to personalise online learning

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Clients' stories of their lived experience of disease and illness are an important part of the nursing curriculum that fosters the development of a client-centered approach to healthcare. While opportunities for these types of learning experiences have historically been possible via placements or simulations, opportunities for such personalised interactions in the online context is more difficult. Digital stories offer a way to bring the lived experience to online learning. Digital stories are short multi-media clips that bring a character's experiences to life, yet research into the impact of these stories on student learning is sparse. This paper presents a work in progress and preliminary findings from 20 students' responses to client's digital stories in a fully online course using the construct of empathy to identify themes in the students' comments. Themes indicated that the digital stories helped student learning, assisted with the development of empathy, and stimulated engagement by tapping into the emotional dimension of learning. The study suggests that learning design incorporating client digital stories assists with the development of empathy, aids in understanding and stimulates engagement by inspiring students through personal connections with clients.

Keywords: Digital stories, Nurse education, Student engagement, Empathy, Learning design

Background

The opportunity to study online rather than needing to come on campus to study has enabled many students to participate in higher education who would otherwise be unable to due to geographical, work or family commitments (see eg. Stone & O'Shea, 2019; Muir et al. 2019). Online students tend to be older, first in family, come from low SES backgrounds and regional areas, and be juggling work and family commitments alongside studying (Muir et al., 2019; Stone & O'Shea, 2019). In addition, online learners have higher attrition rates than on-campus students (Muir et al., 2019), and face a number of challenges that are unique to the online study experience. For example, they report feeling isolated and disconnected, without a sense of belonging to their institution (Burton, et al. 2016), that is, there's a sense that their learning experience isn't personal.

Findings such as these suggest that it is not just interest in the content that keeps online students engaged in their studies, but that there are relational components to their engagement. Moore (Moore, 1989) describes some of these relations in his model of online interaction by conceptualising online interaction as consisting of three elements; student-content interactions, student-student interactions and student-educator interactions. Moore (1989) explains student-content interactions as the defining characteristic of education, as it is through these interactions that students come to understand new concepts, take on new perspectives or alter the cognitive structures of their mind. Student-student interactions are also seen as important, as peers act as valuable, if not essential learning resources (Moore, 1989). And finally, student-educator interactions are also essential, especially in motivating and maintaining students' interest, and as a source of feedback to students (Moore, 1989).

Although Moore's model was conceived of some time ago, his advice of the need to specifically design for all three types of online interactions and to use multiple mediums to facilitate each interaction is very much relevant today (eg.(Bates, 2015). In addition, his model highlights the idea that not only is cognitive engagement with content important (ie. student-content interactions), but that social interactions between others, ie the relationships, are also an important part of the learning process.

The importance of social relationships is also central to experience based learning pedagogy, which, apart from assuming that experience is the foundation and stimulus for learning, also has as its central tenants that 'learning is socially and culturally constructed', that 'learning is influenced by the socio-emotional context in which it occurs', and that it is a 'holistic' process involving feelings and senses as well as the intellect of the learner (Andresen, Boud, & Cohen, 2000), ch. 14). Once again highlighting that learning involves more than just intellectual engagement, but that emotional connections with others, and the content and context are important. One way that we can foster both intellectual and emotional connection with content with the aim to ignite the 'spark' for learning in the online environment is through the use of digital stories.

Client stories in nursing education

Client stories are not new in nursing education, indeed they are a fundamental part of the curriculum bringing the lived experience of disease and illness to the student learning experience. Importantly, this lived experience enables students to develop empathy and take a client-centred approach, but they can also reduce preconceptions and challenge stereotypes, and develop students' confidence in future clinical encounters (Codd, Burford, Petruso, Davidson, & Vance, 2018). Further, as such stories are grounded in reality, they are recognisable to students, provoking reflection on a variety of viewpoints and can also assist with sense making (Waugh & Donaldson, 2016). Traditionally these client stories have been told during student placement experiences or patient simulations –however these experiences are difficult to transfer to the online learning environment where physical contact with clients is not possible.

We used digital stories to bring clients' stories to life in an fully online Graduate Certificate in Diabetes Education (GCDE) course as a proxy for face-to-face client stories that have traditionally formed a fundamental part of the on-campus learning experience, but to also personalise the online learning experience and foster emotional connections with the content. Digital stories are short multi-media clips created by weaving together images, music, story and voice (Haigh & Hardy, 2011). Haig and Hardy (2011, p. 410) describe the power of digital stories resulting from the "tapestry bring[ing] depth and colour to everyday characters, situations, experiences and insights. They not only touch hearts and therefore influence minds, but they provide opportunities for reflection". However a recent systematic review found that client's digital stories alone had minimal impact on understanding or knowledge of a topic, and concluded that more research was needed on the impact of digital stories on health professional's behaviour (Moreau, Eady, Sikora, & Horsley, 2018). This study sought to contribute to our understanding of the impact of clients' digital stories on post-graduate students by investigating students' responses to digital stories in a fully online course.

Curriculum context

The GCDE is a fully online degree offered by the School of Nursing and Midwifery a large Australian regional university. The GCDE aims to prepare graduates to practice effectively as diabetes educators in a range of healthcare settings, and is the first step towards professional recognition with the Australian Diabetes Educators Association. The majority of students are registered nurses, although demand has increased over the past several years from other allied health areas.

The degree consists of four units, each offered in 5 x 2 week 'courses' broken down into a series of 'steps' (ie. individual html pages) on the FutureLearn platform. Each step ended with a 'Your Task', which represented a call to action for students to do some form of learning activity, or to respond to a discussion prompt by 'commenting' in the peer discussion space which was located within the step. Digital storytelling formed the backbone of the curriculum design due to the importance of a patient-centred approach in the discipline, but to also provide context and a framework for students to link together new concepts (Moon & Fowler, 2008). We used a variety of practitioner interviews and client digital stories throughout the degree, with clients re-appearing throughout the unit in order to tell different aspects of their story as it aligned to the content.

Digital stories: Production considerations

In developing the digital stories, the digital production team worked collaboratively with academic staff to ensure that the content of the videos aligned to the unit and course learning outcomes. Further, the production team approached each client's story as though it were a miniature movie –this included selecting clients who were comfortable telling their stories on camera and developing backstories for clients so that the audience got to know them as a person. In addition, they spent time working with clients to do practice shoots, build rapport and develop relationships –again contributing to the client's comfort in telling their story to camera.

Rather than having clients come into the studio, filming occurred on-location in client's homes and included them undertaking daily activities (eg. driving, running, preparing meals). There were also different characters in the stories, those who were important in the lives of the clients (eg. family members, pets). Post-production focused on shaping the footage into a story, complete with image overlays that produced a 'photo-album' look and feel, and the images and music overlays were contextualised to the character to once again promote a personal connection to the client.

Method

Aim

The aim of this study was to explore the impact of client's digital stories on post-graduate students by analysing students' comments in response to digital stories.

Conceptual framework

This study used the construct of empathy as a framework for understanding the impact client's digital stories had on students. Empathy is considered a basic component of therapeutic relationships, it is critical in patient perceptions of quality care, and has a positive influence on patient health outcomes (Levett-Jones, Cant, & Lapkin, 2019). As empathy is an essential component of the healthcare curriculum (Levett-Jones et al., 2019), it is important to understand factors that can influence the development of empathy in the online context when physical contact with patients is not possible. The study used a generally accepted definition of empathy, defined as "the cognitive ability to comprehend what another person is feeling, an emotional resonance with those feelings, and the willingness to respond appropriately to the person's needs" (Levett-Jones et al., 2019, p. 80) as a lens through which to analyse students' comments in response to client stories. In addition, consistent with learning involving the whole person as per experience based learning, the analysis also focused on the impact these stories had on students' feelings in relation to the content.

Participants

Following ethics approval (HEA-H 139_2017) from the relevant university body, all students enrolled in the GCDE were invited to participate in the study via a hyperlink to the Plain Language Statement and Consent Form in the last step of their unit. Twenty-three students volunteered to participate, three of these students did not post any comments and were therefore excluded from the study leaving a total of 20 participants. All participants were female, ages ranged from under 25 (n=1) to 40+ (n=10). Participants came from a range of professional backgrounds, including registered nurses, pharmacists and dietitians.

Comment analysis

At the end of the study period, participants' comments from steps that included a client digital story or a step that included a 'Your Task' that related to the client story were downloaded from the FutureLearn platform and de-identified (See Table 1). Once de-identified, a deductive thematic analyse was conducted using empathy as a conceptual framework. The data presented in this paper only includes data collected in the first two units of the GCDE, and is part of a larger data set of comments collected across the course as a whole.

Table 1: 'Step' information and comments analysed

Unit (course)	Step number	Step title, type and length of video	Number of participants who commented	Number of comments
Unit 1 (1)	1.9	Being diagnosed with diabetes: Video of Kirsty; 4:59mins	8	8
	2.9	Practical strategies for living with diabetes: Video of Kirsty; 2:27mins	**7**	**7**
	2.10	Reflect on Kirsty's experience: Article (Reflective task)	6	**7**
Unit 1 (2)	1.14	Quality of life and self-care: Article (Application task)	7	8
	2.4	Joan and Colin's Story: Video of Joan and Colin; 9:00mins	9	10
	2.9	Colin putting it all together: Video of Colin; 2:15mins	6	6

Unit 1 (3)	1.5	Kirsty's experience of life transitions: Video of Kirsty; 5:14mins	8	8
	1.7	Sense of Coherence and chronic illness: Article (Application task)	8	8
Unit 1 (4)	1.7	Joan's experience accessing diabetes information: Video of Joan; 2:40mins	10	11
	2.8	Interprofessional practice in diabetes care: Article (Application task)	9	9
Unit 1 (5)	1.7	Nola's story: Podcast of Nola; 5:15mins (audio and images only)	10	13
Unit 2 (1)	1.10	Living with diabetes: Video of Beth; 3:40mins	7	14
	1.11	Beth's story, your story: Article (Reflective task)	9	14
	2.4	Diabetes: a personal perspective: Video of Beth; 2:53mins	5	6
Unit 2 (2)	2.2	Being diagnosed with type 1 diabetes: Video of Kirsty; 3.03mins	8	10
Unit 2 (3)	Clients' digital stories not used in this course			
Unit 2 (4)	Clients' digital stories not used in this course			
Unit 2 (5)	Clients' digital stories not used in this course			
Total comments analysed = 139				

Preliminary findings and discussion

Preliminary analyses of students' comments in response to digital stories suggested that the stories impacted the development of empathy. The definition of empathy used as a conceptual framework in this study can be thought of as consisting of three dimensions; a) the ability to comprehend another's feelings, b) having an emotional resonance with another's feelings, and c) a willingness to respond to that person's needs. Table 2 illustrates how each one of these dimensions was illustrated in the students' comments. In relation to comprehending another's feelings, you can see that students indicated that they could relate to the clients in the stories, they could imagine what it might be like to walk in their shoes. Regarding an emotional resonance with another, the students used emotive language (eg. 'I like', 'I love', 'I'm glad') in their responses, indicating that they had an emotional connection with the client. And finally, students comments demonstrated a willingness to respond, these comments also demonstrated that students thought about how they would respond as their future professional self (eg. 'As a diabetes educator', '…for us as educators'). These findings suggest that the client stories had an impact on students' attitudes toward empathy, although we are unable to tell from these results whether this would translate to a change in behavior or transfer to clinical practice.

Levett-Jones et al. (2019) claim that immersive and experiential interventions are most effective at fostering the development of empathy as they enable students to see the world through the eyes of another, in addition they point out that these interventions are most effective when coupled with guided reflection and opportunities for de-briefing. The findings of this study support this view, as not only did client stories enable students to comprehend another's feelings (ie. see the world through another's eyes), but as the stories were integrated into the curriculum alongside learning activities prompting students to reflect, apply and discuss with their peers (ei. enabling opportunities to de-brief), this made the learning experience all the more powerful.

Table 2: Students' comments illustrating empathy

Dimension of empathy	Example comments
Comprehending another's feelings	Is understandable…I can definitely relate…I also share Kirsty's flux and flow (P01) Kirsty's story completely resonates with me…Believe me, for a runner (P09) When my husband was diagnosed (P14)

	I can't begin to imagine how overwhelmed I would feel. Imagine you are young and …(P12)
Emotional resonance with another's feelings	I like the way she has found…I like the way she finished…very inspiring (P11) It was good that she was able to…I'm glad that she is able…I like how she (P13) I love how Kirsty…This lady does not cease to amaze me…I sensed that her relationship (P09) I admire the way she…I definitely take my hat off to Kirsty and will remember when I see my patients (P12) I loved how empowered Beth was…I was pleasantly surprised that she looked so well (P01) I love Beth's principal of 'getting on with her life' (P14)
Willingness to respond to need	As a diabetes educator, our role is to …(P04) It is important for us as educators to realise… (P12) I think this [being diagnosed] is a very overwhelming experience…so anything we can do to ease this would be beneficial (P20) I think the person giving the diagnosis will need to use active listening skills (P14)

Students comments also suggested that the client stories assisted with student-content interactions (Moore, 1989) by sparking students to further inquire into client's lives, "I wonder if …It would be interesting to see how she…" (P19), "I love Beth's attitude…I envisage she has good family support (P09)", "It is interesting to consider other's diagnosed at a similar time and maybe compare their outcomes…I had a quick look at the most recent list of medal recipients and there are not many" (P15); and by stimulating imagination related to the client's stories, "I imagine that initially she would have started…also I imagine" (P05), "And I wonder if in the early years…It is possible too that the school helped…"(P14), but also at times this imagination related to their future professional selves"Unfortunately not all sufferers understand…so that is why I plan to specialise. I want to guide/educate…"(P16).

Comments also suggested that students' felt inspired by the stories, "Nola is truly inspiring" (P07), "Nola is a very impressive lady and her passion for people is evident" (P04), "Beth's story of her journey with diabetes is quite inspirational" (P15), demonstrating that not only were student's intellectually engaged, but that the stories tapped into students feelings for learning, as per experience based learning (Andersen, et al. 2000).

Finally, in addition to the comments in the steps related to the client stories, some participants also made comments about the client stories in 'wrap-up' steps throughout the units. The analysis of these comments is currently underway, however some of these are included here to illustrate how the stories impacted students' overall learning experience, and made their interactions with content more personalised because of the connections they felt with the clients, "Having the personal stories of people living with diabetes has really helped to consider the impact of diabetes and its complications on the individual rather than it just being something you read about in a text book (P20)", "I particularly liked Kirsty's video and her reflection of diagnosis and adjustment to type 1 diabetes…I have found the personal stories invaluable (P07)", "This is the stuff I love about working with people with diabetes. The individual, their personal story, their challenges and their successes (P12)"; by also assisting students to connect new information together and see the relevance of the content, "The case stories gave real life experiences and made concepts easier to understand; and the expertise gave me the confidence that what I was learning would be useful (P04)".

Conclusion

The preliminary findings of this study suggest that client digital stories have an impact on empathy and enhance the overall learning experience of post-graduate students in a fully online course. It is suggested that in order for client stories to be most effective in fostering empathy, they be complemented by learning activities which include opportunities for application, reflection and discussion. Client stories offer a way in which we can foster a more personalised online learning experience by enabling students to make connections with clients, which in turn increases student-content interactions. Client stories also appear to tap into students feelings as well as their intellect, making for a more holistic learning experience.

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Conversational Bots as Electronic Performance Support System for the Professional Development of Teacher Educators

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With the increased demand and interest in designing technology-enhanced lessons for 21st Century learners, ways to empower and enable teacher educators to use educational technologies effectively underpinning sound instructional strategies had to be reinvented. Teacher educators may require on-demand support in order to have the necessary knowledge and skills to meet the needs of the rapidly changing learning landscape. A learning intervention or a job aid had to be developed to provide just-in-time bite-sized knowledge in time of need. This conceptual paper elaborates the design and development of a next generation electronic performance support system for teacher educators and outlines a possible approach of using a rules-based chatbot as a means of empowering teacher educators to become active designers of meaningful technology-enhanced lessons.

Keywords: Electronic Performance Support Systems, Chatbot, Instructional Design, Educational Technology, Teacher Education

1. Introduction

Technology has been an integral part of higher education evolving into the 21st century. In order for universities to strive and thrive in the 21st century, we will need to develop the next generation of teaching-learning practices enabled with various technology tools. Even more than before, faculty are now required to work in tandem with learning experience design and educational technology teams to constantly innovate in their classrooms by designing and developing technology-enhanced lessons.

In 2015, the National Institute of Education (NIE), Singapore's only teacher education institution and an institution of Nanyang Technological University (NTU) carried out a "Pedagogical Approaches and Technological Tools Survey" for the very first time for all 12 academic groups. The purpose of the survey was to ascertain the status of technology mediated learning in NIE. The survey was administered to 319 faculty and had a response rate of 63%. The findings from the survey (Divaharan, 2017) revealed that 52% of the courses offered by NIE are technology mediated, 48% are non-technology mediated and 0% are fully online. The survey results had also given insights into the top 10 pedagogical approaches, instructional strategies and educational technology tools prevalently used across the 12 academic groups.

The quantitative and qualitative data collected from this survey have also revealed there is a cognitive dissonance and lack of common understanding of terminologies related to pedagogy, instructional methods and affordances of technology tools. Hence, this led to various interpretations and the disparate views on technology mediated learning. To design, operationalize and facilitate technology-mediated courses, a fundamental understanding of pedagogies and affordances of technology is required and even more so important in a teacher-education institute like NIE where the best and next practices are modeled.

To empower and enable faculty to meet the emerging needs, NIE has decided to adopt a multi-pronged approach. A professional development series that varies from learning by the means of traditional instructor-led classroom trainings to performance-based through individualized and just-in-time support is in place for faculty.

In the past couple of years, there has been a significant shift in the demand for instructor-led workshops to individualized just-in-time support to help ease the transition of face-to-face lessons to blended. As stated by Rosenberg M. J., (1995), for a performance-based approach the concepts of students, courses, curricula and instruction have little meaning. Rosenberg, Coscarelli, & Hutchison (1999) note that the overwhelming amount of complex information required to perform work at a competent level has placed considerable strain on traditional education and training systems. This situation has led to the development of job aids, computer databases, and electronic training systems as well as of structured text design.

Therefore, with the availability of new technologies, the use of Electronic Performance Support Systems (EPSS) to increase both performance and productivity has prevailed.

The goal of an EPSS is to enable learning in the workflow while performing the job (Laffey, 1995). Additionally, Gery (1989 & 1995), Raybould (1995) and Gustafson (2000) concur that the utmost goal of an EPSS is to provide the right amount of information and detail, at the time of need in order to reduce the time spent on performing a task. Laffey (1995) also describes an EPSS as not a passive medium that just disseminates information, but it is one that is very tightly integrated with the context of the task which includes, a dynamic work environment and workflow.

The purpose of this article is to describe the design and development of an EPSS for teacher educators of NIE and eventually make this resource available to NIE student teachers and teachers from our local primary and secondary schools and junior colleges. The primary objective is to help improve the teacher educators' understanding of learning theories, pedagogies, instructional strategies and affordances of technology tools and ability to design technology mediated learning activities. We approached the development of the EPSS by examining what is their thought process and questions that arises when designing technology mediated learning and used this data to develop an EPSS eventually.

2. EPSS on Pedagogical Approaches & Educational Technology Tools for Technology Mediated Learning Design

A basic definition of an Electronic Performance Support System (EPSS) is a custom built computer-based system that supplies access to one, several, or all of the following: integrated information, advice, learning experiences, expert consultation, and tools where the user can control the sequence and scope of the information at the moment when the information is needed (Gery, 1991; Raybould, 1990). Learning may occur during the use of an EPSS, but the primary purpose is to help the user to perform a task and improve productivity (Witt & Wager, 1994).

2.1 Web-based Pedagogical Database

For the first phase of developing an EPSS, we performed a literature review to curate definitions, theoretical frameworks and characteristics. A sitemap was created for an online database to organize the curated content and visually represent the link amongst the broad categories (refer to Figure 1).

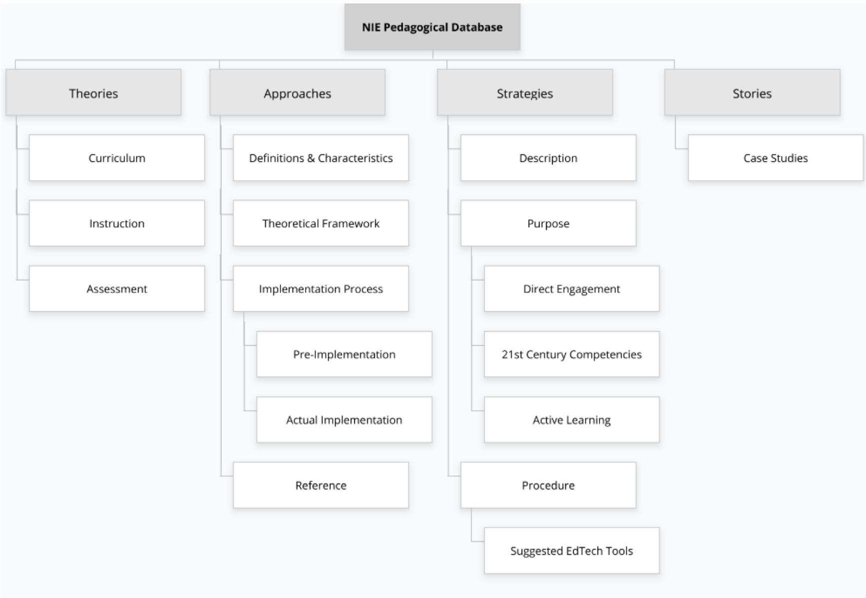

Figure 1: Sitemap of content for 'NIE Pedagogical Database'

In addition, task analysis was carried out on the tasks performed by teacher educators and the data was used to write the implementation processes. The implementation processes were accompanied by infographics or animation to illustrate how a selected pedagogy and instructional strategy will be facilitated with the use of technology and how it should be executed in an actual classroom (refer to Figure 2). The Teaching and Learning

Committee that comprises of a representative from each academic group provided feedback for enhancements and extensions to the prototype. Thus, the initial prototype reflected ideas of both the learning designers as well as the teacher educators.

Figure 2: Screenshot of the Procedure section of the 'Jigsaw' strategy page from 'NIE Pedagogical Database'

2.2 Tessa, a Conversational AI

The prototype of the Pedagogical Database was enhanced further to render human like conversations to replicate the conversations that teacher educators have in person, via phone calls or emails with the learning design and educational technology teams. In order for them to get information quickly, they could select the default responses presented for each pre-determined question in order to receive more information or leave their contact details via text-based chat should they not obtain a satisfactory answer. Thus, a decision was made for the use of a chatbot, a tool for users to submit their query, system fetches information from an online source and responds in a natural-language dialogue. In order to identify the type of chatbot we needed for our purpose, we analysed all email inquiries, categorised and list them under pedagogy and technology. A coded dialog flow map was created and tables were used to link the queries to ideal responses that will direct users to appropriate content in the Pedagogical Database prototype. Based on the plan we had on paper, the closed domain retrieval-based chatbot (refer to Figure 3) that imitates an agent while answering the questions from customer best suited our requirements. Thus, various online retrieval-based chatbot platforms were evaluated.

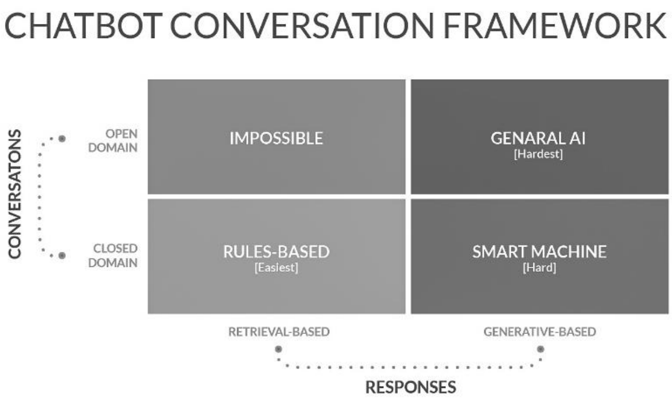

Figure 3: Typology of chatbots
Source: https://www.datasciencecentral.com/profiles/blogs/a-comparative-analysis-of-chatbots-apis

The chatbot used in our context was named ‘Tessa’. This chatbot was derived by an online chatbot platform Quriobot. Several approaches can be used to add knowledge to a chatbot created using Quriobot. One possible approach is to use an existing sample bot by Quriobot. For Tessa, an empty database to which chatbot designer program the database so that it has pre-programmed questions, phrases or words and how it is to respond to each question, phrase or word (refer to Figure 4). The options selected by users are captured in the backend report enabling the chatbot designer to learn from user inputs on possible knowledge and skills gaps.

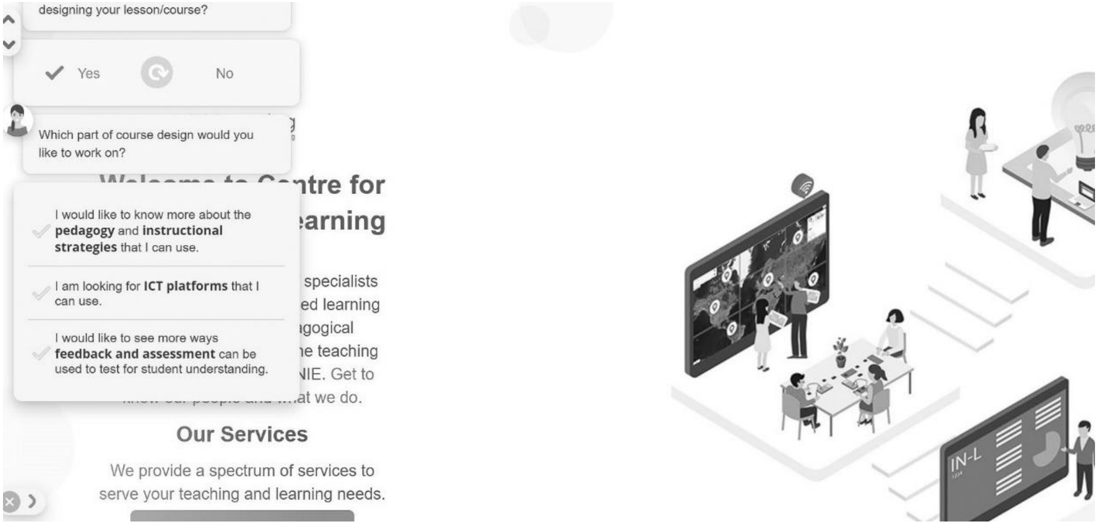

Figure 4: Pre-programmed questions in a conversation with Tessa

Based on the data from the backend report generated from 31 January 2019 to 30 June 2019, we are able to report there has been 39 attempts to use the chatbot using desktop or mobile devices via a browser. Out of the 39 attempts, 19 attempts were to seek guidance on getting started on designing their own tech-enhanced lessons or courses. 31.6% selected the option to explore ICT platforms to facilitate online communication and collaboration whereas 42.1% selected the option to know more about pedagogy and instructional strategies specifically those rooted in Constructivism. The remaining 26.3% selected the option to find more ways feedback and assessment can be used to test for student understanding. This set of preliminary data ascertains the conclusion drawn from the “Pedagogical Approaches and Technological Tools Survey”. It is also evident that undeniably most interest is in the area to gain a better understanding of terminologies related to pedagogy and instructional methods grounded in Constructivism to aid in designing lessons and courses for 21st century learners. Tessa has indeed been effective in providing support to faculty on-demand as the report generated further informs us that chat attempts were made as early as 7.15AM and as late as 11.26PM. This would not have been possible if faculty was rendered support the traditional way as the learning design and educational technologist teams operate 8.30AM to 5.30PM only on weekdays.

Therefore, for successful integration of an EPSS, it is necessary for developers to understand the total work environment. Providing the resources that performers need to be successful is important, but it is just as important that these resources support the processes of the work environment (Laffey, 1995). It is hard for any computer tool to be effective when it does not support the performances within work environment. Thus, we must carefully analyse the current work performances and events that can and do influence these performances. Furthermore, we should provide a tool that is customized to the needs of the teachers (Chiero, 1996).

3. Conclusions and Recommendations

In summary, an EPSS can contain tools and templates that are relevant to the tasks of the employee, mini-tutorials and simulations that are relevant to a specific sub-task, a database that provides information to support job performance, and a set of guides to aid the performance as it is being carried out (Gery, 1991). The key to the inclusion of specific features is to tailor it to the performance that it is designed to support which in our context was to provide faculty with knowledge and tools to design and develop technology mediated lessons and courses. In the case of our initiative, we went beyond an online database of curated content and produced graphics and animations on possible ways to implement, but we also aim to include templates and mini-tutorials that goes beyond “knowing” and allows teacher educators to perform the action of designing technology-mediated lessons by “doing” as they use Tessa as an EPSS.

In order to support a 21st Century teacher educator’s competencies, it is necessary to align the professional development goals with the institution’s goals. In our case, it was extremely crucial in understanding the current status of the technology mediated courses at NIE with the deployment of the “Pedagogical Approaches and Technological Tools Survey” to measure the difference between the institution’s goals and actual outcomes in order to develop a functional, robust tool that teacher educators and eventually teachers would use. Drawing conclusions from the survey results and backend report generated from Quriobot, this survey should be carried out on a biennial basis so that we are aware of our current technology mediated learning status and to study the trends. This survey could also be used as a tool to measure the effectiveness of Tessa as an EPSS by analyzing the data pre and post Tessa.

Furthermore, using chatbots as an extension of human-human conversation and not as a replacement is recommended in order for teacher educators to not underestimate the complexity involved in the actual works of learning design.

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Normalising practice – moving a technological implementation from project phase to operational phase

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It is widely acknowledged that successful implementation of new technologies relies on a project-based institutional approach with a dedicated and motivated project team to champion the technology and support professional development. One challenge that arises following project-style implementations is how to transition support structures and project drivers to 'normalisation' phase where technologies are seen as 'business-as-usual'. Griffith University's PebblePad implementation project team deliberately planned an end-of-project to business-as-usual transition. This planning involved; embedding PebblePad in the institution's Virtual Learning Environment (VLE); setting up ongoing scalable support structures; and ensuing there were suitable institutional partnerships to sustain the diffusion of the institutional adoption. Griffith's implementation project was led by the central learning & teaching unit (Learning Futures) and relied heavily on buy-in and support from many institutional stakeholders. Therefore it was essential that stakeholder teams were empowered to maintain the existing users and continue to look for opportunities for targeted and meaningful implementation. Similarly, Learning Futures had to find staffing capacity to continue to support PebblePad as a technology within the VLE. This ongoing work involves maintaining vendor relationships, providing ongoing professional development and continuing to be a centralised point for managing internal and external communications between stakeholders.

Keywords: ePortfolios, Ed Tech, Implementation Project, Institutional Technological Adoption

Introduction

Griffith University adopted PebblePad in 2017 as an institution-wide ePortfolio tool and as part of the Griffith employability strategy. The implementation was led by a centralised project team within Learning Futures (LF) who were appointed to the project for a two-year term. This paper focusses on the transition from project mode to embedding PebblePad as another tool in Griffith's Virtual Learning Environment (VLE).

Many institutions take a project-based approach when implementing new technologies (Marshall, 2010; Reynolds & Pirie, 2016, Slade, Murfin & Trahar, 2017) however there are a variety of issues that arise when these projects end and there are 'risks associated with the short-term nature of projects only building limited capacity, which is lost when resources cease' (Hansen & Greenaway, 2017). These risks also include; changes in institutional strategic priority, lack of funding, supporting continued use, supporting continued innovation, loss of project sponsor and inability to offer continued professional development. As noted in Reynolds and Pirie (2016), [future use] 'is dependent on how we use this new base and continue to innovate and support…'. The LF project team were conscious that significant transition planning would be required to ensure operational success.

Late in 2018, Griffith University announced a Digital First strategy which included a broader view of educational technologies (ed tech) and the implementation of a Virtual Learning Environment (VLE). The timing of the introduction of the VLE meant that PebblePad became a key platform in the initiative and reinforced its position in the operational suite of ed tech tools.

As with many technology implementations, the Griffith PebblePad implementation can be seen to follow the five Gartner Hype Cycle stages of, Innovation Trigger, Peak of Inflated Expectations, Trough of Disillusionment, Slope of Enlightenment and Plateau of Productivity (Gartner, 2019. See Figure 2). Towards the end of the project, Griffith use of PebblePad was still following the cycle and it became apparent that there was a need to set up supports to ensure that the Slope of Enlightenment phase bridged the end of the project and the move to normalisation.

Approach

Campbell & Trahar (2017) identified the relationship between the Griffith PebblePad implementation and Rogers' Diffusion of Innovation theory (2003). This paper draws further on Rogers' work to examine the stages of the implementation and compare this experience with his evaluation of innovation across organisations and institutions. Rogers' diagram of *The Innovation Process in an Organisation* (sic) (Figure 1) is useful to situate Griffith's project time-line with diffusion of innovation theory. In the PebblePad implementation, the project phase included both initiation stages and the Redefining/Restructuring and Clarifying stages of the implementation phase. The project team was careful to work with the Group Learning and Teaching Consultants (LTCs) in clarifying their role to continue to embed PebblePad in their contexts. By the time the implementation project concluded, the institutional expectation of routinising the technology was clear and it is even possible that a new diffusion cycle may have begun in each of the respective academic groups. This could be the focus of further research but it out of the scope of this paper.

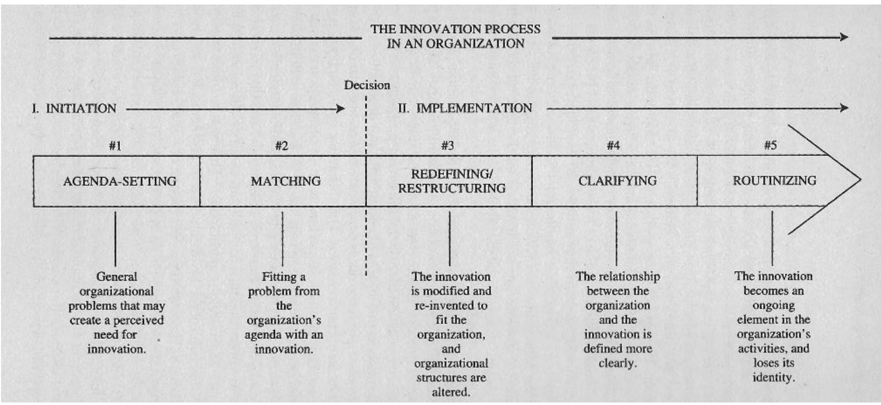

Figure 1: Five Stages in the Innovation Process in Organisations (Rogers, 2003)

Project Transition

A common way to analyse the adoption and integration of new technologies is the Gartner Hype Cycle (see figure 2). 'The hype cycle is set up in a predictable shape that defines the mainstream adoption of various technologies' (Grundmeyer, 2014). When a product or technology is initially adopted, there are high expectations and early adopters jump onboard, often driven by a fear of missing out. Some early adopters then experience disillusionment due to incorrect implementation, not enough understanding of the technology or not using it in a fit-for-purpose manner. Once these issues are addressed and the technology begins to become normal, users are more enlightened which leads to the plateau of productivity (Gartner, 2018, Grundmeyer, 2014).

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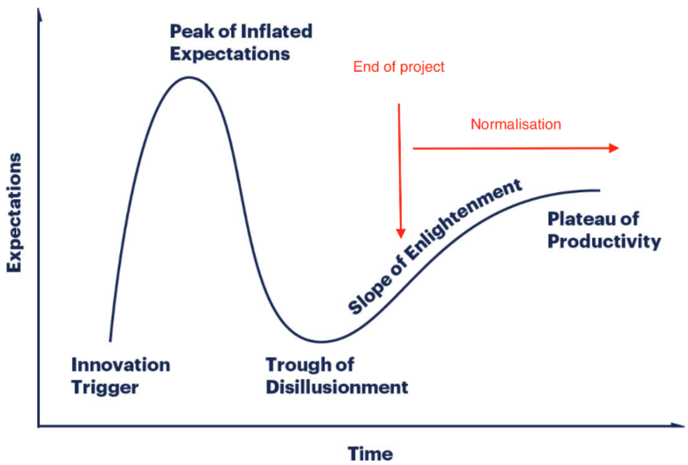

Figure 2: The Gartner Hype Cycle and indications of Griffith's PebblePad implementation

In the case of Griffith's PebblePad implementation, the project was coming to an end as users were reaching the 'Slope of Enlightenment' (see red arrows in Figure 2, below). In order to reach the longer-term institutional goal of ensuring all 50,000+ students develop an employability portfolio there needs to be institutional growth of another 20,000+ users. Once this level of growth is achieved it may signal that PebblePad use at Griffith has climbed the Slope of Enlightenment and reached the Plateau of Productivity.

Data from PebblePad reports support the continuing uptake of PebblePad in courses at Griffith. During the two-year project there were 732 active workspaces (a workspace is attached to a course and is where student work is collected and viewed/marked). At the time of writing (eight months post-project) there are 1087 active workspaces which indicates a 48% growth in usage in that period.

Learning Futures transition planning

Over the two-year initiation and implementation (Rogers, 2003) phase of the project, it was clear that the implementation phase had moved through the redefining and restructuring stage (see Figure 1) and to ensure successful organisation diffusion, the end-of-project requirements included clarifying and routinising the position of PebblePad within the institution. The project team deliberately planned for the transition of PebblePad from a supported and nurtured environment with significant central resources to an environment where PebblePad became one of many educational technologies supported by LF. As noted by Hansen & Greenaway (2017) and Slade et al. (2017), there is significant institutional risk if post-project resourcing is not considered as part of the end-of-project planning. Marshall (2010) goes further to say that as well as the typical products and processes developed during technology implementations, it is imperative that consideration be given to developing deep capacity and strengthen e-learning capability so that implementations remain valid and sustainable.

To this end there was not only a transition of support structures but also of the product knowledge, help-seeking and problem-solving skills. The team was conscious of the need to think about end-of-project and PebblePad's life after the project and therefore several focus areas were identified. These were:

- Training & workshops
- Online showcase
- Communications strategy
- Support resources
- Events
- Evaluation

Training & workshops

In order to maintain capacity-building and sustainable knowledge transfer, maintaining a schedule of training and workshops was important in the project-normalisation transition. During the project, four different workshops made up the workshop series, these were: *An Introduction*, *Supporting Reflection, Creating Interactive Resources* and *Understanding the Assessment Lifecycle*. As may be expected when introducing new technology, attendance was high throughout the project period with 402 unique attendees who attended one or more of the sessions (total session attendance numbers: 611). There were 88 sessions offered over the project period. These workshops provide structured content to participants while allowing them opportunities to learn from LF staff and their academic peers.

Train-the-trainer sessions were designed to develop LTCs as champions within their academic groups. Rogers (2003) highlights the importance of champions when innovating in organisations. He asserts that champions have common qualities which are:

> [T]hat they (1) occupied a key linking position in their organisation, (2) possessed analytical and intuitive skills in understanding various individuals' aspirations and (3) demonstrated well-honed interpersonal and negotiating skills in working with other people in the organisation. Thus champions [are] brokers and arrangers for an innovation in an organisation, helping fit it into the organisational context. (Rogers, 2003)

These qualities are all the qualities held by Educational Designers and LTCs at Griffith. Given that one of the goals of the project was to ensure sustained capacity, the train-the-trainer sessions were imperative to ensure champions diffused their knowledge of and belief in the system throughout the institution. These sessions would often include vendor attendance to deliver training in specific advanced functions.

Online showcase
The purpose of the PebblePad showcase website was to have a central place to direct staff and students who were looking for exemplars. These included student and staff portfolios as well as academic examples of PebblePad in practice. The showcase website provided links to further resources, specifically the 'Student Centred Activities in PebblePad' case studies which were housed in the Explore Learning and Teaching site (ExLNT). The web showcase was not only to inspire academics who were interested in seeing examples of PebblePad being used at Griffith, but also for LTC and support staff to refer to in their consultations with academic staff in the planning and design of courses and programs. This helps the LTCs continue to champion the implementation and supports them with broadening the use in their academic groups.

Communications strategy
Identifying and managing communication channels was critical as the channels provide an avenue to disperse information. Blog posts were submitted to LF Press (the Learning Futures blog site) on a regular basis. The project team use this channel to communicate many stories about PebblePad including the latest feature upgrades to the platform and successful use-cases. The current audience data shows this blog has reached over 5,700 unique visitors which makes it an excellent way to reach academic colleagues.

An important component of the ongoing communications strategy is in contributing to wider LF staff professional development sessions such as the Foundations of University Teaching course which specifically targets new to teaching and/or new to Griffith academics. PebblePad updates are presented to the monthly technology working group and on a less regular basis, to the ePortfolio Working Party (ePWP). The ePWP has stakeholders from across the university including representatives from each of the four academic groups. LF holds monthly meetings with the vendor to discuss any topics relevant to the PebblePad installation at Griffith. By ensuring that decision-making is still happening at various levels and by a variety of stakeholders, it is more likely that the innovation will become normalised. Rogers (2003) notes that when more stakeholders are involved in decision-making processes, innovations tend to have greater sustainability.

Support Resources
PebblePad support resources are an important part of the transition strategy as they provide users with just-in-time support and self-help resources. Online facts sheets provide users with easily digestible information on the tools in the VLE, and online modules (the Getting Started Series) give further information on how to use tools and include use-case examples. Student Centered Activities are case studies of pedagogical practice using ed tech tools and encourage academics to read, consider and, hopefully, design their own SCA. Griffith's PebblePad website contains help for staff and students, access to the showcase section and houses the archives of PebblePad event recordings. The embedded help menu inside each user's PebblePad home page is a direct link to Griffith's PebblePad support site. These just-in-time resources aid in the process of routinising practice because they are not seen as special or specific to the project, but rather are adopted as normal modes of support (Rogers, 2003).

Events
Events provide an opportunity to promote PebblePad's various applications within learning and teaching. This is an important component in the transition strategy because it highlights the versatility of platform to a wide audience. The Griffith PebblePad Symposium provides colleagues with highlights of in-practice examples and opportunities to see how others are using the platform. External events are further opportunities for staff to share their stories with the wider community and be recognised professionally for the results that they are achieving. Sharing at events also helps situate the work being done at Griffith in the wider ed tech and higher ed communities and reinforces the nomalisation of practice.

Evaluation
The purpose of evaluation in the transition strategy is to continuously improve practice, to identify trends and to be able to make decisions based on data. Several of the initial courses identified as early adopters were surveyed as part of the project. During the transition phase, survey results were used to make decisions on where to direct future resources (ie: conduct further face-to-face training) given that there was going to be reduced capacity with Learning Futures. Face to face training participants were also evaluated and the training sessions and workshops were adjusted according to feedback.

Normalisation

Since the project's conclusion PebblePad is being normalised within the suite of tools in the VLE. The LTCs in the Academic Groups have taken responsibility and ownership of PebblePad within their respective teams while LF still maintains custodianship. With the introduction of the Digital First strategy, LF must ensure that PebblePad maintains its position as a key technology in the VLE. Griffith's Digital First strategy includes commitment to use ed tech more broadly with the Learning Management System (LMS). PebblePad is integrated with the LMS via LTI allowing links from course materials to workbook and template resources. ATLAS (Active Teaching, Learning and Assessment Space) was also integrated and assessments could be completed within PebblePad resources, submitted directly to ATLAS and marks sent through to the LMS. This deep integration was one of the factors that aided in wide-spread use of PebblePad in coursework across the institution and is also a key factor in sustaining current use. These, along with other transition measures have assisted in moving PebblePad to a well-integrated tool in the VLE.

PebblePad was implemented in courses in each of the four academic groups, but to varying degrees. Two groups had well-embedded champions and these groups saw the biggest initial implementation. A third group was not as well resourced with champions so PebblePad took longer to embed. Monash University reported a benefit of having champions to develop relationships and continue to support capacity-building in academic staff (Hook, Macfarlan & Smith, 2018). Hansen and Greenaway (2017) similarly place importance on a "distributed support approach" to ensure that there is minimal risk to the institution if staff members leave or take on other roles.

Although the implementation project had concluded and the core project team disbanded, LF is still responsible for overseeing the ongoing uptake and use of PebblePad. Since the introduction of the VLE LF looks to maximise opportunities for PebblePad to integrate with other VLE tools. This includes liaison with the development team to explore how integrations work with products such as Echo360, H5P and Microsoft Teams.

Learning Futures is growing the visibility of PebblePad by highlighting the pedagogical uses of the tool in the newly-developed *Teaching in the VLE* (TiVLE) course. TiVLE is designed to provide academics with experiences using and integrating VLE tools in their courses. Participants in TiVLE have the choice to submit an optional assessment in a PebblePad template which means that anyone who submits will have had an experience using PebblePad (possibly for the first time) and will create a PebblePad asset. Slade et al. (2017) identified the benefit of attaching assessment weighting when introducing new technologies to students. Academics who participate in TiVLE and would like to be rewarded with a micro-credential will have been introduced to PebblePad through a meaningful but low-stakes assessment approach.

Conclusion

PebblePad was adopted as part of Griffith's employability strategy and the implementation was led by a project team within Learning Futures. The project team were aware of the risks associated with transitioning beyond the conclusion of the project and wanted to put a transition strategy in place to ensure PebblePad remained relevant, championed and continued to grow in use post-project. If this transition was successful, it would ensure that the institution was not subject to the risks identified with the end-of-project problems of other implementations (Slade et al. 2017 and Hansen & Greenaway, 2017).

As Griffith placed strategic importance on the VLE, PebblePad was embedded as a key VLE tool. This has helped institutional champions to continue to find ways to grow the use of PebblePad and progress along the Gartner Slope of Enlightenment. The deliberate systematic approach to ensure there was integration in academic use, support for champions and continued stakeholder communications meant that PebblePad is becoming part of the 'culture of the institution' (Hook, Macfarlan & Smith, 2018).

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Supporting student writing with an intelligent tutoring system for assignment checking

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In this paper we present the results of a prototype system designed as a draft assignment checker that students can use prior to the submission of their assignments. The tool was designed to provide descriptive timely feedback to students on their digitally submitted text-based assignments. This process allows students to submit draft versions of their assignments, obtain feedback and improve them before they make a final submission for marking. Students are able to access the results and descriptive feedback generated for the assignments they have uploaded and the software allows customisation of the evaluation measures based on the type of assignment and expectations of the academic staff. Findings from a survey of student feedback on the system are presented. Overall students found the system useful, but the tool needed to be incorporated into the assignment preparation process more closely to be effective.

Keywords: Data analytics, Assignment feedback, Evaluation

Introduction

The incorporation of technology into education has quickly become a serious consideration for educators and educational designers. Learning Management Systems, CD ROMS and online learning software have been leaders in the move from chalk and whiteboards to more serious considerations of education data mining and machine learning that enlist the power of computing for the purpose of teaching and learning design. The ability to analyse student behaviour in terms of LMS page views, log-ons, keystrokes and automated processes that deliver adaptive learning are just part of the current arsenal at the disposal of modern educators. Indeed, learning analytics is now considered a "thing" with the proceedings of the annual Learning Analytics and Knowledge conference (LAK) now ranking in the top six publications in the 2019 Google Scholar metrics for Education Technology (SOLAR, 2019).

An early development in the Education Technology area has been the emergence of Automated Writing Evaluation (AWE) systems and more recently the opportunity it has provided as a forerunner to intelligent tutor systems (Vitartas et. al., 2016). Most of the existing AWE systems have been designed for schools or as tools to assist in graduate entry testing rather than for use in higher education. In this paper we present the results of a prototype system designed as a draft assignment checker that students can use prior to the submission of their assignments in the higher education context. We start by providing a brief introduction to AWE's then provide details of the prototype trialed in this research before presenting preliminary results and feedback from students who have utilized the system.

Automated Writing Evaluation Systems

AWE is also known by the acronyms AES (Automated Essay Scoring), AEG (Automated Essay Grading) and AEE (Automated Essay Evaluation) (Hockly, 2018). Commentators with a less optimistic orientation towards the use of technology for this purpose are more likely to use the term 'machine scoring,' as, for example, in (Herrington & Moran, 2012). A history of AWE generally begins with the work of English teacher turned researcher Ellis Page, and his Project Essay Grade (PEG) beginning in the 1960s. In a 1966 article in The Phi Delta Kappan, Page insisted that "we will soon be grading essays by computer, and this development will have an astonishing impact on the educational world" (Page, 1966, p. 238). Ellis had an optimistic vision for writing feedback being provided to students much more extensively and in a timely manner than could be achieved by English teachers in school or college.

Page's vision is now much closer to reality in various automated formative tools, offering immediate descriptive feedback on writing (e.g. WriteLab, Turnitin's Revision Assistant, Pearson's WriteToLearn™, ETS' Criterion®, and Vantage Learning's MyAccess!). In addition to these proprietary products, a number of freely available services from the academic domain are also available to examine text and extract phrases including Coh-Metrix, WordNet, TerMine, MALLET Stanford Core NLP and Natural Language Toolkit. In 1999, E-rater, a tool developed by the Educational Testing Service, was used in the General Management Admissions Test, making it the first AWE to be used in a high-stakes assessment situation (Zhang in O'Leary, Scully, Karakolidis, & Pitsia, 2018, p. 162)

The field of AWE has made significant advancements and has attracted an impressive body of both scholarly and commercial interest. In 2003, researchers Mark Shermis and Jill Burstein edited a collection of work on the subject called Automated essay scoring: A cross-disciplinary perspective (Mark D. Shermis & Burstein, 2003). In their updated version, published in 2013, the title shifted to Automated Essay Evaluation: Current Applications and Directions. As Carl Whithaus points out in the foreword, “The shift indicates that feedback, interaction, and an altogether wider range of possibilities for software is being envisioned in 2012 than was seen in 2003” (in M. D. Shermis & Burstein, 2013, p. viii).

Newer possibilities for the application of AWE software include an increased focus on more complex forms of feedback and ‘feed-forward’ which support the learning process. Systems like WriteLab and Turnitin’s Revision Assistant have focused on the iterative nature of writing and on providing formative feedback, rather than grades, in order to encourage students to revise and rewrite their work. The most recent scholarship is all focused on using this technology as a learning tool which provides feedback and encourages revision (Ajetunmobi & Daramola, 2017; Allen, Likens, & McNamara, 2018; Bektik, 2017; Knight, Buckingham Shum, Ryan, Sándor, & Wang, 2018; Nathawitharana et al., 2017; Roscoe, Wilson, Johnson, & Mayra, 2017; Shibani, Knight, Buckingham Shum, & Ryan, 2017; Vitartas et al., 2016). Automated feedback can be embedded into discipline-related skills in order to become a valuable teaching and learning tool to develop writing (Shibani et al., 2017). Significant research interest has also been devoted to the use of AWE in teaching and finessing the acquisition of second languages, particular in relation to English as a Foreign Language (Bai & Hu, 2017; Huang & Renandya, 2018; Ranalli, 2018; Ranalli, Link, & Chukharev-Hudilainen, 2017).

Methods

The Next Generation Rubrics (NGR) project (Vitartas et al. 2016) was established at an Australian university initially as a proof of concept but then further developed into a working prototype. The tool was designed to provide descriptive timely feedback to students on their digitally submitted text-based assignments. Drawing on the concept of a marking rubric, or a “a scoring guide used to evaluate the quality of students’ constructed responses” (Popham, 1997, p.1), a set of evaluative criterion and guidance on expectations for the criterion were incorporated into the tool.

The main functionality of the software is to assess digitally submitted assignments and providing descriptive feedback to students. This process allows students to submit draft versions of their assignments, obtain feedback and improve them before they make a final submission for marking. Students are able to make multiple submissions to the assignment checking tool prior to submission. Upon submission of an assignment to the system, the software conducts content analysis, evaluates the assignment based on an evaluation criterion developed in association with the academic, and generates feedback via graphically based dashboard that highlights areas that could require further improvements. Students are able to access the results and descriptive feedback generated for the assignments they have uploaded, and the software allows customisation of the evaluation measures based on the type of assignment and expectations of the academic staff.

Study Design

The tool was made available to students enrolled in two subjects. The first was an introductory first year subject in the Bachelor of Arts (BA) that included 383 enrolments. As part of the assessment tasks, students were required to submit a 1500-word critical assignment in essay format. The second subject was a first-year subject from the Bachelor of Business with 271 enrolments. It required students to submit a 1500-word report on a macroenvironmental analysis of a manufacturing industry.

Information on the tool, instructions for its use and links to an external site hosting the software were posted on the subject’s learning management system (Moodle) assignment page. The introduction of the software was supported by internal emails to students and a briefing with staff undertaking the tutorials for the subjects. As the tool was relatively new and only in the prototype stage of development the use of the tool was made optional and there were no incentives or requirements for students to use the system. This may have limited the uptake of the tool, but it also provided insight into the interest and support among students for such a system. Ethics approval was obtained from the La Trobe University Human Research Ethics Committee.

Participants and Setting

A total of 35 students, 19 from the Business School and 16 from the School of Humanities and Social Sciences (HUSS) used the tool for one of their assignments during the semester. This represented a relatively low take-up as the subjects were relatively large. For example, the response rates were 7% and 4% for the Business and HUSS students respectively. However, it should be noted that there was no compulsion or promotion of the Tool's availability to students other than having an information link on the LMS site and so it was only those students who were self-motivated that engaged with the tool. In addition, the HUSS students were spread across regional campuses which may also have accounted for a lower take-up rate.

Students were able to submit their draft as many times as they liked. This allowed them to make adjustments to their assignment, then to recheck it. In this way a type of learning takes place by having students made aware of potential errors in their work and checking if the changes they make address the issues. This type of immediate feedback also has the advantage of learning in context as they have the feedback immediately and can see improvements based on their actions.

The total number of submissions by the HUSS students was 41, an average of 2.7 submissions for each student. However, several students only submitted once while others took advantage of the tool for multiple submissions. A similar approach was found with the Business Students, where there were 37 submissions, an average of 2.0 per student. The majority of students submitted only once, however a small number of students submitted more than five times. In the case of HUSS one student submitted six times while a Business Student submitted ten times.

Data Collection

At the end of the semester a survey was sent to the 35 students who had used the tool seeking feedback on their experience. Twelve students responded – a response rate of 34%, four from each subject and four who sought to remain anonymous. The following section reports on the findings to an online survey administered through qualtrics. An inducement to go in the draw for one of five $30 shopping vouchers was used as an incentive for the sample to respond. The survey consisted of 11 multi-part fixed and open-ended questions and took an average of 11 minutes to complete. The questions sought to identify the type of computer systems students used when accessing the tool, their experience with four features of the tool, the type of feedback they used, ratings for the feedback elements and opinions about the tool's usefulness and whether they would recommend the tool.
The majority of students (58%) used PC's to access the system while two (17%) used Mac's and three (25%) used a mobile device (phone or tablet). There appeared to be no differences in responses or difficulties encountered based on the system they used to access the feedback tool.

Results

Respondents were asked 'How easy or difficult did you find…' four aspects of using the system. These included their initial login to the tool, locating where to submit their assignment, uploading their assignment, and interpreting the feedback. Responses were recorded on a five point 'Extremely easy' through to 'Difficult' scale. The responses are reported in Table 1. The majority of students found the tool easy to use on all four aspects. However the majority of students found interpreting the NGR feedback only moderately easy rather than extremely easy. This may have been because some of the statistics were new to them and they had to read the detail on the feedback report to interpret the information. Only one student found the aspects of the initial login and interpreting the results as difficult. It is believed that some students encountered problems with the system because they were using the system off campus or had not logged on through the University system.

Table 1: Ease of use for steps in system use

How easy or difficult did you find:	Extremely Easy	Moderately Easy	Neither Easy nor Difficult	Slightly Difficult	Difficult
...your initial login to the Assignment Checker	41.7	41.7	8.3	8.3	0.0
...locating where to submit your assignment in the tool	50.0	33.3	16.7	0.0	0.0
...uploading your assignment(s)	66.7	25.0	8.3	0.0	0.0
...interpreting the feedback	41.7	50.0	0.0	8.3	0.0

Students were asked "What aspects of the feedback did you find most helpful" for three aspects of the tool. These included statistics on the assignment, the gauge showing target performance and the description of rubric criterion. Responses were reported on a five-point scale of 'Very helpful' through to 'Very unhelpful'. See Table 3 for the results. The majority of respondents indicated all aspects were either very helpful or somewhat helpful. One student indicated statistics on the assignment and the gauge showing target performance very unhelpful while another considered the gauge and description of the rubric criterion neither helpful nor unhelpful. It would appear the description of the rubric criterion was indicated as the most helpful aspect of the feedback.

Table 2: Most helpful features of the tool

What aspects of the feedback did you find most helpful?	Very helpful	Somewhat helpful	Neither helpful nor unhelpful	Somewhat unhelpful	Very unhelpful
Statistics on the assignment	33.3	58.3	0.0	0.0	8.3
Gauge showing target performance	33.3	50.0	0.0	8.3	8.3
Description of rubric criterion	58.3	25.0	8.3	8.3	0.0

Table 3 presents the results for student's ratings of ten statistics provided to students as part of the feedback. Responses were recorded on a five-point scale of 'Extremely Useful' through to 'Not useful'. Students found the word count, grammar error count and count of formatted in-text references to be the most useful of the statistics provided by the tool. The readability and spelling error count were also rated highly. The least useful measures were the discipline coverage and critical thinking term coverage. It is believed there may have been some misunderstanding among students of these tools based on qualitative comments and feedback on the tool.

Table 3: Usefullness of writing statistics

How useful did you find each of the following measures:	Mean	Extremely useful	Moderately useful	Neither useful nor not useful	Slightly not useful	Not useful	N/A
Word count	1.91	54.5	18.2	18.2	9.1	0.0	0.0
Spelling error count	2.00	63.6	9.1	9.1	9.1	0.0	9.1
Grammar error count	1.91	63.6	18.2	0.0	9.1	0.0	9.1
Referencing - count of formatted intext references	1.91	36.4	54.5	0.0	0.0	9.1	0.0
Referencing - count of number of references	2.36	27.3	54.5	0.0	0.0	9.1	9.1
Critical thinking coverage	2.45	27.3	27.3	27.3	9.1	9.1	0.0
Readability score	2.00	45.5	18.2	27.3	9.1	0.0	0.0
Discipline content coverage	2.18	45.5	18.2	18.2	9.1	9.1	0.0

Qualitative responses

Students were also asked if there was a measure they would have found useful that wasn't included in the tool. One student indicated that it would be helpful to have some tips to help improve the work and an interpretation of the gauges. Another thought they would like to have the tool look more like the Turnitin tool which highlights areas where there is similarity detected.

When asked whether they thought their reworked assignment was improved after using the assignment checker the majority said yes. For example, "Yes it helped me see where I was going well and where the mistakes were" (HUSS Student). Another replied "Yes, helped stay on point, made me re-think what I needed to change to meet the criteria" (Business Student). While a HUSS student noted "It made me realise I hadn't used enough critical thinking and topic terms, so I kept improving until I got the desired outcome on the gauge."

Students were also asked two summary questions about the tools usefulness and whether they would recommend the tool to others. For both questions the majority of students indicated they found it either extremely useful or very useful (64%) and most would recommend the tool to others – the net promoter score was 45.5 indicating a positive score.

Discussion and Conclusions

For the majority of the small sample of students who completed this study it was found the assignment checker was either very useful or extremely useful and they would recommend it to their colleagues. This is despite some students indicating that they did not find the tool useful. Of particular interest in this study was the small number of students who took the opportunity to use the tool. While the tool was available well before the assignment due date, it would appear that many students did not complete their assignments in time to use the tool, or could only use it once before the due date. The benefits from using assignment feedback tools such as the assignment checker will only occur if the tools are incorporated into the planning and development phases for the assignment preparation. This would require students understanding the benefits of using and editing their work prior to submission dates.

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A user-centred approach to understanding the support needs of university teachers using a Learning Management System: A Pilot study

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Providing effective, timely and relevant Learning Management System (LMS) support to teaching staff working within the higher education context is challenging, yet essential in order to meet learning and teaching goals. Crucial to the success of an effective support model, is understanding the needs of teaching staff, together with their enablers and barriers to using technologies. This paper reports on the work-in-progress of a user-centred project initiated by a large university faculty located in Victoria, Australia. The aims of the project are to: 1) gain insights into the way teaching staff use and understand the LMS in their learning and teaching context; 2) use these insights to assist in developing a service support model which improves the experience of teachers using the LMS. The project adopts design thinking and thematic analysis methodologies. This paper reports on the first aim of the project.

Keywords: Learning Management System, design thinking, user-centred, thematic analysis

Introduction

The adoption of Learning Management Systems (LMSs) for managing learning content and activities in the higher education context has grown rapidly over the last 17 years, and makes up a large portion of the technology support requirements for teachers (Schoonenboom, 2014). Whilst there in an increasing expectation for teachers to employ innovative and active learning strategies in both face-to-face and blended learning environments, there is still dissonance amongst teachers as to the value and usefulness of LMS tools to achieve learning goals (Schoonenboom, 2014). The extent to which a teacher uses the LMS tools may be connected to their personal underlying approach to teaching: whether they focus on information transfer or on student learning (González, 2012). More broadly, in a recent published survey, lack of academic staff knowledge re-emerges as one of the top three barriers to technology enhanced learning (TEL) development, in combination with lack of time and a supportive departmental/school culture (UCISA, 2018). Some studies refer to barriers such as lack of time, lack of academic staff knowledge, institutional and department level culture and budgetary constraints (Jenkins et al., 2018; Zanjani et al, 2013; Jenkins et al., 2011), others refer to technical and structural barriers (Scherer et al., 2019; Mosa et al., 2016; Rienties et al., 2013; Lawrence & Lentle-Keenan, 2013). Wingo and colleagues (2017) used the extended technology acceptance model (TAM2) to synthesise studies about faculty teaching online and highlight personal barriers such as fear of change, concerns about the reliability of technology, scepticism about student outcomes in online learning environments, and workload issues.

Designing a technology support model that effectively meets the needs of users (teachers), means understanding those users. To this end, we adopt design thinking and thematic analysis methodologies to focus on part 1 of the project: gaining insights into the way teaching staff use and understand the LMS, with the main goal of the project to address the question: How might we improve the teacher experience of using the LMS so that teachers can support and enhance the learning needs of students more effectively? This paper outlines the background for the project, methodology and methods used to develop an initial thematic map that identifies key themes and subthemes, and conclude with limitations and an outline of the next phases of the project.

Background

The Faculty of Medicine, Nursing and Health Sciences (MNHS) is one of the largest faculties at Monash University, employing over one thousand academic staff and delivering courses to over 14,000 enrolled students (Monash University, 2018). The Faculty typically has 400 to 450 active teaching units per semester. The university uses Moodle as its central LMS platform. Over the last four years, it has introduced a range of changes to the LMS, and how it is used in the delivery of courses. Factors that impact changes range from centrally invoked shifts to teaching strategies (for example, active learning strategies), potentially higher student numbers, more courses moving toward a blended learning strategy and/or teaching fully online. Day-to-day LMS support to staff in the Faculty is largely provided by the Faculty-level support team, e-Learning Services (eLS), who escalate issues to the central team (eSolutions) where necessary. Faculty and School-based Educational designers also provide additional individual learning design assistance and group training workshops on key learning and teaching topics.

Methodology and methods

This project adopts a user-centred design thinking methodology, which provides a framework for decision-making that reduces risk through evidence. The project phases are identified as Phase 1: discover and interpret, and Phase 2: ideate, prototype and test. This methodology considers Buchanan's (1992) process perspective of design thinking as an alternative to a step-by-step linear model and identifies communication among all stakeholders as a way of making sense of organisational services (or service design). A singular definition of 'design thinking' is problematic as it can have distinctly different meanings depending on the context in which it is used (Johansson-Sköldberg et al., 2013). In the context of this project, a simple, iterative and non-linear design thinking framework is used. At the heart of each phase is empathy for the user. Whilst these phases may appear to be linear, they are in fact non-linear and collaborative. We use thematic analysis (Braun & Clarke, 2006) to support the user-centred design thinking methodology.

To inform the design thinking discovery phase data were gathered using 1) an anonymous online survey, 2) one-on-one interviews and 3) journey mapping sessions. The collection of data and all subsequent analyses are approved by the Monash University Human Research Ethics committee. Informed consent was obtained by completion and return of the survey. A total of 96 participants from one faculty (Total N = 1128) responded to an online survey regarding their experience of using the LMS for teaching since January 2018. The survey was delivered using Qualtrics survey software and a frequency analysis was performed on all quantitative data using SPSS software. Following the survey, ten one-on-one, semi-structured interviews of 30 minutes duration were conducted. Interviewees were recruited via expression of interest (anonymous) from survey participants. Interviews were recorded and transcribed verbatim. Responses were analysed and coded for thematic analysis using QSR International's NVivo 11 data analysis software. Two informal journey mapping sessions (Rosenbaum et al., 2017; Kalbach, 2016) of approximately one-hour duration were conducted with 11 participants from teaching and support roles, recruited via an email invitation, from across two campuses (Clayton and Peninsula).

Results and Discussion

Initial thematic analysis of the online survey, one-on-one interviews, and journey mapping sessions highlights three main themes: 1) teacher interaction with the LMS, 2) seeking help, and 3) barriers. Figure 1 illustrates the themes, sub-themes and their relationships. This map will be refined through subsequent iterations.

Teacher interaction with the LMS

Results indicate teacher interaction with the LMS most frequently (more than five times per semester) centres on the use of tools related to assessment ('Assignment', 'Turnitin', 'Gradebook' and 'Quiz'), as well as access issues ('Groups' and 'Groupings'), followed by discussion forums ('Forum'), the latter of which can be used for instructional tasks, such as a discussion to enable peer interaction and learning. Whilst the context of use of the forum activity was not central to this study, in our experience, this activity generally ranges from simple socialisation to higher level cognitive and collaborative participation. For example, one interviewee stated they would "… ideally like to learn how to use the forums better… and it's difficult to get students to participate." Participants also indicated the frequent use of tools to add, organise and distribute content in the LMS, such as uploading files, URLs, pages and folders. This coincides with findings that LMS tools are more frequently used for the distribution of learning content and to provide information to students and less for collaboration and communication (Schoonenboom, 2014; González, 2010; Blin & Munro, 2008). Use of the LMS for information transfer rather than for student-teacher / student-student engagement has been identified in various studies on technology use in higher education (Laurence & Lentle-Keenan, 2013; González, 2010). In line with this, teacher's beliefs and teaching practices also influence the use of technology and particular tools to support learning and teaching (Laurence & Lentle-Keenan, 2013; González, 2012; Bain & McNaught, 2006).

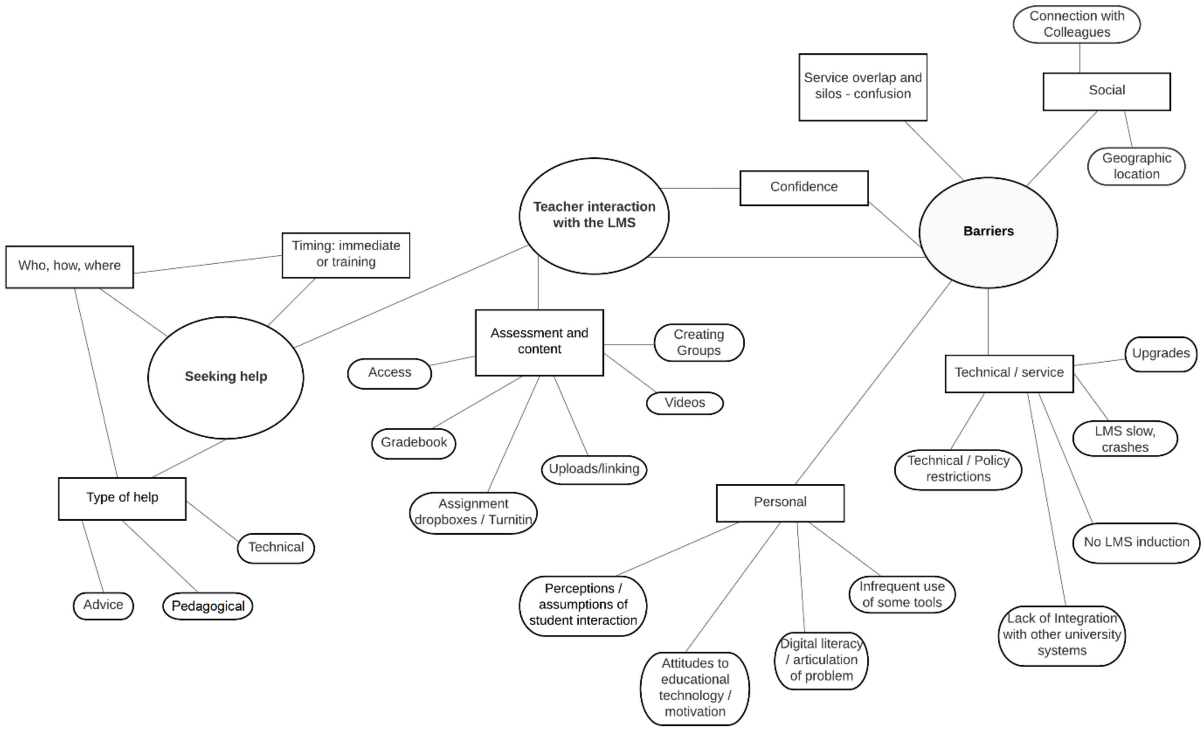

Figure 1: Initial thematic map

Seeking help

The channels by which teachers seek help with using the LMS shows that the majority ask their colleagues for help, followed by emailing support service or logging a ticket with eLS, or using Google to search for help. Times when help was most needed included the start of semester and before submissions of assessment tasks during semester and then again at the end of semester to ensure that grades and gradebooks were correct. A major issue is that interviewees indicated frustration and/or confusion about where to find or ask for support. Confusion stems from lack of transparency and clarity of the roles of central (eSolutions), faculty-based (eLS) support services and educational designers. Many interviewees got the names of the support groups mixed up and often did not know who they had spoken to or which ticketing system they had logged a job with. One interviewee stated: "Sometimes I must admit it is very difficult to know whether something is an eSolutions issue or an eLS issue." Some did not know about support services until well into their teaching roles, and found out about them through word of mouth, speaking to a colleague, or by ad hoc means, such as attending a teaching and learning workshop where it may have been mentioned. Once teachers knew where or who to go for help and established connections with specific support staff, they largely felt comfortable and confident in seeking the right type of help where needed, highlighting the importance of personal connections with support staff.

Barriers

Initial thematic analysis identified personal, social, as well as technical and service provision issues as barriers. Personal attitudes and motivations to use the LMS tools and the ability to be able to articulate a technical or problem or pedagogical challenge were issues for many teachers. Infrequent use of some tools and a lack of confidence in being able to use tools such as the 'Gradebook' by themselves were common – many worried whether they set up the Gradebook correctly for fear of potential error in student marks. For example, one interviewee stated: "… if you get Gradebook wrong, that's a big issue… because that's not something we necessarily do all the time, and I don't think it is completely intuitive…" Other barriers relate to the social connectedness to other teachers. In this faculty in particular, diverse geographic locations of teachers and teaching divisions can result in feeling isolated from colleagues. Similarly teachers who are new to teaching, with varying levels of experience with the LMS, may not know there are support services available and support services may be unaware of the difficulties faced by teaching staff because they do not hear from them.

Project limitations

This project focuses on the LMS, primarily because all teachers are expected to use this technology for their teaching, however, extrapolation to other educational technologies or platforms would be useful.

Being a large faculty with over one thousand teaching staff, we acknowledge the participant sample represents only a small portion of teachers (who volunteered their time), and not reflective of the full spectrum of teacher experiences, for example, teachers who, for whatever reason, never seek help from support services. Similarly demographic information, such as age, gender, level of teaching experience, whether full-time, part-time or casual was not captured, which means these factors are not considered in the analysis. In our survey teachers overwhelmingly self-rated their Moodle sites as 'good' to 'very good' on factors such as functionality, navigation and design, yet end of semester formal student feedback appears to contradict this. By nature, design thinking embraces broad stakeholder input, and in future we would like to broaden the project parameters to include the student experience of the LMS.

Next steps and conclusion

This paper discusses the work-in-progress of a user-centred project which aims to gain an understanding into the way teaching staff within a large university faculty use and experience the LMS, and then use this understanding to improve teacher support in using the LMS. It discusses the university context for the project, then provides initial analysis of the following methods used: online survey, face-to-face interviews, journey mapping and the creation of an initial thematic map. The broad themes of the thematic analysis that emerged in this project so far will require refinement as the project advances to Phase 2 and the following design thinking methods are undertaken: the development of personas, card sorting, ideation, prototyping and testing.

A clear pathway to developing a robust educational technology service delivery model is an understanding of: the teacher interaction with the LMS, how they seek help, and the barriers they face. However, we acknowledge that in order to close the gap between provision of educational technology services and teacher understanding of their use in truly innovative and engaging ways, it is crucial to recognise the importance of external factors such as strategic leadership and policy decisions in fostering TEL developments (Jenkins et al., 2018).

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An affordance based design framework for technology-enabled learning spaces

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Educational institutions today are transforming their traditional learning spaces into technology-enabled learning spaces to facilitate innovation in pedagogy and enhance the teaching and learning experiences of its users. This transformation is driven by the changing needs of the 21st century educators and learners, and changes in pedagogical practices to meet these learning needs. The advent of digital technologies into the classroom has altered the traditional notions of teaching and learning. It has redefined the idea, design and implementation of learning activities and experiences. Learning spaces play an important role in the educational enterprise because it is the locus where educators and learners; pedagogy, content and technology; environment and experience converge. The various affordances integrated into its design play a critical role in defining the opportunities and constraints that it imposes on educators and learners using the space. However, due to the existence of diverse needs, contexts and use cases, the conceptualisation, design and implementation of such spaces vary from institution to institution. This paper discusses how the PECTS affordance framework was used to conceptualise the design of a technology-enabled learning space and how Education Design Research (EDR) was used as a developmental framework for the iterative design cycles.

Keywords learning spaces, learning space design, technology-enabled learning spaces

Introduction

The steady proliferation of technology into classroom during the last decade has made possible new ways of teaching and learning which was previously unimaginable. It has torn down barriers and empowered educators and learners worldwide and enabled them to transcend the confines of their traditional classrooms and step into a brave new world where the only encumbrance is perhaps the limits of their imagination. This unprecedented access to a wide range of technologies has obligated a dramatic reimagination of how teachers, students, content and space can interact with each other and how various affordances of technologies and space design can be taken advantage of to support teaching and learning. It has also redefined the conceptualisation, design and implementation of various learning activities and experiences that takes place in such spaces. As a result, transformation of learning spaces has increasingly become one of the key concerns of policy makers and school leaders worldwide (Bannister, 2017).

The main objectives behind the transformation of traditional learning spaces into technology-enabled learning spaces is obviously to cater to the changing needs of the 21st century educators and learners and to support the changes in the pedagogical practices in response to these changing needs. The emergence of a constructivist learning paradigm and the shift of focus from teaching to learning has rendered most of our current learning spaces ill-suited to support the needs of today’s learners (Oblinger, 2006). Another important objective is to create opportunities for pedagogical innovation that leverage the affordances of space design and the technologies embedded into the space to enhance the teaching and learning experiences of its users. This focus on innovation in the design and use of learning spaces is an effort to “make a difference to pedagogical practice in the classroom” (Bannister, 2017). Oblinger (2006) has argued that innovation in learning spaces themselves can become drivers of change in pedagogical practices.

Learning space design plays a critical role in enhancing educational attainment (Leringer & Cardelino, 2011) because it “facilitates and inhibits behaviour and relationships between different actors” that use the space (Heerwagen et al., 2004; Rashid et al., 2006). Therefore, its design and the affordances integrated into its design, play a critical role in defining the opportunities and constraints that it imposes on educators and learners using the space. According to Sanoff (2001), learning spaces “mirror the ideas, values, attitudes and cultures of the people within it”. They create conditions and mediate interactions that promote teaching and learning (OECD, 2017). And when we add the element of technology integration, the relationship between learning space, its users and the learning resources becomes even more complex (Goodyear, 2008). Therefore, it is important to appreciate fully how technology is integrated and used in a learning space, how it informs its design, and how it mediates the social interactions that promote learning (OECD, 2017).

However, due to the existence of diverse needs, contexts and use cases, the conceptualisation, design and implementation of such spaces vary from institution to institution. Therefore, to embark on such an enterprise, institutions need strategies and guidelines to identify design considerations and good practices to deal with their own specific context and constraints. They need a design framework to ensure that the developmental outcome meets the institution's "educational visions and approaches to teaching and learning" and to help achieve the desired "educational transformation" (Leringer & Cardelino, 2011).

In this paper, we will discuss how the PECTS affordance framework was developed and used to conceptualise the design of a technology-enabled learning space and how Education Design Research (EDR) was used as a developmental framework to guide its iterative design cycles. It is hoped that our experiences of using these two frameworks can inform the design of similar technology-enabled learning spaces in the future.

Background

In order to meet the changing needs of 21st century learners and faculty in our institution, and to promote innovative pedagogies, the Learning Sciences and Technologies (LST) Academic Group (AG) at the National Institute of Education (NIE), Singapore embarked on the i-Space project to create a technology-enabled learning space. The AG is responsible for conducting training in ICT integration in education for pre-service student teachers, in-service teachers and higher degree learners at NIE. Prior to the development of i-Space, tutorials and workshops were held in eight Educational Computing Laboratories (ECLs) which followed the design of traditional computer labs with rows of personal computers arranged side-by-side.

Feedback from learners and faculty was that while this layout was suitable for carrying out traditional ICT lessons, the constraints imposed by design and technology called for a major rethink to meet the teaching and learning needs of a 21st century classroom (Bautista, 2013; Brown, 2006). It was also found that these ECLs were not really conducive for experimentation and implementation of innovative pedagogies supported by technology. Therefore, a team led by LST faculty and technical support members along with other relevant institutional stakeholders was constituted to conceptualize, design and implement the i-Space project.

The Design Process

The conceptualisation of i-Space began with articulation of the objectives behind the project. The key objectives identified after much deliberations were to:

- facilitate a wide range of innovative technology-enabled learning activities and experiences,
- lead and exemplify the use of technologies for innovative pedagogies to meet the learning needs of 21st century teacher educators,
- support the development of innovative mind-set and practices in teaching and learning with the support of technologies amongst faculty and students,
- promote digital literacy and nurture future-ready teacher educators, and
- translate research on various technology-enabled pedagogies into action in our various teacher education programmes.

While articulation of the objectives behind the project was the first and perhaps, the most important step towards its realization, some of the more pressing challenges that the team faced were determining its scope and scale, and deciding on framework used to guide the conceptualisation and implementation of project.

A list of affordances was populated after several rounds of consultation with the faculty, learners and other stakeholders about their specific needs and requirements. This is congruent with current and common practice of user-participation in decision-making activities (Burke & Grosvenor, 2003; Leringer & Cardelino, 2011). The goal was to promote greater sense of ownership of the learning space and user satisfaction by allowing the various stakeholders to have a say in the design process (Higgins et al., 2005). The PECTS framework was developed and then used to delineate and classify these required affordances. Various intended use case scenarios pertinent to the institution's context were also developed to further refine and update this list of required affordances.

Some of the intended use case scenarios for i-Space were for it to serve as:

- A teaching and learning space that supported the implementation of a wide range of existing technology-enabled pedagogies such as blended learning, distance learning etc.
- A space that supported ideation and experimentation of innovative technology-enabled pedagogies such as blended synchronous learning which requires live broadcast and synchronous communication and collaboration capabilities
- A digital maker space where faculty and learners could gain expertise in and co-create digital learning resources and solutions including 3D printing, chroma key technology, Audio Video editing and production, coding etc.
- A BYOD learning environment which was highly flexible and allowed multiple configurations.

This was then used to develop an initial concept of how this learning space would look like (design-wise) and what features it would have (affordance-wise). Education Design Research (EDR) methodology was adopted as a framework to guide the iterative design cycles of the i-Space project (Plomp, 2013). After each cycle, changes were made to the initial design based on feedback and new insights gained through an extensive evaluation process, which we called SELF. The SELF acronym stands for:

- Consultations with the relevant ***S****takeholders* to guide the technology and design choices (faculty, admin, computer support and services, finance, estate etc.)
- Consultations with ***E****xperts in the field (pedagogy, technology, learning space design etc.)*
- Review of ***L****iterature* (relevant theories, research on the design of technology-enabled learning spaces and the technologies embedded in them etc.)
- ***F****ield* visits (to review current technologies available in the market, to study the deployment of such technologies, and the design of existing technology-enabled learning spaces)

Using the SELF process, the initial concept was refined until the final design iteration stage was reached. Figure 1 depicts the adapted version of Plomp's iteration of systematic design cycles used by the team to conceive, design and implement the i-Space project (Plomp, 2013). Whenever important technology and design choices such as choice of technologies, furniture and space design had to be made during the iterative design cycles of the project, it was made with reference to this list of affordances and the intended use case scenarios.

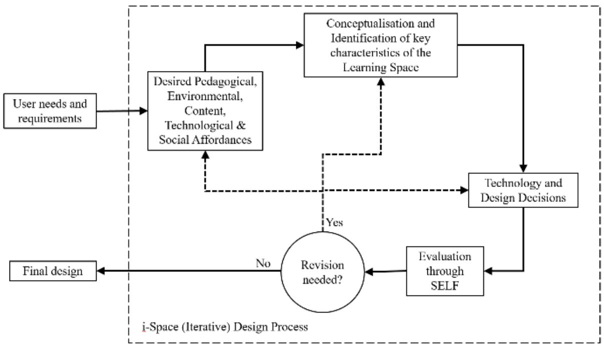

Figure 1: Adapted version of Plomp's iteration of systematic design cycles

Once the design did not need any further revision and the approvals of various institutional stakeholders were received, the final design was implemented and project realised within a year.

The PECTS Framework

Amongst the various frameworks explored were Pedagogy-Space-Technology (PST) framework by Radcliffe (2008) for designing new learning spaces and Pedagogical-Social-Technological (PST) affordance framework by Kirschner et al. (2004) for determining the utility and usability of educational systems. The OECD Learning Environments Framework which focuses on the core elements of learners, teachers, resources (i.e. space and technology) and content as well as issues of spatiality, connectivity and temporality was also among the important literature reviewed (OECD, 2017).

Radcliffe's Pedagogy-Space-Technology Framework (2008) is based on a question-driven inquiry process and focuses primarily on questions about the types of learning and teaching that the learning space aims to foster, how the design of the learning space (i.e. furniture and fittings), and integration of technology supports the types of learning and teaching envisioned. This framework is quite versatile and can be applied to a wide range of learning space projects (Radcliffe et al., 2008). The PST framework is a systemic approach towards achieving a good balance between pedagogy, space and technology by intentionally sequencing the design process and design considerations in a logical manner with recognition of the interrelationships that exists between these three elements and their influence over each other (Radcliffe et al., 2008).

In contrast, the Pedagogical-Social-Technological (PST) framework proposed by Kirschner et al. (2004) looks at learning environment and technologies as having pedagogical, social and technological components and their respective affordances. The concept of affordance, proposed by Norman (1998), refers to "the perceived and actual …properties of technologies that determine their usefulness and the ways they could possibly be used". According to Kirschner et al. (2004), the usefulness of a system can be determined by its utility and usability. While utility refers to the functionalities of a system, usability focuses on the ability of the system to support the intended tasks in an efficient and effective manner (Wang, 2008). Both utility and usefulness are critical considerations in the design of educational systems and artefacts such as learning environments (Kirschner et al., 2004; Nielsen, 1994; Wang, 2008). In educational contexts, while utility is more concerned with pedagogical and social affordances, usability is more concerned with technological affordances (Kirschner et al., 2004; Nielsen, 1994; Wang, 2008). Thus, pedagogical affordances of a learning environment refer to the teaching and learning activities that it supports; social affordances refer to the type of social interactions and presence it supports and technological affordances refer to its potential to help the users accomplish teaching and learning tasks with ease (Kirschner et al., 2004).

After studying these frameworks, a combined framework called PECTS, which synergises the important focus areas and considerations of both these frameworks and the OECD framework, was developed to help the team delineate the various affordances that we wanted this new learning space to have. PECTS stands for **P**edagogical, **E**nvironmental, **C**ontent, **T**echnological, and **S**ocial affordances. While environmental affordances consider both space and design elements of the learning environment; content affordances not only takes cognizance of content as one of the core elements of the OECD Learning Environments Framework (2017) but also as an important consideration of learner-content (resource) interactions in a learning space.

A list of affordances (Table 1) was populated after several rounds of consultation with the faculty, learners and other stakeholders about their specific needs and requirements. Various intended use case scenarios pertinent to the institution's context were also developed to further refine this list of required affordances. This was then used to develop an initial concept design of how this learning space would look like (design-wise) and what features it would have (affordance-wise).

Table 1: i-Space's PECTS affordances

Pedagogical	Environmental	Content	Technological	Social
Blended synchronous learning	Flexible	Resource creation	Intelligent recording and storage	Remote conferencing
Distance learning	Comfortable	Curation and access	Learning anytime and anywhere	Content sharing
Flipped learning	Interactive	Data collection for research	BYOD	In-class collaboration
Collaborative learning	AV Recording friendly	Analytics	Support for collaboration	Remote collaboration

Conclusion

Recent studies on learning spaces advocate the need to engage stakeholders in the conceptualization, design and implementation of learning space designs. The usage of PECTS to delineate the required affordances of the learning space in concert with a high ratio of end-user engagement and the utilization of the EDR framework to guide the iterative design cycles of the i-Space project led to its successful implementation and great end user feedback. Use of SELF, as a process, informed and refined the iterative designs of i-Space. It ensured that it met the needs of the stakeholders, supported the pedagogical innovations envisioned, kept us updated with the various developments in the field of technology-enabled learning space design, and helped us understand the various affordances of emerging technologies and make informed decisions. The concept of learning space design is constantly evolving and becoming more complex and multi-disciplinary. As such, four most important determiners of success in the implementation of a learning space design project are i) the degree of end-user engagement to clarify the needs and requirements, ii) framework(s) used to guide the design process, iii) the breadth and depth of expertise of the project team, and iv) the rigour of the iterative design process. In terms of technology integration, while innovation is important, it must always be guided by practicality and impact on teaching and learning. What is available and good may not always be right for your institution. Therefore, ultimately learning space designs must meet the needs of its users; not the other way around.

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Open to learning

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The Open Learning Environment (OLE) is a novel feature of the new curriculum at The University of Sydney, aimed at encouraging students to personalise their learning through a suite of short modules and fully interdisciplinary units.These units are designed to present students with opportunities to broaden their education, develop graduate qualities and upskill. Comprising an open market for students, the OLE provides fully flexible, online and fee-free units incorporating auto-marked assessments and credentialing using badges and blended for-credit units to develop skills or try new disciplines and areas of interest. Launched in 2018, overall enrolments are strong but vary hugely across available units. Satisfaction and performance similarly varies considerably with both higher failure rates and higher numbers of students receiving higher grades than in other units.

Keywords: open learning, microcredentials, online, graduate qualities, interdisciplinary

Introduction

In 2018, The University of Sydney launched a new undergraduate curriculum designed to revitalise its liberal studies degrees and ensure that they are flexible and relevant for contemporary society and future careers (Horizon Report, 2018). The Bachelors of Arts (BA), Commerce (BCom) and Science (BSc) were completely restructured with shared curriculum rules to ensure flexibility for students to take majors from across the institution and the ability to innovate at the component level. Alongside the re-configuration of the course structure, novel curriculum features were introduced including:

- Experiential, real world, interdisciplinary project units involving industry and community partners
- Exchange and overseas study opportunities
- Shared majors
- “Dalyell stream” for high achieving students
- The Open Learning Environment (OLE)

The OLE comprises a collection of units that aim to offer opportunities for skill and knowledge extension through a diverse range of topics, typically from outside their discipline. Students in the BA, BCom and BSc and some smaller degrees are required to take credit-bearing units from the OLE. All students and staff can 0 credit OLE units for free, either as taster courses or as short modules in their own right. This paper describes its structure, development, implementation and evaluation. Alongside a description the function at the curriculum level, it includes an overview of how OLE units operate in the learning management system (LMS).

Overview of The University of Sydney and the need for the OLE

The University of Sydney is Australia’s oldest and is a public institution offering an extremely comprehensive range of disciplines. Like other Australian universities, it has rapidly expanded both through the widening participation agenda of the federal government and substantial growth in international student numbers. In 2019, there are around 70,000 students and 7500 staff. Given the diversity in the student body and the increased interdisciplinary nature of the curriculum, there is a strong need for students to be able to pick up skills at all stages of their degrees, as and when they need them. The comprehensive nature of the curriculum means that students potentially have the opportunity to study a wide range of topics. However, such a huge variety can be daunting. Many students will not want to explore outside their broad disciplinary interests and strengths or commit valuable credit points and time. The OLE was conceived to meet these needs by:

- Encouraging breadth of learning and exploring individual interests outside their main discipline(s)
- Assisting students in building novel skill combinations for their studies and careers

Students taking liberal studies degrees must complete 144 credit points. Commonly, they do this through completing four 6 credit point units in each semester, over three years. Students must now include 12 credit points from units in the OLE. Although most units are worth 6 credit points, credit-bearing OLE units may be 2 or 6 credit points. The smaller value reflects the desire for shorter modules to develop skills, as tasters and to allow students to choose a wide range of units. Students take between 2 and 6 OLE units to complete the requirements of these which contribute to the overall mark with the same way as other units.

One of the most novel aspects of the OLE is the pairing of each credit-bearing unit with a 0 credit point version. As detailed below, the latter are devised to be a subset of the former and to be self-contained courses in their own right. The 0 credit point OLE units are free for all students and staff, both of whom can take as many of them as they want. Whilst the credit-bearing units are timetabled in particular sessions, the 0 credit point units are intended to be available throughout the year with students completing them at their own speed. Although every credit-bearing unit must be paired with a 0 credit point unit, standalone 0 credit point units are also allowed. The full range of marks and merit grades are available in the credit-bearing units but the 0 credit point units can only be passed. Presently, completion is not recognised on the transcript. Instead, students receive a digital badge as a microcredential, to display on social media.

The OLE is conceived as an internal collection of MOOCs. The 0 credit point units are free, available throughout the year with usually no teacher presence week-to-week. This has led to considerable design challenges, particularly as the institution is very inexperienced in fully online teaching in the undergraduate space. However, a strategic benefit of this is an enhancement of the wider curriculum and teaching approaches.

Structure and design of OLE units

In 0 credit units, content is delivered through short videos, podcasts and readings and assessment is through multiple choice question (MCQ) quizzes. Students must be allowed to complete quizzes multiple times. This requires the quizzes to be built from question banks. In the better units, feedback is both given and designed to assist the student with their misconception or error rather than to simply give the correct answer away (Butler, 2018). Professional learning support in writing good MCQs and feedback is vital.

The remaining teaching in the credit-bearing units can follow any form from fully online to fully face-to-face. Similarly, the full range of normal assessment types are possible, with rigorous academic integrity. Given the experimental nature of the OLE and its increased focus on personal and skill development, interdisciplinarity and online learning, a strategic aim was to use it to develop more interactive pedagogical approaches and more authentic and multimodal assessments (Villaroel et al, 2018), (Kress, 2005).

Within these constraints, two modular approaches were used to design the learning outcomes, activities and assessments depending on the intent of the course:

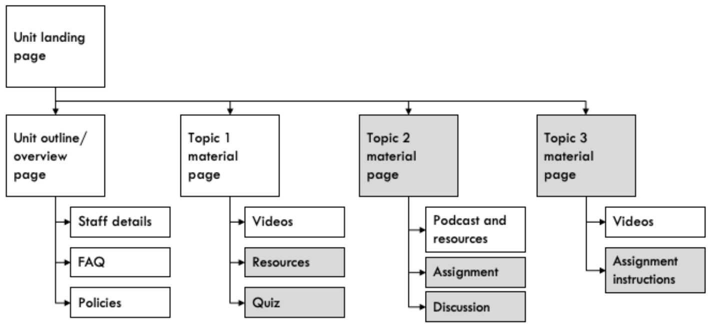
1. Taster. In this approach, all students complete the first few modules and those enrolled in the 2 or 6 credit point version complete the remainder. The course completed by the 0 credit point students is a meaningful introduction or ‘taste’ of the overall topic. The learning outcomes for the 0 credit point unit form a subset of those for the credit-bearing version. This approach is illustrated in Figure 1(a).
2. Spiral. This approach is akin to Bruner’s spiral learning model (1985). The 0 credit point students covers all material at a basic level and the credit-bearing version covers the same topics at a deeper, more complex level. The learning outcomes for the two units thus cover the same topics but the initial active verb is different. This approach is illustrated in Figure 1(b).

There are several reasons for fully embedding the 0 credit point unit in its credit-bearing partner. Pedagogically, it allows for both the taster model, aimed at developing initial skills in a subject, and the spiral model, for expanding knowledge. Each coordinator can choose the appropriate model or a mixture of both. Strategically, it encourages coordinators to actively produce engaging tasks and assessments in a fully online environment. If these were not embedded within the credit-bearing unit, resources might not be made available for their development or improvement. Practically, because they do not attract fees, a ‘set and forget’ approach might lead to them being neglected. To avoid this, the marks from the 0 credit point unit must contribute to those of the credit-bearing unit and this is only practical if they are housed in the same website.

Unit website design and operation

Both the 0 credit point and its credit bearing partner unit are in the same website in the learning management system (Canvas). The educational design follows that illustrated in Figure 1 with the topics utilising Canvas modules. The two cohorts of students belong to different Canvas sections to control access to assessments. There are no fees associated with the 0 credit point units: no staff workload can be assumed for the assessments. All of their assessments must use automarking tools inside Canvas or available LTI tools. Most coordinators have chosen to use MCQ quizzes, drawing questions from pools so that students can meaningful repeat them. Two particular issues arose as the operation of the OLE was considered:

(a)



(b)

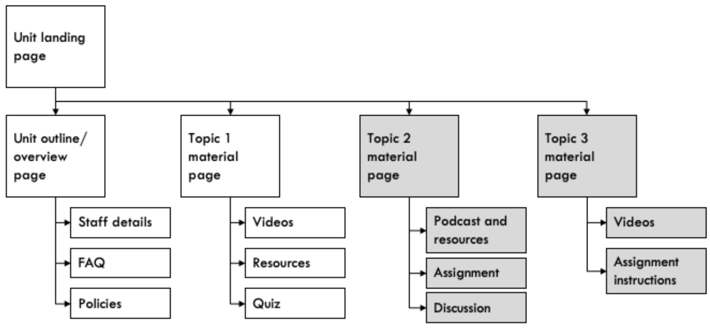


Figure 1: Indicate modular structures for (a) taster and (b) spiral OLE units with tasks undertaken by the students enrolled in the credit-bearing units shown in grey.

1. The student enrolment system (SITS) could not be configured to handle 0 credit point units that run all year. To overcome this, a separate website was developed for students both to learn about the 0 credit point OLE units on offer and to enrol/unenrol from them.
2. Canvas presently has no mechanism for controlling access to content for different cohorts of students. To overcome this issue, a 'fake' assignment is built into each site as a pre-requisite for accessing all modules belonging to the credit-bearing unit. When a student enrols through SITS, a fake grade is entered for this assignment through the enrolment script so that the student can access the required content. If a student unenrols, the mark is removed and the module completions are refreshed via the enrolment script.

Completion of the 0 credit point modules and assessments by a student triggers release of a digital badge using the Badgr LTI. These are downloadable by students and each badge's authenticity can be electronically confirmed. Figure 2 shows a badge obtained for one of the OLE units.

(a)

(b)

Figure 2: Example of (a) an electronic badge and (b) backpack for completion of a 0 credit point unit.

The 2 and 6 credit point units are evaluated by the standard institutional unit of study survey and the results form part of the normal faculty quality assurance processes. Given the interdisciplinary and cross-faculty nature of the OLE, however, the results are also reported to the institutional Board of Interdisciplinary Studies which has an overall role of monitoring the performance of the OLE. A separate survey is also continuously available on each Canvas site for the students enrolled in the 0 credit point units.

Composition of the OLE and enrolments

The OLE launched with 60 pairs of 0 and 2 or 6 credit point units and 8 standalone 0 credit point units. In 2019, an additional 35 pairs were added together with a further 3 standalone units. 36 pairs and 2 standalone units are currently under development for 2020 including a set of 11 pairs of 0 + 2 credit point units designed for higher degree by research (HDR) students as part of a new PhD curriculum. These units cover a wide range of topics as can be seen from their titles. The OLE is an open market – undergraduate students can choose any combination of units and there are no pre-requisites. Table 1 shows the number of units in broad theme areas and the 2019 enrolment numbers. Unit names and links to handbook descriptions for currently available units are listed in. the Supplementary Information. As shown in Figure 3, enrolment numbers in individual units vary hugely – two units have enrolments over 1000 and several have fewer than 10 students.

Table 1: 2020 OLE units and 2019 enrolments (as measured in April 2019).

Theme	Number of units			Enrolments
	0 only	0 + 2	0 + 6	
Basic skills in programming	0	8	0	634
Data analysis & numerical skills	1	11	0	892
Developing research skills	6	3	0	90
Economics, entrepreneurial & design thinking	0	9	0	1571
Ethics, ethical reasoning, contemporary debates & critical thinking	0	21	0	2833
Foundational & advanced communication skills	2	11	2	2925
Health challenges & medical science	2	19	0	3909
Personal, interpersonal & intercultural skills	1	18	9	3064
STEM literacy	0	6	0	1039
Teamwork, team leadership and project management	1	1	0	132
Ethics (HDR)	0	2	0	0
Qualitative analysis (HDR)	0	2	0	0
Quantitative analysis (HDR)	0	7	0	0
Total	13	118	11	17089

Whilst the 6 credit point units tend to run in the usual 13-week semesters, many of the 2 credit point units run in intensive, month long sessions. Coordinators can also elect to run their units in multiple sessions.

Figure 4 shows the 2019 enrolments and the number of units available by session. Whilst staff and students appear to prefer the traditional semesters, the April intensive session seems to be popular with both. The July intensive, corresponding to the conventional winter break has been selected by a surprising number of coordinators but does not appear to be popular with students.

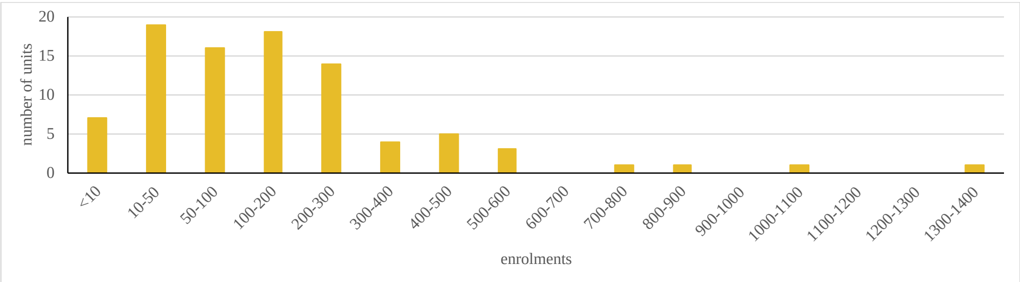


Figure 3: Variation in enrolments for units of study

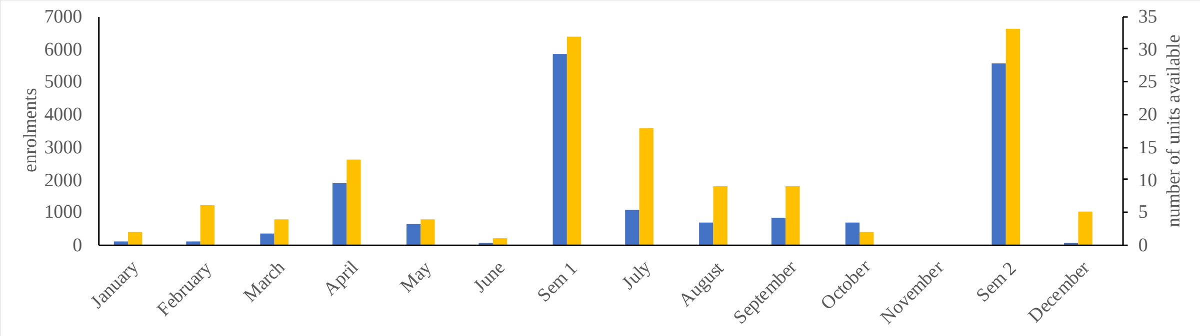


Figure 4: 2019 enrolments (blue) and number of units (yellow) available by session.

Evaluation of the first year of the OLE

In its first year, the OLE attracted 8,279 enrolments with students averaging just over 6 credit points. Preliminary figures for 2019 also suggest that students are taking units approximately equally over the first 2 years. Students from Engineering, Business and Science seem to take advantage of its interdisciplinary nature, with strong enrolments in units run Arts and Social Sciences (FASS). Students from FASS, though, tend to enrol in units from their own faculty, although these cover a wide range of topics. Although Business students tended to pick units run by FASS, very few external students chose units from Business. Overall, in its objective of allowing students to broaden their education, the OLE appears to have been reasonably successful.

OLE units showed wide variability in both student performance and feedback, with pass rates of around 5% lower than for other units and markedly higher absent fail rates. This points to underlying issues with student engagement and the educational design. The percentage of students gaining a “High Distinction” (HD - a mark over 85%) was over twice as high as in other units. This figure hides a considerable variation - 100% of students gaining a HD in some units and zero in others. This may reflect the skill mastery nature of some units but there are equity concerns given the open market nature of unit selection by students.

Overall, students were somewhat less satisfied with their experiences in the OLE units. Again, the performance varied markedly with many popular and unpopular units. Students were particularly critical of the feedback they received on their assessments, including that in the auto-marked online quizzes. Students were also critical on the reliance on video for delivering content and for variation in the expected workload across the OLE. Students also felt that some topics were not sufficiently academic in nature.

Given the experimental nature of the OLE, the institutional immaturity in online learning and the need to build enough units to meet the breadth required and the number of students in the participating degrees, it is perhaps not surprising that the results from 2018 were somewhat mixed. At the end of 2018, educational designers produced reports on each OLE unit website, with areas identified for improvement. Each coordinator received these and a detailed quantitative and qualitative analysis of the performance and feedback data. In 2019, coordinators can apply for additional central grant funding to enhance their units. It is likely that low enrolment units will be removed and additional units added as needs or interests are identified. A further review will be carried out at the end of 2019 to ensure that quality improvements have been made.

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Supplementary Information - Open Learning Environment Units

The table below lists all of the OLE units available in 2019 and in development. Links to the 2019 Handbook entries outlining the content of the units and assessments are given where available.

Theme and unit name	Credit points	Level
Basic Skills in Programming		
Coding Literacy	0 + 2	1000
Interactive Web Pages with Javascript	0 + 2	1000
Understanding Web Skeletons & Skins	0 + 2	1000
Analysing & Plotting Data: Python	0 + 2	1000
Analysing & Plotting Data: R	0 + 2	1000
Numbers & Numerics	0 + 2	1000
Foundations of Quantum Computing	0 + 2	2000
Writing with Latex	0 + 2	1000
Data Analysis & Numerical Skills		
Statistical Data Visualisation	0	5000
Beginner Programming for Data Analysis	0 + 2	1000
Managing & Analysing Data with SQL	0 + 2	1000
Data Science in Astronomy: Algorithms	0 + 2	1000
Data Science in Astronomy: Analysis	0 + 2	1000
GIS: Geographic Information Systems	0 + 2	1000
GIS: Problem Solving	0 + 2	2000
GIS: Thinking Spatially	0 + 2	2000
How to Estimate Anything	0 + 2	1000
Shark Bites & Other Data Stories	0 + 2	1000
Complexity: Grids, Contagions, Swarms	0 + 2	2000
Social Network Analysis Principles	0	2000
Developing Research Skills		
Approaches to Cross-Cultural Fieldwork in Southeast Asia	0	5000
Ethnographic Research Methods	0 + 2	1000
Presenting Your Research	0 + 2	5000
Fact or Fake News? Evaluating Sources	0	1000
Field Notes: Interdisciplinary Methods	0	5000
Going Beyond Google: Search Basics	0	1000
Quality of Life Research Principles	0	5000
Research at Large National Facilities	0	5000
Research Data Management	0 + 2	2000
Economics, Entrepreneurial & Design Thinking		
Economic Strategy & Negotiation	0 + 2	2000
Economics of The Everyday	0 + 2	1000
How Economic Policy Remade Australia	0 + 2	1000
The Global Economy in Australia	0 + 2	2000

Understanding Creativity	0 + 2	2000
Business Entrepreneurship: Bootstrap Finance	0 + 2	1000
Business Entrepreneurship: Business Models	0 + 2	1000
Business Entrepreneurship: Guerrilla Tactics	0 + 2	1000
Cryptocurrency Markets & Investments	0 + 2	1000
Ethics, Ethical Reasoning, Contemporary Debates & Critical Thinking		
(Im)Politeness in Global Society	0 + 2	1000
Australian Perspectives: Rugby League	0 + 2	1000
Culture & Urban Environmental Design	0 + 2	2000
Global Ethics: Migration & Nation	0 + 2	2000
Global Ethics: Philosophy	0 + 2	2000
Global Ethics: The Great Barrier Reef	0 + 2	2000
Power & Identity in a Global Era	0 + 2	2000
Thinking Critically	0 + 2	2000
Understanding Europe	0 + 2	2000
Understanding the Arab World	0 + 2	2000
Understanding the USA	0 + 2	2000
World Cultural Heritage	0 + 2	2000
Business Ethics: Interactive Cases	0 + 2	1000
Pseudoscientific Thinking	0 + 2	1000
Understanding Animal Welfare	0 + 2	1000
Music & Australian Indigenous Identities	0 + 2	2000
Mindfulness Research & Practice	0 + 2	1000
Surviving Australia's Deadly Animals	0 + 2	1000
Modern Alchemy: Lotions & Potions	0 + 2	1000
Drug Wars	0 + 2	2000
US Violence	0 + 2	2000
Foundational & Advanced Communication Skills		
Digital Influence Through Social Media	0 + 6	2000
Presentation Skills: Public Speaking	0 + 2	2000
Presentation Skills: Speaking in Class	0 + 2	2000
Writing A Literature Review	0	5000
Writing for The Digital World	0 + 6	2000
Wiki Writing for The Web	0 + 2	2000
Communication In STEM	0 + 2	1000
Reading & Writing Mathematics	0 + 2	1000
Digital Communication: Sound	0 + 2	1000
Music Theory & Notation Essentials	0 + 2	1000
Presentation Skills: Speaking Formally	0 + 2	1000
Writing About Music	0 + 2	1000
Origins of Mathematics	0 + 2	2000
Telling True Stories	0 + 2	2000

Health Challenges & Medical Science		
Cancer Survivorship	0 + 2	2000
Radiological Interpretation: The Chest	0 + 2	1000
Chronic Disease Prevention	0	1000
Health Challenges: Cardiovascular Disease	0 + 2	1000
Health Challenges: Diabetes	0 + 2	1000
Health Challenges: Evolution, Health & Disease	0 + 2	1000
Global Challenges: Planetary Health	0 + 2	2000
Health Challenges: Allergy & Autoimmunity	0 + 2	1000
Health Challenges: Oral Health	0 + 2	1000
Health Challenges: Pain & Society	0 + 2	1000
Health Challenges: Physical Inactivity	0 + 2	1000
Health Challenges: Sleep	0 + 2	1000
Toxicological Evaluation	0 + 2	2000
Anxiety & its Disorders	0 + 2	1000
Health Literacy for Better Lives	0 + 2	5000
The Science of Health & Wellbeing	0 + 2	1000
Introduction to Pathogen Genomics	0	5000
Pharma Insights: A Global Perspective	0 + 2	5000
Medical Frontiers: Assisted Reproduction	0 + 2	2000
Medical Frontiers: Stem Cell Therapies	0 + 2	2000
Health Challenges: Weight Regulation	0 + 2	1000
Personal, Interpersonal & Intercultural Skills		
Aboriginal Sydney	0 + 2	1000
Community Engagement for Change	0 + 2	1000
Cultural Competence: Fundamentals	0 + 2	1000
Cultures of Food: Europe	0 + 2	1000
Disability Awareness & Inclusivity	0 + 2	1000
Experience China	0 + 6	2000
Experience Germany	0 + 6	2000
Experience Indonesia	0 + 6	2000
Experience Italy	0 + 6	2000
Experience Japan	0 + 6	2000
Experience Korea	0 + 6	2000
Experience the Arab World	0 + 6	2000
Experience the French-Speaking World	0 + 6	2000
Experience the Spanish-Speaking World	0 + 6	2000
Indigenous Histories	0 + 2	2000
Professionalism in the Workplace	0 + 2	2000
Sacred Feasts: Ritual Food & Drink	0 + 2	2000
Understanding Critical Reflection	0 + 2	1000
Student Leadership: Community Engagement	0 + 2	1000

Student Leadership: Peer Mentoring	0 + 2	1000
Student Leadership: Representation	0 + 2	1000
Cultural Competence in Natural Science	0 + 2	1000
How We Make Decisions	0 + 2	1000
The Science of Sexuality	0 + 2	1000
Developing Your Emotional Intelligence	0 + 2	1000
Psychology of Faith	0 + 2	2000
Ethnopharmacology	0 + 2	2000
From My Degree to My Career	0	1000
STEM Literacy		
Astronomy: From Big Bang to Darkness	0 + 2	1000
Astronomy: From Earth to Exoplanets	0 + 2	1000
Astronomy: From Stars to Black Holes	0 + 2	1000
Psychology of Crime	0 + 2	2000
STEMM in the Workplace	0 + 2	2000
Symmetry	0 + 2	1000
Teamwork, Team Leadership & Project Management		
Managing Your Project	0 + 2	1000
Project Management for Research	0	5000
Ethics (HDR)		
History of Research Ethics	0 + 2	5000
Fieldwork Ethics	0 + 2	5000
Qualitative Analysis (HDR)		
Qualitative Research for Law & Policy	0 + 2	5000
Understanding & Using ABS Data	0 + 2	5000
Quantitative Analysis (HDR)		
Research Design for Clinical Studies	0 + 2	5000
Computational Analysis for Omics Data	0 + 2	5000
Data Wrangling	0 + 2	5000
Linear Modelling	0 + 2	5000
Multivariate Data Analysis	0 + 2	5000
Experimental Design for Life Sciences	0 + 2	5000
Quantitative Research Design	0	5000
Fundamentals of Quantitative Research Design	0 + 2	5000

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It's Elemental: Technology Enhanced Learning (TEL) as scalable and sustainable student-centered practice in context

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Many educational institutions are facing the challenge of how to implement Technology Enhanced Learning (TEL) in a meaningful, scalable and sustainable manner. This implementation is not a transition from change project to business as usual, but a fluid and continual narrative embraced by all that must be personalized for the diverse cohort it impacts. RMITs ongoing and evolving solution involves a combination of approaches that touch on strategic initiatives that operationalize standards (Elements) for consistency of student-centered teaching, capability building and training, resource development, technology implementations and organisational structures. This solution allows meaningful collaboration between professional and academic staff that values the interplay between learning design and discipline specific teaching practice. To operationalize this TEL solution with a focus on student-centred teaching, agile approaches have been used at RMIT. These approaches assist in placing value on people and the holistic relationship and interdependencies between the context of teaching and learning activities, and the methodologies used to enable change in practice.

Keywords: TEL, pedagogy, practice, agile, student-focused, student-centered, capability, teaching strategies, organisational change, framework, elements, standards

Introduction

Many educational institutions are facing the challenge of organisational change and how we can implement Technology Enhanced Learning (TEL) in a meaningful, scalable and sustainable manner (Marshall, 2018). Furthermore, evidence suggests that higher education teacher engagement with TEL is a complex relationship. The efficacy of TEL use is interdependent on conceptual approaches to higher education being student-centered, with clear distinctions between novice and experienced teaching staff in their ability to adjust conceptually in practice (Englund, Oloffsson & Price, 2017). The TEL challenge is not simply one of technology implementation and integration, but also of process, faculty (both professional and academic staff), pedagogical training, resourcing, and of organisational structure to facilitate the evolution of working within an industry whose students are part of changing social, cultural and political structures. Thus, the challenge of implementation is not that of a transition from a change project to business as usual, with clean change management between organisational states; implementing TEL is a fluid and continual narrative for all that must be personalized for the diverse cohort it impacts.

The narrative conveyed in this paper, and more broadly as a chapter in RMIT University's ongoing implementation of TEL, explicitly emerged in 2017 with the introduction of our new LMS – Canvas. The proposed solution, ongoing in its evolution, involves a combination of approaches that touch on strategic initiatives driven by RMIT leadership, endorsed and operationalized benchmarking and standards, capability building and training, resource development, technology implementations, and the facilitation of organisational structures to allow meaningful collaboration that capitalizes on existing institutional expertise. It describes one institution's change journey and exemplifies RMIT's response to the challenges faced by all.

At the core of TEL solutions is the need to place a focus on the holistic relationship and interdependencies between the context of teaching and learning activities (students, faculty, department, institution, technological and societal) and the criteria for effective teaching practice (Devlin & Samarawickrema, 2010). It has been well established that effective teaching in outcomes-based higher education is successful when constructive alignment and student-centered approaches are employed that promote deep learning (Biggs & Tang, 2011). Student-centered approaches to teaching that incorporate digitally-enabled learning are scalable and sustainable when we utilize a complementary implementation to build capability and engagement. Teaching staff must be encouraged to personally reconstruct their conceptual knowledge and application of teaching practice against a set framework with robust organisational support that scaffolds achievement of the intended outcomes.

Background

In 2017 RMIT University transitioned from its existing LMS to Canvas. As part of this transition the opportunity arose to strategically define and support a clear engagement with TEL; therefore, every course previously offered in Blackboard, or wishing to be newly offered using Canvas, was "lifted" to meet a new set of required standards. RMIT had established a *Digital Learning and Teaching Framework* through consultancy with key stakeholders across the University to meet strategic and legislative requirements, and consequently defined a set of six guiding principles: connected, clear, aligned, inclusive, dynamic and consistent. To operationalize the framework and principles the *14 Elements for Canvas Success* were authored and used as a clear set of specific in-situ criteria required to be evidenced in each Canvas course prior to it being made available to students. These Elements helped shape template design for courses in Canvas, provided the backbone for initial staff training in using Canvas and building courses as part of delivery, and formed a quality assurance (QA) process for our digital learning and teaching content. As well as being informed by student feedback, the Elements themselves are grounded in the literature and broader sector benchmarking, including rubrics such as *Quality Matters*.

The official 14 Elements document is a set of foundational standards provided as a resource consisting of: a name for the Element (descriptive), a rationale for why it is applied, essential requirements that need to be present in a course for passing a QA review, guidance advice on how to implement, and resources to support implementation. The Elements themselves cover the requirements for an introductory module structure with specified content for every course, details of teaching team (contact, bio) and how to use the course, course schedule with key activities, requirements for assessment information, menu structure for consistent navigation, and accessibility and style considerations. Various resources are available to staff on the RMIT *Teaching with Canvas* website including the 14 Elements, explanatory videos, online training sessions and drop-ins for at-elbow support, customized requests for training and support, information on Canvas features or integration and process updates that affect the implementation of the Elements.

The Elements are not a rubric for online course design, since they apply to both online-only and face-to-face courses. Instead, the Elements are an explicit intent to translate student course experience feedback into specified requirements that enable effective LMS usage. The 14 Elements therefore ensured that the RMIT student cohort had a TEL experience that was consistent across the institution - regardless of College, School, discipline or program of study. The Elements are also not static and undergo review and refinement on a regular basis referencing staff and student feedback, policy changes, and process changes. While this is still an evolving process, a commitment to continual improvement ensures that the Elements remain relevant and the approach by which quality assurance and support is provided can also evolve.

Strategic initiatives

By establishing a *Digital Learning and Teaching Framework* and operationalizing this into specific standards as QA criteria to establish a foundation, RMIT began to use technology in a targeted manner as an enabler of pedagogy and student-centered practices. While there is always work occurring in this area across the various structures of the institution, the key was to facilitate and drive TEL at scale – creating a clear roadmap aligned to strategic priorities that united core areas of the university to this goal (ITS, HR, professional and academic staff, vocational teaching staff). In 2018, this was tackled by authoring aspirations for digital pedagogy as a set of additional and complementary Elements to those that formed the foundation – titled *Canvas Uplift. Canvas Uplift* was authored based on research into student-centered teaching practices in higher education, as well as reference to established and validated learning design approaches, and then contextualized to have institutional resonance and meaning within RMIT.

The *Canvas Uplift* document contains similar components to that of the 14 Elements, specifically a name for the Element (descriptive), a rationale for why it should be applied, essential requirements that need to be fulfilled to qualify it as being implemented (aspirational), guidance advice on how to implement, and resources to support implementation. The *Canvas Uplift* Elements also include an estimated 'Level of Effort' to aid staff in planning their implementation. Additionally, various resources and details are also provided via a staff website with ongoing iterative development and review. A high-level overview of the Elements and their rationale is included for reference in Table 1.

Table 1: Canvas Uplift

Element & Name	Rationale
Element 15 Course Material: Accessibility	This element is designed to ensure all students have access to inclusive and accessible types of learning materials to support their learning. Designing your learning content with this in mind from the beginning means all students can benefit.
Element 16 Course Material: Student study	Students should be encouraged to manage their approach to learning. To enable this, they should be able to identify the difference between materials which a) support their learning and assessment completion and b) provides further details or exploration if the subject/topic is of particular interest (thus supporting consideration of future studies or professional growth). To enable student success, the volume of required materials should be suitable for both its format and intended purpose and be calculated in relation to other activities occurring in the course.
Element 17 Embedding language and readings support	Students have clear and direct access to content, readings, and associated resources to support their learning. The use of RMIT tools and LTIs provides a consistent and reliable approach to achieve this across courses.
Element 18 Course Material: Structuring a consistent layout design	To facilitate student engagement through a consistent 'layout' with the chosen pedagogical approach or teaching strategy when accessing materials, activities, or assessment. To tie the structure of the course materials with the curriculum design and ensure complementary practice between physical (in-class) and digital (out-of-class) learning. This is particularly effective across programs and reduces cognitive load for learners.
Element 19 Course Assessment: Scaffolding student learning	This element is designed to assist students in preparing for their assessment tasks and providing opportunities for feedback. An activity is included in the weeks preceding assessment submission that prompts student preparation and sets them up for success. Students are provided with a video describing the task and what is required as a complimentary artefact to the assessment description. After submission of the assessment, providing an audio or video of whole of class feedback can benefit all learners in preparing for their next assessment tasks.
Element 20 Course Refresh: Uplift	This element is designed to provide the opportunity to review and refresh courses within a program that align to the Program Principles and capitalize on support by learning & teaching specialists through pilot initiatives, resources, and blended approaches.

The *Canvas Uplift* Elements drew upon existing and emerging RMIT technologies such as *Reading Lists* (Leganto) through the Library, *Ally* through the Accessibility Working Group, and tools developed in-house including a *Glossary*, and EMBLE for designing course page content. DVC Education, Professor Belinda Tynan stated upon their release

In my vision for our learning and teaching at RMIT I can see Canvas providing us with the support we need to develop what I might call the 'digital spine'. Our initial efforts have started us on a journey that will take some time to mature. A truly remarkable, inspiring and relevant learning experience won't happen without some real planning on all our behalf. So, the next 6 Elements are suggestions for how we can lift to the next level and create a digital spine on which to create truly remarkable learning experiences. I ask that you look at them carefully and consider your road-map for how you might achieve all of them. These are elements that are scalable and will make an impact on how your students learn and how you teach them (RMIT, 2019, p.3)

The *Canvas Uplift* Elements provide a road-map to drive digitally-enabled pedagogy and the prioritization of technologies (learning tools) that implicitly facilitate teaching approaches identified by Trigwell and Prosser (2004) as at minimum student-teacher interaction and ideally student-focused strategies. By utilizing the *Canvas Uplift* Elements as a framework for the current evolution of our TEL approach for programs, it also facilitates focused evaluations of technologies that can enable the student-centered approach aligned to the intent of each Element.

University wide initiatives at institutions the size of RMIT that intend to achieve transformation at scale in a sustainable manner, require a willingness to engage in innovative structures and collaborative approaches to facilitate the desired deliverables. Traditional approaches to professional development and course design, especially around initiatives that touch on pedagogical training of teaching staff, can have limited effect depending on the cohort for achieving student-centered practice (Ödalen, Brommesson, Erlingsson, Schaffer & Fogelgren, 2019). However, should this come as a surprise when these professional development approaches are not providing the equivalent of a student-centered learning strategy to the teacher? It must be remembered that higher education teachers and academics are often simultaneously trying to reconstruct their knowledge and skill for disciplinary teaching to both a student-centered approach and through TEL.

RMIT has an ‘Area of Focus’ framework for implementing institutional strategy that has also been beneficial in solving the professional development dilemma. This framework provides a structured approach to prioritization and project management – endorsed by senior leadership and operationalized collaboratively across the institution as a coordinated initiative. TEL curriculum transformation was embedded in the ‘Area of Focus’ approach – the 2019 *Student Area of Focus* centered on curriculum enhancement and contemporary learning experiences in the form of embedding *Canvas Uplift* Elements as a deliverable. In this manner, *Canvas Uplift* has become an initiative for selected programs across all discipline areas prompting valuable input from a diverse set of professional and academic staff. Figure 1 indicates the foundational and aspirational Elements that drive achievement of the *Digital Learning & Teaching Framework*, from which the ‘Area of Focus’ initiative incorporates *Canvas Uplift* as part of its digital uplift deliverable.

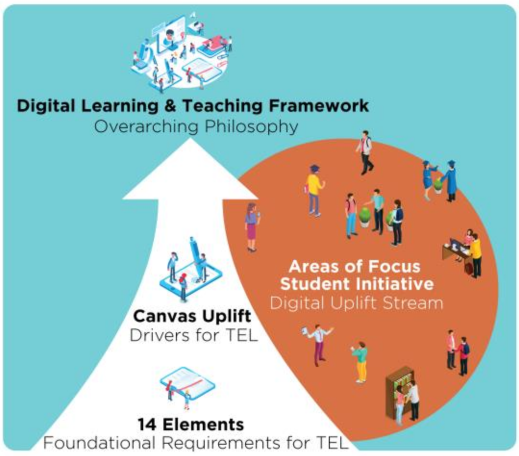

Figure 1: RMIT digital standards and institutional frameworks

For the *Student Areas of Focus*, organisational structures and collaborations are a key factor in ensuring all academic and professional staff can be included in the adoption and scaling of *Canvas Uplift* as a prioritized TEL solution. Although formal organisational structures remain, the ‘Area of Focus’ implementation recasts selected teams using agile principles, practices, and tools - whilst providing appropriate support to engage in a new way of working. As an approach, agile is particularly suited to such an initiative that is focused not only on transforming teaching practice but also prioritizing TEL as it focuses on the people doing the work (Agile Alliance, n.d.). The solution for sustainable and scalable change in teaching practice and TEL therefore capitalizes on providing a consistent language and set of prioritized technologies (*Canvas Uplift*) to unite the diverse expertise of professional and academic staff from various disciplinary areas in *holistically* creating student-centered experiences specific to their programs. The people drive the process with collaborative interactions enabled by a consistent narrative that uses the agile methodology to ensure a diversity of disciplinary skill and knowledge is present within the team.

This design solution allows stakeholders to be taken out of training and into ‘doing’. Support and resources are developed by a diverse set of institutional wide professional staff with knowledge of learning design and design-thinking approaches. This is far superior to training or resource development driven in isolation by process, and the agile practices and tools used mean that resource and support is continually refined, improved and fundamentally iterative in development. Best practice can be surfaced naturally and showcased easily, and discussion that is personalized around professional development specific to program delivery is meaningful. As stated by Alexander et al. in rethinking the practice of teaching:

The redesign of courses and programs to take advantage of digital tools enables instructors to evaluate their teaching practices and use student-centered approaches to facilitate learning. Professional development supporting the use of digital tools has evolved into collaborations with instructional design teams and other professionals in the learning science filed, accelerating the application of new teaching practices. Without sufficient access to sustained support and the tools and resources essential in the design of a student-centered environment, instructors are challenged to create these experiences on their own. Managing the changing practice of teaching requires that institutions intentionally design faculty support that is not bound by location or time (2019, p. 19)

Thus, we can see the value in acknowledging the holistic relationship and interdependencies between the context of teaching and learning activities and the methodologies used to enable change in practice. It is only when all criteria for enabling TEL is addressed – frameworks, pedagogical training, support, resourcing, and organisational structure, that a transformation in practice can occur.

Conclusion

The introduction of a new LMS can be a useful trigger for improving engagement with TEL and establishing a foundation for positive student experience in the digital environment. Universities utilize different approaches to achieve what they often cast as 'transformation' – these range from highly templated approaches, just-in-time support or mandatory professional development for key stakeholders. At RMIT, the key challenges are scale (over 90,000 students), complexity (multiple campuses, vocational and higher education sectors), and culture (the usual challenges in academic institutions). The 'elemental' approach of articulated standards – with a foundational *14 Elements for Canvas Success*, subsequently amplified by the *Canvas Uplift*, provide strategic scaffolding towards student-centered teaching practice using TEL at RMIT. Combined with the 'Area of Focus' approach incorporating agile principles and methodology, these scaffolded standards drive TEL development and practice to underpin sustainable and meaningful implementation at scale. The value can be articulated with reference to the interplay between these combined strategies and their ability to capitalize and engage with the diversity of expertise and skill across both professional and academic staff. Standards such as *Canvas Uplift*, implemented through initiatives such as the 'Areas of Focus', operate in a complementary manner to prioritize practice led transformation undertaken by people that scaffolds sustainable and appropriate technology enhanced learning in RMIT courses and programs.

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Data-informed advisories to support the adult learner in higher education

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Providing learners with continuous advisement and feedback is a key part of encouraging positive learning behaviours. This paper presents the development of data-informed learning advisories for the adult learner in higher education. As part of the university's learning support, this set of data-driven advisories were designed and targeted to nudge the adult learners to improve course-taking and online learning behaviour. As many have to balance work, study and family commitments; the advisories are designed to encourage and share positive academic practices that are drawn from the data. The advisories also nudge struggling learners into awareness that their learning behaviour differs from that of more successful peers. Reminder nudges assist adult learners in their decision-making. The advisories take into account both the phrasing and mode of communications in order to clarify information, assist planning and increase engagement.

Keywords: learner advisement, data-driven advisories, adult learners, learning analytics

Introduction

In the past decade, universities have experienced a "massive expansion in adult enrolment" (Eduventures, Inc., p.5, 2012). Technological developments and a knowledge-centric economy in the workplace in Singapore have led to a demand for a highly skilled and knowledgeable workforce. To further complicate the situation, Singapore is facing a rapidly ageing population coupled with declining birth rates. These developments are both disruptive and positive for the economy and the society. While workers are being displaced, new job opportunities are made available. Strategic policies and provisions are required to build and support an educated and skilled workforce. Policies and provisions included widened access of education to various non-traditional communities, such as adult learners. This is significant, as more adults are turning to higher education institutions to start, continue or complete their degrees (Finn, 2011; Chong, Loh & Babu, 2015). Many pursue learning to enhance their competitiveness in the workforce, attain a professional requirement and be enriched intellectually.

With increasing adult learner enrolments in colleges and universities, adult learners, more than ever, will require support and nudges to help them successfully transition into student life (Sandman, 2010). Adult learners enrolled in higher education face several challenges. Adult learners juggle competing demands on their time from study, family, work, and other commitments. With more adult learners seeking to enter higher education than ever before, there is a growing need to provide appropriate and targeted advisement for the adult learner. "The experiences of adult learners in higher education and their learning needs, interests, styles, and overall success have largely been neglected" (Kasworm, Sandmann, & Sissel, 2000, p.17).

As institutions amass data, adopting an evidenced-based approach is key to improving and maximising learners' outcomes. Data collected from and about the adult learners can better inform teaching and learning as well as put in place advisories that nudge learners towards positive learning. Higher education institutions are able to identify predictors of university success for the adult learner population. These advisories are a key source of nudging constructive and productive learning practices as well as providing open avenues for communication with the learner.

Advisories in the form of nudges have been used by governments to change behaviours around health, finances and recycling. This use of behavioural economics can be used in education to promote learner success. However the advisories or nudges will require an understanding of how and why adult learners make the decisions they do. As such, universities can employ analytics tools to target their nudge interventions. These tools use existing data to determine patterns of successful behaviour, predict future outcomes, and inform interventions that put learners on the path to success. In this context of advisories and nudges, guidance that are data-informed rather than based on anecdotal advice is usually more beneficial to the learners (Cuseo, 2008). This paper presents a set of data-informed advisories that were used to improve course taking and online learning behaviour in a Singapore university for adult learners. To craft and develop the advisories, data is collected from explicit learner actions, such as completing assignments and taking exams, and from tacit actions, including online interactions as well as other types of learner data to provide insights for purposeful teaching and learning.

Context & Scope of Study

As Singapore's only university targeted primarily at working adults and adult learners, the university created a unique flexible learning environment that enables learners to learn at their own time, place and pace. In addition, to better serve its learners the university adopted a web-based learning management system in 2007 and a substantial portion of learning in the university is situated in this online learning environment. The online learning platform becomes an important touchpoint where learners and instructors engage to exchange information and knowledge; hence, online engagement invariably revolves around the learning management system, its online access and is associated with learner-to-learner, learner-to-content, and learner-to-instructor interactions (Wong & Chong, 2018). Importantly, the proxies of online learning behaviour together with other attributes associated with course-taking behaviours can be associated with different patterns of learning behaviour. These patterns of course-taking and online learning behaviour, together with other potential determinants of academic performance, are associated with particular levels of academic success for translation into learning advisories.

The study explored the design and implementation of data-driven advisories to encourage positive and productive learning behaviours with adult learners in part-time undergraduate programmes. The design focused on a structure of advisories that nudge current learners to benefit from the ‘successful experiences and behaviours of others’. The ‘successful experiences and behaviours’ were based on in-depth analysis of trend data of the adult learners’ course taking and online learning behaviour. This approach combined analytical insights with positive psychology and behavioural nudges – where reminder nudges are constructed from insights gleaned from analytics, and carefully construed in a positive manner to motivate and foster learning.

From data to learning advisories

Data Acquisition

Data came from six intakes of the part-time undergraduate programme of over 8,000 records. Data collected about the learners are categorically put into several phases and as they progress along their learning journey – this includes enrolment data, throughput data, and graduation data. There are two populations of interest. The first group comprises the “good performers” who managed a cumulative grade point average (CGPA)/grade point value (GPV) of > 4.0, and the second group of learners who managed a CGPA/GPV of ≤ 2.5 and are at risk of academic attrition. Hence, a dichotomous target variable is also constructed for modelling, representing the two populations of interest (i.e., good performers and those at-risk).

Enrolment data
The use of enrolment data in predicting learner success at the tertiary level is well-documented and established across many studies; and this includes determinants such as prior academic ability, demographics and work-related indicators (Palmer, Bexley, & James, 2011). As a university that is rooted in providing life-long education to adult learners, the university’s learner profile is typically characterised by a diverse range of learners from different life stages and educational backgrounds; and the learners manage the rigours of a university programme in different ways. In view of this, the enrolment data is of particular interest as they can have an association with learners’ performance. Table 1 provides a sample of the enrolment data that is used for modelling.

Table 1: Variables used in effects assessment of good performing and at-risk adult learners

Phase	Data type	Data attributes
Enrolment data	Demographics	Gender, Race, Age, Marital status, Nationality, Residency, National service status
	Work-related	Employment status, Industry, Company sponsorship, Company size, Designation level, Annual salary, Relevant industry experience, (Whether degree is) Applicable to work environment
	Prior Educational	Level of academic qualification, Awarding institution, Pre-university grades, Mode of study, Relevance of prior education to degree
	Matriculation	Matriculation identifier, Matriculation information
Throughput data	University	Transfer of programme status, Restart status, Credit units exemption, Semestral grade, Student phase
	Course-taking behaviour	Number of courses taken/completed/failed/withdrawn, Credit units taken/completed/failed/withdrawn, Number of coursework-only courses taken, Number of examinable courses taken, Number of university core courses taken/completed/failed/withdrawn
	Online learning behaviour	Proxies of online learning behaviour (Wong & Chong, 2018)

Learning behaviours of good performing and at-risk learners

Various analysis and data mining techniques were used. Decision trees, specifically the Chi-square Automatic Interaction Detector (CHAID) tree algorithm, was used to associate the groups' academic performance (i.e., good performers whose CGPA > 4.0, and those at-risk whose CGPA ≤ 2.5) with enrolment variables, university variables, and course-taking behaviour variables. The resulting tree generated a series of significant splits ($p \leq 0.05$) allowing for a multivariate interpretation of the independent variables and its effect on academic performance. By introducing behavioural data into the algorithm, the resulting tree will be an informative illustration of how a sequence of determinants leads to higher probability of academic success, which can be converted into a series of learning advisories for improving learners' study habits.

Analysis of variance is used to support the validity of statistical conclusion when comparing the online learning behaviour across the two groups: high performing learners with GPV > 4.0 and the at-risk learners with GPV ≤ 2.5. Their online learning behaviour which is measured by the proxies of online learning behaviour are examined to deduce whether observed differences in the group behaviour are significant. The results are then translated into a series of learning advisories.

Analysis and findings

Several determinants of academic success stood out from the analysis. The main significant findings ($p \leq 0.05$) from the CHAID tree are consolidated in Figure 1. There are consistent patterns among learners who are able to achieve a CGPA > 4.0. These patterns repeat themselves across different cohorts at various phases of their learning journey. Good performers have been observed to have taken fewer credit units (CU) per active semester. They have also withdrawn less from courses, and are found to have a better balance and spread of core university courses (UCOR) across the 1st half of their programme. In addition, good performers have better foundations in numeracy and literacy skills. Furthermore, learners with more working experience have benefitted from the applied learning approach of the university.

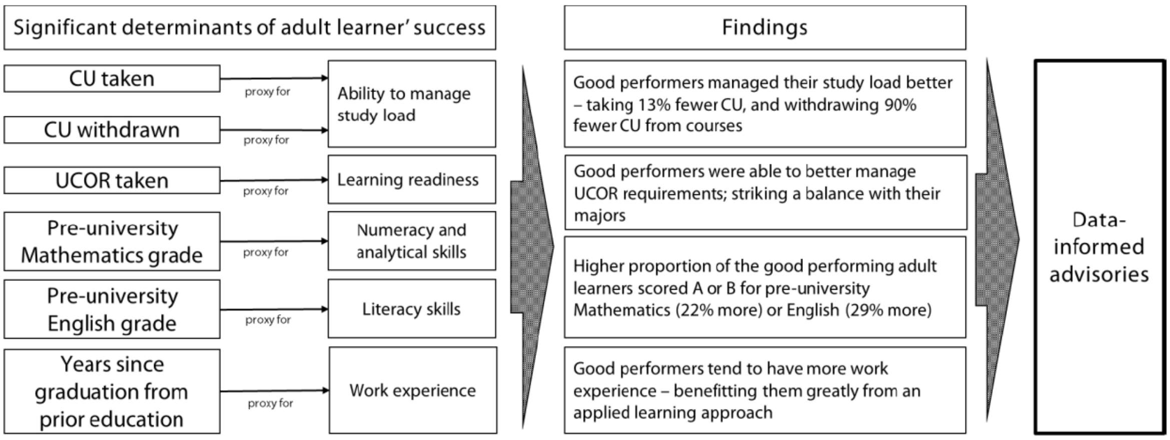

Figure 1: Summary findings from CHAID analysis of course-taking behaviour and other attributes

Collectively, the proxies of online learning behaviour explain up to 55% of the variation in the GPV of good and at-risk performers. On average and of statistical significance ($p \leq 0.05$), good performers have been observed to access their online learning materials earlier; they have also frequent the online learning activities to scaffold their learning; are associated with a wider access of online learning materials; and have been found to optimise their revision with online materials close to end-of-course assessments (see Figure 2).

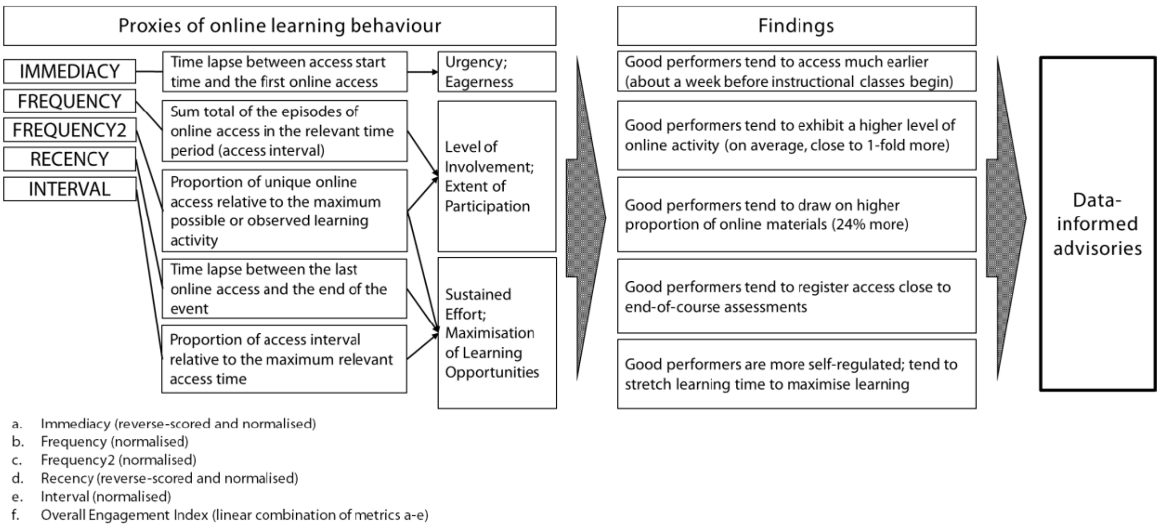

Figure 2: Summary findings from analysis of online learning behaviour

Structuring of the learning advisories

The findings of the high performing learners highlighted key determinants that influence academic success and these included (1) real-world working experience and applied learning to the workplace, (2) stronger fundamentals in literacy and numeracy skills, (3) better management of study load, (4) good balance and spreading out core university courses over more semesters, (5) better planning, (6) advance preparation by accessing online course materials earlier, (7) more utilisation of the online course materials to build up knowledge, (8) revision and consolidation of their learning near end-of-course assessments. These findings are consolidated and translated in a series of positive advisories depicted in Figure 3. For example, one advisory which urge learners to pick up *COR160 Essential Academic Writing Skills early* are for learners who may need to strengthen their literacy skills. Another advisory for learners who (are on course) may have already taken a few courses into their programme to be mindful *not to overload on CUs*, and to exercise greater agency to better manage their study load. This advisement is repeated again to remind learners who are near completion of their programme to keep to maintaining a good balance.

Clear communication of the advisories is a priority. The format of it (whether in print or digital), the timing of the communication, the mode of its delivery and its location (i.e., which mode or location can maximise our catchment) are some of the considerations. At the end, we adopted a multi-pronged effort – where some of these advisories were highlighted by deans during the orientation to newly-matriculated learners, which was complemented with the use of digital boards to reach the wider population of adult learners who are in different stages of their learning journey.

Progress along learning journey

Start Zen: Keep calm and cool; **don't rush** on University Core	Hone Your Craft: Accumulate **literacy & numeracy skills**: e.g. **pick up** COR160 Essential Academic Writing Skills **early**	Devise a Strategy: Zoom in on **online materials**; build knowledge and maintain momentum
Eyes on the Prize: **Be an active learner**, focus on your course objectives	Garner Experience: Real-world experience counts, **apply to** your **learning**	Stay on Course: Steady wins the race; **don't overload** on CUs
Sharpen your Repertoire: Enhance **learning readiness** with University Core	Preparation Wins All: **Plan in advance**, pin down all materials **early**, retreat, reflect and absorb	Level-Up: Take stock, **revise** with past-year exam papers. Keep levelling up
Practise Makes Perfect: Put **theory** into **practice**	Aim for the Finishing Line: Focus on a **study plan**; be disciplined and keep to the grind	Stay Agile & Nifty: Be flexible with your **CU load**

Figure 3: Series of advisories

Other considerations

Student learning support is essential for reducing gaps in achievement. Advisories should be supplementary. While the advisories represent a low cost way to have a positive impact on the adult learners, the university will still need to support other retention and success efforts. Advisories or nudges without additional supports may not make significant improvements with learners who are struggling. Subgroup analyses of early alert and predictive analytics data can help identify emerging achievement gaps early. Technology-mediated advisement is another increasingly popular approach. Technology-mediated advisement can leverage on the robust data, early alert, predictive analytics, and other advisement technologies to identify and intervene with learners who need help, when they need it.

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What learning means to you: Exploring the intersection between educational and digital lives of university students through digital narratives

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The inclusive nature of the student experience in higher education has been recognised by a growing number of researchers (Arambewela & Maringe, 2012). Understanding how the whole experience is affected by students' emotions, connections and use of technologies is essential for higher education providers and professionals in a post-digital context (Verdonck, Greenaway, Kennedy-Behr, & Askew, 2019). Conducted in 2018 and 2019, the Work. Live. Play. Learn (WLPL) project series collected digital stories from 143 university students about their technology empowered holistic learning experience. These stories covered topics around how students' educational, digital and personal lives intersected with the use of social media and learning technologies. Apart from providing access to more expansive and accessible learning spaces, the use of technology also revealed the challenges in the transitive state many students are facing, such as social isolation, pressure and engagement with disciplines (Barnett, 2007). While exposing some complexity in their learning experience, the students also engaged in actively seeking for ways to better their own learning experience. The findings and digital narrative method in this study can be used sustainably in getting students' feedback and understanding modern learning to design better educational experiences for students.

Keywords: learning experience, student satisfaction, digital narrative, digital storytelling

Introduction

The student learning experience in higher education has received more and more attention from contemporary researchers and education providers as a response to the changes and challenges in the modern education system in a complex and increasingly internationalised environment (Tan, Muskat, & Zehrer, 2016). Historically, student satisfaction surveys and service quality management processes have been employed by educators, institutions and researchers to evaluate and improve educational experience (Appleton-Knapp & Krentler, 2006; Lowery-Hart & Pacheco, 2011; McGhee, 2017; Sabri, 2011; Smith & Segbers, 2018). Traditional definition and deeply held assumptions have also been adopted to interpret the student learning process and experiences. Marton and Säljö (1976) developed surface and deep approaches to describe different level of learning a task. Biggs (1979) claimed that student learning involves "three stages of input, process and output", input includes different elements in the teaching context, process is how students select and learn from the input, and output is the quality and quantity of the outcome. Temple et al. (2016) described student experience as the "totality of a student's interaction with the institution". Although previous studies have extended the understanding of the student experience, few of them have approached students directly to get their first person authentic lived experience. We know little about how students' personal, digital and educational lives intersect and shape their learning experience. As noted by Montgomery (Lim, 2012), "learning takes place in contexts beyond the classroom and beyond university walls". The aim of our study is to explore some of the internal and external factors around student experience, examine learning from both inside and outside of the classroom and add insights and new approaches to the existing research in the student experience.

Methodology

Digital storytelling and narrative techniques

According to Porter (Porter 2010), digital storytelling is "the combination of the ancient art of oral storytelling with a palette of technical tools to weave personal stories using digital images, graphics, music, and sound mixed together with the author's own story voice". Digital storytelling has been used by researchers and educators for tasks such as engaging student learning, replacing assessments, creating new knowledge, supporting creative writing and teaching (Barber, 2016; Benmayor, 2008; Clarke & Adam, 2012; Porter, 2010). However, few researchers have adopted digital storytelling into student experience and empowering students to tell stories of their personal and educational lives. Building on the previous implication, we developed a unique way of employing digital storytelling in capturing student satisfaction with their educational experience.

Selected randomly across the faculty, 143 students were engaged into the project WLPL series from 2018 to 2019 to have conversations and share stories with the research team. In WLPL1.0, all conversations were filmed in *situ* at the faculty building and recorded and edited into forty-one hours of video. More digital narrative methods were employed in WLPL1.5 including digital storytelling, podcast and online information journal. A range of prompts such as flash cards, white board exercises, drawing sessions and games were used to trigger the conversations. Open-ended questions were incorporated to enhance the storytelling on broad topics around student's work, life, leisure and learning from both inside and outside of the institution. Questions that closely related to the students learning experience were used to help us address the critical research questions:

- What are our students lived and authentic experiences of learning?
- How do our students react/respond to the requirements placed upon by the faculty?
- How do they balance the interactions and tensions of work, life and play with learning?
- What role does technology and social media play in all this?
- (WLPL 1.0)

- What does being a student/graduate of the faculty mean to them? (Identity)
- What does it mean to them to be a member of the community of the faculty? (Community)
- What importance do they place on making, leveraging and sustaining networks and connections whilst studying at the faculty? (Connection)
- (WLPL 1.5)

The students in the project were also asked questions that touched on their experiences in areas such as their classroom learning, learning support, study habits, engagement with discipline, career options, work life, leisure, socialisation, clubs and societies, hopes and dreams and suggestions. The design of unstructured questions ensured interaction between students and the team while letting stories emerge from the flow with openness, freedom and playfulness.

The use of digital narrative approaches including high quality video recording, audio recording and digital journals expanded the access through which students would share their stories. The students expressed ideas and share their experiences by not only participating in the project but also co-creating themes and content with an interactive dynamic of the conversations and storytelling (Barber, 2016). The form of digital storytelling ensured that whilst there was a sense of spontaneity on the conversations, the permanence and lasting nature of video and audio shifted the way students engaged with the team. This was reinforced through asking students to hold the microphone during the filming, which added sense of centering the students as both the storyteller and the recorder of the narrative. The use of video and audio and the way in which it was set up also ensured that:

- Students were active story tellers rather than passive interviewees;
- There was an atmosphere of excitement, fun and freedom;
- A sense of community was fostered and bridged the faculty and community where the stories reside.

Student-led analysis through reflection workshops

Three main analysis techniques were used to show the patterns and connections among the stories (drawn from transcripts made of all the conversations and journals). Firstly, student researchers were engaged in analysis and reflection workshops to identify key themes and dichotomous stories during and after the conversations through mapping, brainstorming, poster notes exercise and Q&As (Li, Marsh, & Rienties, 2016). The themes and dichotomies revealed from the reflection workshops were then used to support the thematic and content analysis to disclose the stories among common and conflicting themes. The transcripts were coded and categorized using *NVivo* and the connections between different themes were drawn out of the codes and textual reviews from the reflection workshops. The stories that emerged from the analysis were then edited into short videos to share with students, academics and audiences across institutions and countries through social media channels, presentations and articles.

Findings and discussion

Group work is where everything begins

The stories that the students shared with us show that their study habits impact how they interact with others, what they do in their leisure time, and ultimately shape their holistic learning experience. We found that the students often stay with group members either for doing group projects or because they choose to study with peers. One commonly raised idea is that group work is the main, if not the only, way to make friends and socialise with others. They prefer to stay within a group as opposed to studying alone, because they can communicate with students from different backgrounds and open up about their problems in learning while receiving feedback and support from peers. This is quite different from the deeply held assumption that students do not like group work because there are issues such as unequal work allocation, free riders and managing various expectations (D'alessandro & Volet, 2012; Gammie & Matson, 2007; Soon & Sarrafzadeh, 2010). This study learned that students need better solutions in forming groups, setting group rules, getting tailored feedback from instructors and efficient communication. At the heart of those stories, students emphasize the importance of connection with peers and staff, socialisation and engagement with discipline and institution in shaping their learning experience while revealing the issues of disconnection, isolation and loneliness. As a starting point to understand the learning experience, the stories of how students learn after class and with whom are essential in informing the practices of educational designers looking at curriculum and teaching practices (Berbegal-Mirabent, Mas-Machuca, & Marimon, 2018).

Technology empowered learning

Several authors have suggested that the modern students are self-directed learners, who take responsibility for their own learning process, learn how to build and use networks, collaborate with others, and use information and communication technology to find appropriate information (Beckers, van Der Voordt, & Dewulf, 2016). Social media channels were one of the many technologies where learning resides as revealed by the students, along with online learning portals, cloud storage and digital communication tools. The boundary between classroom learning and social learning is blurred from the immersive use of social media in the students' everyday university life (K. Smyth, 2012; L. Smyth, Mavor, Platow, Grace, & Reynolds, 2013; Yang & Wu, 2012). While providing learning resources and information to the students, the application of social media platforms empowers students to transit from passive recipients into active learners, content makers and learning co-producers during their university experiences without limiting to location, space or personnel. The students also constantly used a range of technology tools and platforms in learning which require high level of creation and collaboration with peers. Some main ones discussed during the conversations are online peer assessment and feedback, student-designed online tests, self-created video recordings for main topics and online discussion board. Apart from traditional ways of using tools like *Canvas* or *Wikipedia* in providing resources, choices and control to enhance the learning, the students are empowered in collaborative and self-led learning supported by a developed use of technology (Smyth, Bruce, Fotheringham, & Mainka, 2011). This technology empowered learning process, according to Smyth (2012), will help students in reflecting "how knowledge is created and used in professional environments". Challenges associated with the use of technology, however, highlighted that the lecture engagement and student-staff liaison is low due to the lack of face-to-face interaction.

I, You, We – learning through connections in a community they call their own

This study explored the student perceptions, experiences, affordances and reactions around their identity being as a student at the faculty, the connection they made during university experience and what is means to them to be a member of the community of the faculty. The students developed personal interpretation around the 'I', 'you' and 'we' aspects of their identity within the community. While they identified and defined themselves as unique individuals, the students also explained their identity through relationship with others such as friends, tutors, lecturers and other people from the community. We found that they generally have a sense of community and experience community life by participating in student societies and unions, interacting with friends in the classes and attending a wide range of events and activities happening within the community. They acknowledged that they have received various forms of support from the faculty which reinforces their sense of community. Despite the diverse background of the people within the community, they co-exist in harmony while reflecting on their own identity of being part of them. They are motivated by others to play their roles to achieve their personal goals as well as the goals of the community as a whole. The students are also positively making efforts to build social and professional connections through tutorials, lectures, peer-assisted groups and various societal meetings and hope to keep these connections even after graduation. The sharing of those stories in turn helps other students locate themselves in the community not only through watching the stories of other students but more importantly, passing them on to others.

Conclusions

The digital narrative method offered opportunities for students to express and share their insights, feelings, cases, stories and experience widely with their peers and a broader network. This will inform the community and education designers to develop various aspects in learning and teaching. The repeated application of the digital narrative method also proved that it can be sustainably used by other institutions and stakeholders to support their research. In our future studies, more digital narrative approaches will be explored to further enhance the depth of the conversations and make it more accessible for students to share stories both online and offline.

At the core of the stories, a diverse and supportive community was revealed by the students where they connect with others, develop their own identity, get support and help each other. The major themes around emphasis on group work, extensive use of technology, and sense of community set the tone of their learning experience in an increasingly competitive post-digital context. The other side of the stories, however, exposed the common issues and challenges modern students are facing, which are social isolation, disconnection and lack of engagement with the institution. These findings combined draw out a picture of a complex and multi-dimension student experience.

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Learning Analytics in SUSS: Vision, Action, Implementation, Translation and Collaboration

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Universities invest substantial resources into supporting learners to enhance their academic success. As universities become more inclusive and accessible, the range of learner ability increases, making learner-support more critical. For the Singapore University of Social Sciences (SUSS), an added impetus stems from large enrolment of adult learners. These include learners who balance family, work and study, and learners who left formal study for several years. For many, the learner-support is a critical component of their learning experience and academic success.

SUSS's learner-support is implemented primarily by academic units interacting with the learners. This is facilitated by the Business Intelligence & Analytics (BI&A) department and Teaching & Learning Centre (TLC). BI&A implements learning analytics projects and dashboards to deploy the analytics findings, while TLC translates the findings to enhance learner support. This data-driven support facilitates "personalised learning" for effective teaching and learning experiences. Adopting top-down strategies and bottom-up initiatives, the SUSS learning analytics eco-system comes together to provide support that enhances the learners' learning and academic success. The panel discussion of 4 presentations will share how stakeholders collaborate to increase academic success. The significance of this session is the institutional-wide application and implementation, which is unique in the current educational landscape.

Keywords: learning analytics, teaching and learning support, institutional analytics

Presentation 1 - Analytics Vision for SUSS

With advancing technology and digitalisation, and the increasing use of blended and online learning, there are massive volumes of data being generated and collected at increasing speed and in greater variety. These data are not useful unless they can be transformed into information to provide insights and support decision making. In August 2016, SUSS embarked on a strategic initiative to promote a data-driven and evidence-based decision-making culture by building up the analytics capability of its faculty and staff. A great part of this initiative revolves around providing better learning support to students to create a positive learning experience and conducive learning environment. This collaborative effort involves the Business Intelligence & Analytics (BI&A) department [to generate insights], the Teaching and Learning Centre (TLC) [to propose potential interventions] and Schools [to interact with students to provide learning support].

Presentation 2 - From Vision to Action

The Business Intelligence & Analytics (BI&A) department was set up in August 2016 to spearhead SUSS' strategic analytics initiative. Firstly, a data warehouse is built to store institutional data and provide appropriate data for reporting as well as analytics projects. Secondly, training programmes are developed and conducted for SUSS faculty and staff to build up the University's analytics capability. Thirdly, analytics and dashboard projects are undertaken to provide insights for decision making. Fourthly, platforms are provided to share and deploy analytics findings and models (e.g., seminars and roll-out events). Moving ahead, BI&A will serve as an institutional group that provides assistance and advice to facilitate decentralised analytics. Also, analytics applications will extend to other areas such as finance and human resources. Without doubt, SUSS will encounter challenges along the way but there are also valuable benefits that can be harvested.

Presentation 3 - From Analytics to Teaching and Learning Insights

The analysis of data collected about the learners and from the interaction of learners with educational and information technology is able to provide insights for advancing our understanding of the learning process. Drawing meaningful insights from the analysis requires an understanding of the relationship among technology functionality, observed interactions behaviours and educational theory. A key challenge posed by learning analytics in SUSS is the conceptual bridging and understanding between the technical and pedagogical domains. This presentation will share the SUSS Student Learning Journey, an integrated view of the learners' data, to provide a framework for making sense of diverse sets of student data. The associated data sets, the range of analytical tools and models for analysis on the success and outcomes of learners experience are applied on projects that are related primarily to student learning. The presentation will conclude by discussing the collaborations with the Schools using visualisation methods and tools to make sense of the analysis and to translate the findings into learning interventions.

Presentation 4 – From Insights to Interventions

The Teaching and Learning Centre (TLC) was formed to enhance the quality of teaching, and to support students towards academic success. Broadly, learning support is conceived and implemented on four planes. First, to ensure support is extended to students early in their academic journey. Often, these learning supports are online and flexible, extended to students even before the start of the semester. Second, to focus on key academic competencies that are either an area of need or have proven to enhance students' academic performance. Students are made aware of these competencies in the form of advisories, or they can choose to participate in enrichment workshops to further develop those competencies. Third, to personalise learning support viz one-on-one coaching. Learning support service provided in the form of individual coaching has been found to be a successful approach in retaining adult learners in higher education, and achieving greater academic success. Students have also expressed gratitude to the coaches who are not only their partners in learning, but also mentors and friends. Last but not least, in tandem with the implementation of learning support, there is the ongoing evaluation of the efficacy of the learning support. This is necessary not only in the spirit of continuous improvement to ensure that the interventions are working, but ultimately, for students to experience a meaningful and fruitful learning journey.

Biographies of Panel Members

Cheong Hee Kiat	Professor Cheong Hee Kiat is Founding President of Singapore University of Social Sciences (SUSS), formerly known as SIM University. He joined the academia in Nanyang Technological University in 1986, and held various academic and administrative appointments including Deputy President and Dean. He has served on the boards of several tertiary education institutions, statutory boards and public committees. He has also been active in university accreditation and academic audits in Singapore and internationally. He is currently a member of the NIE Council, the Singapore Engineering Accreditation Board and chairs the BCA Academy Advisory Panel.
Koh Hian Chye	Dr Koh Hian Chye is the Director of the Business Intelligence & Analytics department, which is responsible for the implementation of learning analytics in the University, among initiatives. He has more than thirty years of experience in data analysis and data mining, having served as a statistical/data mining consultant to SMEs, statutory boards, government agencies and large organisations. He has published in international journals and presented at international conferences in various areas of analytics.
Sylvia Chong	Dr Sylvia Chong is an Associate Professor with the Business Intelligence & Analytics department. She oversees the analytics projects in BI&A. Her research interests are inter-disciplinary in nature and include both substantive and methodological approaches in areas of education.
Lim Wei Ying, Rebekah	Dr Lim Wei Ying Rebekah is currently Associate Professor and Director of the Teaching & Learning Centre at the Singapore University of Social Sciences (SUSS). She leads the Centre in areas of academic development of lecturers, academic support for learners, and Scholarship of Teaching & Learning. Her research interests and publication are in areas of professional identities, teacher learning and technology-enabled pedagogy.

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Enhancing the Ethical Use of Learning Analytics in Australian Higher Education

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Ensuring the ethical use of data about students is an important consideration in the use of learning analytics in Australian higher education. In early 2019 a discussion paper was published by a group of learning analytics specialists in the sector to help promote the conversation around the key ethical issues institutions need to address in order to ensure the ethical use of learning analytics. This panel session will explore these ethical issues in more detail and update the conversation with new perspectives and provocations. The panel will include authors of the discussion paper and structured so the audience will have an active role in considering the key issues and advancing the ongoing conversations about these important issues.

Keywords: Learning Analytics, Ethics, Higher Education

Background

In Australian higher education the use of learning analytics to support student learning has been steadily increasing over the last decade. This has been enabled by a growth in the integration of technology across the delivery of educational offerings, resulting in large amounts of data being collected about students' activities as they progress through programs of study. While the ability to explore and analyse this data provides new opportunities to support students and improve the learning environment, there are several important ethical considerations that must be acknowledged to ensure this is done in an ethical way (Slade & Prinsloo, 2013). These considerations are quite complex in nature, requiring institutions to address and balance the benefit of using the data with students' rights and privacy. Not surprisingly, many Australian higher education institutions are still formulating or refining their response in an effort to ensure ethical practice. Research on the implementation of learning analytics across the sector has noted this struggle and encouraged institutions to take action (Colvin et al., 2016; West et al., 2016).

In order to support Australian institutions in this process, a group of learning analytics specialists from across multiple universities came together in 2018/2019 to draft a discussion paper outlining the main ethical issues relating to the use of learning analytics and identified key considerations for educational leaders and practitioners (Corrin et al., 2019). The main ethical principles explored in the paper included: privacy; data ownership and control; transparency; consent; anonymity; non-maleficence and beneficence; data management and security; and access. The discussion paper explored these principles within the context of how learning analytics can be used in universities and with reference to a range of existing frameworks that have been developed and used internationally (e.g. JISC Code of Practice for Learning Analytics). A series of case studies were used to examine these concepts in context and to demonstrate the need for institutions to carefully consider the wide range of issues vital to ensuring ethical practice. The paper concludes with seven key considerations around things institutions could do to in order to address the ethical issues learning analytics raises.

The Panel

The intention of the discussion paper was to offer support to institutions in developing policies and procedures for their approach to using of learning analytics in an ethical way and also to promote a broader national discussion of these key issues. The proposed panel will continue this conversation by revisiting the key considerations of the paper with updated perspectives developed since the discussion paper was published at the start of the year. The chair of the panel will provide a brief overview of the discussion paper which will be followed by a short presentation from each of the panelists on an area of change. Each panelist will be given the opportunity to raise questions for the audience to consider relating to how student data is collected and used by higher education institution and the audience will also be given the chance to ask questions of the panelists. The panel will be made up of authors of the discussion paper and associated who are all active researchers in the field of learning analytics. These include:

Associate Professor Linda Corrin (Chair) is the Academic Director, Transforming Learning at Swinburne University of Technology. Currently, she is working on several large research projects exploring how learning analytics can be used to provide meaningful and timely feedback to academics and students. Linda is co-founder of the Victorian/Tasmanian Learning Analytics Network and a co-ordinator of the ASCILITE Learning Analytics SIG.

Dr Cassandra Colvin is the Research Manager, Student Strategy Evaluation at the University of Queensland. Prior to this appointment, she was Manager, Adaptive Learning and Teaching Services at Charles Sturt University, and Manager, Learning Analytics, and Manager, Enhancing Student Academic Potential – an academic intervention program targeting first-year students who have been identified as 'at-risk' – both appointments at the University of South Australia. Cassandra has researched and presented widely on themes relating to learning analytics, international student support, and intercultural interactions and communication.

Dr Kirsty Kitto is a senior lecturer in data science at the Connected Intelligence Centre, University of Technology Sydney. At UTS she works to deliver learning analytics infrastructure that will help the university to provide students with better feedback and personalised learning experiences. This forces her to consider concepts like scalability of tools, data interoperability and portability, and the ethics of varying infrastructure designs and implementations.

Dr Danny Toohey is a Senior Lecturer in Information Technology at Murdoch University. He teaches in the areas of database design and business analytics, where he makes use of the data collected about his students' interactions with the LMS to inform his teaching and curriculum design. His research has been focussed in the areas of Learning Analytics and Transnational Education. He has been involved with the ongoing Innovative Research Universities (IRU) Learning Analytics projects since 2013.

Intended Audience

The panel session is designed for a broad audience in roles that relate to the use of student data to improve learning and teaching practices. These roles could include, but are not limited to, teachers, learning designers, managers, learning analytics specialists, data scientists, educational support staff and learning analytics vendors. The pervasiveness of the use of learning analytics in higher education means that the issues explored by the panel will be relevant to many and in broadening the conversation started by the publication of the discussion paper the authors would like to promote these conversations to as many people in the sector as possible.

This panel aligns with two of the key themes of this year's ASCILITE conference. It relates to the theme of "Data Analytics & Evidence to Improve Teaching & Learning" by directly exploring a key concept for the field of learning analytics. In exploring and responding to the challenges of ensuring ethical practice it also aligns with the theme of "Practices and Challenges in Technology Enhanced Learning".

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Technology-enhanced assessment: Seizing opportunities & addressing challenges

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Innovation in learning engagement, diversification of student population and massification are pressing concerns in higher education. These interconnected concerns have particular impact on assessment. As our student populations and learning engagements become more diverse and class size grows, the use of assessment for promoting and determining student achievement becomes increasingly challenging.

Technology is often seen as essential to meeting this challenge. Technology enhanced assessment (TEA) is a meeting place for digital learning and assessment of, as and for learning. TEA is an area rich with opportunity, but also fraught with risks. Achieving success while avoiding failure is a key mandate for members of university communities, from individual teaching staff to senior leadership.

This panel discussion explores TEA from several perspectives, drawing on university-situated practice cases, the field of TEA research, and empirical research conducted by panelists. Key topics include understanding what enhancement means in the context of TEA, incorporating student voice, how factors such as teachers' pedagogical beliefs and university culture mediate TEA, how TEA may affect provision of feedback, and negotiating resistance to assessment and technology change.

A key attraction of technology-enhanced assessment is the promise of greater opportunity for personalised learning. Significant challenges in both research and practice raise issues with the degree to which this vision is being successfully enacted. Thus, this panel aligns most closely to Conference Stream 2: Practices and Challenges in Technology Enhanced Learning.

The panel is intended for any ASCILITE attendees, but special attention is paid to areas of interest for subject lecturers, program coordinators, developers and researchers who are interested in successfully exploring and advancing technology-enhanced assessment. Audience engagement will include dialogue with the panelists. Intended outcomes of the panel include further a research and practice dialogue, inclusive of ways forward for better research and practice.

Individual topic areas & speakers

The then and now of tech-enhanced assessment: Implications to teacher practice

What does *enhancement* look like in technology-enhanced assessment? Technology-enabled assessment has progressed over time from supplementing assessment practices to one that is promising to transform student learning experience. Through the use of two examples, this presentation will attempt to unpack what *enhancement* looks like as technology in teaching and learning advanced over time. Specifically, the first example is about the use of pre-determined quizzes with well-constructed distractors that has made way for the more contemporary use of calibrated assessment items presented adaptively to learners based on their responses. The second example illustrates how the more traditional approach of assessing online discussions has made way for the modern use of artificial intelligence that autonomously consolidates 'confusion reports' or thematic clusters for teachers.

As technology-enabled assessment evolves towards the betterment of teaching practice, there are both opportunities and challenges for teachers to consider. Teachers could capitalize on the more intelligent and personalised forms of assessment to engage students in the higher-order or deeper learning. To do so, on the other hand, requires skilful teaching, and perhaps even to incorporate students' voices into the assessment practices to which it begs the question if teachers are ready and prepared for.

Dr Lim Wei Ying Rebekah is an Associate Professor and Director of the Teaching & Learning Centre at the Singapore University of Social Sciences (SUSS). Her research interests include professional identities, teacher learning and technology-enabled pedagogy; areas in which her research grant awards and publications are based on.

Technology-enhanced assessment: Implications for the design and delivery of professional learning

Assessment has been described as 'the Achilles' heel of quality' education. For university teachers, primarily employed for their subject matter expertise, the focus of teaching practice is often on learning outcomes (what do I want students to learn) and teaching and learning activities (how do I want students to learn), with assessment becoming an afterthought. Technology-enhanced assessment offers the potential to transform student learning experiences, for example, through the delivery of personalised feedback at scale. However, the integration of technology with assessment adds a further level of complexity to teachers' assessment practice.

It is generally accepted that the decision by university teachers to integrate technology into their teaching practice broadly, and assessment more specifically, is complex and influenced by factors both intrinsic and external to the teacher. This presentation will examine internal factors, including teachers' pedagogical beliefs, conceptualisations of teaching, and motivations, together with external factors, such as, institutional culture, pedagogical context and access to resources, as a way of highlighting the opportunities and challenges facing university teachers in relation to technology-enhanced assessment. From this analysis a key question then arises – what are the implications of such opportunities and challenges for the design and delivery of professional learning for technology-enhanced assessment?

Dr Kristine Elliott is an Associate Professor in Higher Education within the Melbourne Centre for the Study of Higher Education. The central theme of Kristine's research is how contemporary and emerging technologies can be used to enhance the learning and teaching experiences of students in higher education.

The use of educational technologies to enhance and increase formative assessment and feedback practices

Typically, a key element of students' concerns around their learning and assessment experiences in higher education is the provision of meaningful, actionable, personal and timely feedback. Increased academic workloads and administrative expectations as well as the casualisation of teaching staff can mean that this provision of feedback (especially dialogic feedback and particularly with large student cohorts) proves too overwhelming.

This paper considers how the integration of two polling educational technologies into the classroom and LMS teaching practices of university teachers enhances the provision of at-point-of-learning feedback for students, including the generation of dialogic feedback and peer review opportunities, ultimately allowing for and more adaptive or customisable teaching practices

Bronwyn Disseldorp is a Senior Learning and Teaching Consultant (Assessment) in Learning Environments at the University of Melbourne. Bronwyn provides advice, support, and professional development for staff using the Learning Management System and related learning technologies, with particular focus on assessment and feedback activities. Bronwyn has worked with a multi-disciplinary project team in 2019, helping prepare staff and students for the institution-wide transition to the new Canvas Learning Management

Resistance, perceptions and action: The complexities of TEA change management

Assessment is the most high-stakes element of higher education curricula. It is also the area most resistant to change. Adding technology to the mix affords new opportunities but adds additional risks to an already challenging area. Drawing on key literature reviews and original, empirical research, this panel topic will examine risks, resistance and solutions to TEA change management and adoption. Areas to be addressed include:

- Why stakeholders resist TEA change and how to engage with motives and outcomes
- The complex relationships of perceptions to actions in enacting TEA
- Key factors for making progress in the scholarship and practice of TEA

Dr. Christopher Deneen is a Senior Lecturer in Higher Education Curriculum and Assessment with The Melbourne Centre for the Study of Higher Education. Chris' research focuses on large-scale assessment change management and the critical evaluation of assessment-enabling technologies. He has authored over thirty publications on assessment-related topics, including two books and twenty journal articles.

Appendix I: Full author bios in alphabetical order

Dr. Christopher Deneen is a Senior Lecturer in Higher Education Curriculum and Assessment with The Melbourne Centre for the Study of Higher Education. His work focuses on effective learning engagements in universities. Chris has held several higher education positions in the culturally diverse contexts of New York, Singapore, Hong Kong and Australia. He is the recipient of multiple awards for innovation and excellence in teaching practice. Chris' research focuses on large-scale assessment change management and the critical evaluation of assessment-enabling technologies. He has authored over thirty publications on assessment-related topics, including two books and twenty journal articles. His recent chapter in The Cambridge Handbook of Instructional Feedback critically examines technology-enabled feedback in higher education contexts and the corresponding field of research. Chris has received over 2.5 million AUD in external, competitive research funding; his most recent research grant from the Singapore Ministry of Education examines perceptions, policies and practices of assessment for learning at a national level.

Dr Kristine Elliott is an Associate Professor in Higher Education within the Melbourne Centre for the Study of Higher Education. Her role supports the University's digital learning strategy through the development, implementation and evaluation of professional development for University staff in the use of educational technology for learning, teaching and assessment. The central theme of Kristine's research is how contemporary and emerging technologies can be used to enhance the learning and teaching experiences of students in higher education. Kristine has over 20 years experience in this field, in which time she has been instrumental to the successful development and implementation of more than 25 technology-enhanced curriculum and courseware programs/systems. The high quality and impact of these products is reflected in their current use at local, interstate and international institutions. Kristine has published extensively in the field, including in highly ranked journals, and has either led or been a co-investigator on successful grants.

Bronwyn Disseldorp is a Senior Learning and Teaching Consultant (Assessment) in Learning Environments at the University of Melbourne. Bronwyn provides advice, support, and professional development for staff using the Learning Management System and related learning technologies, with particular focus on assessment and feedback activities. Bronwyn has worked with a multi-disciplinary project team in 2019, helping prepare staff and students for the institution-wide transition to the new Canvas Learning Management System. Bronwyn has taught in several teacher education courses in the Melbourne Graduate School of Education and led staff professional development workshops in the use of technologies to support learning and teaching. In Learning Environments Bronwyn has been involved in the selection and adoption of a range of learning technologies, and supported staff in exploring the opportunities of Technology Enhanced Learning (TEL) in assessment and feedback practices.

Dr Lim Wei Ying Rebekah is an Associate Professor and Director of the Teaching & Learning Centre at the Singapore University of Social Sciences (SUSS). She leads the Centre in areas of academic development of lecturers, learning support for learners, and Scholarship of Teaching & Learning. Her research interests include professional identities, teacher learning and technology-enabled pedagogy; areas in which her research grant awards and publications are based on. Her other awards include the Hewlett Packard Innovation in IT in Education, Dean's commendation for research award, and the teaching excellence award 2011 & 2013. She has served as consultant to both local schools and international bodies, such as the Commonwealth of Learning, and more recently Southeast Asian Ministers of Education Organisation, Southeast Asian Regional Centre for Graduate Study & Research in Agriculture (SEAMEO SERCA) in areas of professional development and technology-enabled learning.

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Are Captured Live Lectures Appropriate for Delivery as Primary Online Course Content? A Question of Fidelity

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David Cameron
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Kavitha Palaniappan
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The use of lecture capture technology to provide students with the ability to review lecture material and to retrospectively “attend” missed lectures has become common practice in Australia and around the world. This panel discussion follows the evolution of university teachers’ acceptance and application of this technology over the past 10 years, and explores the potential for misuse or overuse of captured lectures beyond the provision of review materials.

One specific concern relating to misuse of captured lectures relates to their application for the provision of primary course content to both fully online student cohorts and those studying in different locations from where the live lectures were captured. In other words, using captured lectures as original teaching content for students not attending the lecture that was captured. Panel members consider the style of video learning objects that are most effective for students engaging in online study, and suggest that captured live lectures meet few of these criteria. Recommendations for best practice are offered.

Keywords: Lecture Capture, Instructional Video, Online Learning Objects

With the pervasive availability of lecture capture technology in most university classrooms, the question becomes: what can this content be used for after the lectures are captured? Although often framed as being for the purposes of review for students who could have attended the lecture, increasingly some university teachers are attempting to repurpose captured lectures for use as original content in online courses, for delivery of the same material to different sites, or for future delivery of the same course content.

For the purposes of this presentation, lecture capture is defined as a recording of all content displayed on the screen of a classroom computer, and a voice recording of the lecturer. This is in direct opposition to a full video-recording of a lecture (which includes video of the lecturer, students, and all classroom activities).

The growth in online offerings, the offer of the same course as an online offering, the similarity of content, and the perceived amount of work that academics feel is required to design online courses all contribute to the desirability of repurposing captured lectures as course content. Captured lectures appear to provide instantly available and convenient online content requiring little additional effort. For those teaching both face-to-face and online cohorts of the same course, the captured face-to-face lectures seem to be obvious learning objects for provision to online students.

Issues of academic workload are primary here. In many cases, academics are offered less than full course workload for teaching an online section of the same course they teach face-to-face. This naturally makes them attempt to find efficiencies. A natural efficiency appears to be the use of a captured live lecture to deliver the same course content to online students.

At a large Australian University, an all-in lecture policy was put in place four years ago. The initial push-back from teaching academics related to many believing that capturing the slides and voice of the lectures had a detrimental effect on student attendance. The majority did not want to allow this in their classrooms. Four years later, a different circumstance is arising where course coordinators are attempting to provide lecture capture recordings to cohorts of students never intended to be the original audience at those lectures. This panel discussion will explore how this circumstance came to be, its implications for the student experience, and what can be done to address it.

The international panel explores these issues from a number of perspectives, including that of central teaching and learning support, theories of production of effective online video content, the effectiveness of faculty use of captured lectures received from different geographic locations, the concept of using different ‘explaining voices’ for live or pre-recorded lecture presentations, and appropriate and inappropriate re-purposing of captured lectures.

Speakers and Topics Addressed

Expanding the Uses of Captured Lectures – How far is too far?

Professor Carol Miles, Director, Centre for Teaching and Learning at the University of Newcastle, Australia has been managing university-wide educational technology programs in both Canada and Australia for over 15 years. She was responsible for the implementation of the "All-In" Lecture Capture Policy at the University of Newcastle, and implementing a successful strategy. Professor Miles will address the changing reaction of teaching academics to the availability of captured lectures, and the current impulsion to use captures of face-to-face lectures as original content for online courses and other cohorts of students.

It's All in the Voice! Picturing the Audiences for Lecture Capture versus Original Recordings

Dr David Cameron, Senior Lecturer in Communication, Charles Sturt University, Australia. A former journalist and academic teaching in the areas of communication and media, Dr Cameron will address how understanding of learning content is in part conveyed by a presenter's 'mindfulness' of the context in which it will be received. The nature of lecture capture is to take information overtly presented for one context (the face-to-face lecture) and represent it in another (screen-based media). While this may be adequate when the intention is to provide online review materials for the original live audience , Dr Cameron explores if it is the most effective way to expose new content to students for the first time.

The Usefulness of Repurposed Lecture Capture Recordings for Diverse Student Cohorts

Dr. Kavitha Palaniappan, Academic Director, UON Singapore, Singapore. Dr. Palaniappan specialises in environmental and occupational health and is primarily responsible for academic activities at UON Singapore. For her panel presentation, Dr. Palaniappan will address UON Singapore's experience in delivering a number of courses locally using captured lectures recorded in another country (Australia) as primary content. Recommendations will be made for the limited effectiveness of captured lectures for those cohorts not attending the captured classes.

Intended Audience

This panel discussion will be of interest to university teachers, senior university administrators, instructional designers, and academic developers – or anyone else charged with determining the most effective technologies for presenting materials to students studying in face-to-face, blended, and fully-online modes. The panel sessions will present an opportunity for robust debate around the potential benefits and pitfalls of this limited technology for university teaching**.**

ASCILITE 2019 Theme Addressed and Value to Attendees

The conference theme of Personalised Learning. Diverse Goals. One Heart. is represented within this panel, as the core value being explored is what different types of recorded learning objects will best personalise the learning experience of students learning in different modes, often with different goals of learning. This panel discussion fits well within Theme 2 - Practices and Challenges in Technology Enhanced Learning. The evolving acceptance and expanding uses of lecture capture technology is now presenting different challenges than initially experienced, with a shift to over-use of recordings which is in sharp contrast to the initial reticence by many academics to adopt the technology. These issues will be discussed from a number of different perspectives – those of senior university administration, teaching and learning strategy, classroom university teachers, and students.

Participants will be encouraged to discuss their own experiences and theories surrounding the expanding use of lecture capture, and to explore potential applications within their own institutions.

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Mobile Learning Special Interest Group Symposium: Revisiting Mobile Mixed Reality

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This symposium discussion is based around the 2019 update to the special collection of Research in Learning Technology (RLT) on Mobile Mixed Reality (MMR) Enhanced Learning that the ASCILITE Mobile Learning SIG has coordinated this year - due for publication in November/December 2019 – the authors will use the articles to spark discussion around the critical issues surrounding the design of MMR for higher education, and the current state of the art of these rapidly developing technologies.

Keywords: Mobile Learning, Mixed Reality, Immersive Reality, State of the art

Overview

The Symposium will explore the critical issues around the educational use of Mobile Mixed Reality, based upon the articles accepted for publication in the 2019 update to the RLT journal special issue.The articles cover a range of themes around MMR including:

- Case studies in the design and implementation of MMR in higher education
- The use of Design Based Research as an underpinning methodology
- Key themes in mobile mixed reality use in higher education

Attendees of the symposium will have the opportunity to read the articles accepted for publication in the special issue before the symposium, and ask questions of the authors of the special issue papers – providing discussion around the implementation and design of mobile mixed reality learning environments. The session is aimed at educators wishing to explore the critical issues of integrating MMR in their teaching practice and curriculum design. The session fits the ASCILITE 2019 theme1 “Visions and Explorations in Digital Learning, Pedagogies & Spaces”.

Symposium Participants

Participants will be drawn from members of the ASCILITE Mobile Learning SIG who have submitted accepted papers for the RLT special collection on MMR, and the guest editors. Final accepted papers will be notified by 1 October 2019.

Guest editors and Symposium Presenters

- Dr Thomas Cochrane, Centre for Learning And Teaching, Auckland University of Technology, New Zealand. thomas.cochrane@aut.ac.nz
- Associate Professor James Birt, Faculty of Society and Design, Bond University, Australia. jbirt@bond.edu.au.
- Dr Vickel Narayan, Faculty of Business and Economics, University of Sydney, Australia. vickel.narayan@sydney.edu.au

Additional Symposium Presenters

- Dr Claudio Aguayo, Senior Digital Innovation Advisor, Centre for Learning And Teaching, Auckland University of Technology, New Zealand. Claudio.aguayo@aut.ac.nz
- Todd Stretton, PhD student and Programme Leader, Lecturer, Physiotherapy, Auckland University of Technology, New Zealand. Todd.stretton@aut.ac.nz
- Jin Hong, PhD student and Digital Media Team Leader, Centre for Learning And Teaching, Auckland University of Technology, New Zealand. Jin.Hong@aut.ac.nz
- Associate Professor Michael Cowling, School of Engineering & Technology | Tertiary Education Division, CQUniversity Australia. M.cowling@cqu.edu.au

Focus of the special collection update

Mobile Mixed Reality (MMR) is a rapidly developing technology that is being implemented in many different learning environments. A lot has changed already since the publication of our 2018 Special Collection on MMR, and this update to the 2018 special collection on MMR (Cochrane, Smart, & Narayan, 2018) for 2019 will highlight the latest research in this domain. Mobile device ownership is ubiquitous, leading to many higher and further education institutions exploring a BYOD approach to mobile learning. However, most mobile learning projects are device centric and focus upon repurposing content for delivery to small screens and substitution of pre-existing pedagogical strategies. The potential of mobile learning is to enable new collaborative networked pedagogies and professional practice through enabling authentic learning beyond the classroom. This special issue invites papers that explore the boundaries of current knowledge and approaches to mobile learning, and specifically explore the unique affordances of mobile devices for learner-generated content and experiences via such technologies as collaborative media production and sharing, Virtual Reality (VR), Augmented Reality (AR), Mixed Reality, geolocative and contextual sensors, drones and wearable technologies.

Augmented and virtual reality (mixed reality) is an emerging technology that bridges the gap between computer generated and real world environments. Mobile Mixed Reality enables the design of authentic learning environments that explore the impact of socio-culture influences, and lead to deeper student engagement with the real world via digitally enhanced gamified environments. This is illustrated by the phenomenon of Pokemon Go, and emergent mobile mixed reality projects with the likes of the Microsoft Hololens and Google Cardboard. The use of AR and VR to support teaching and learning has shown to have many advantages which include enhancement of learning achievement in terms of enhanced learning outcomes, motivation and engagement (Bacca, Baldiris, Fabregat, Graf, & Kinshuk, 2014). Interest in the application of VR and AR have increased dramatically over the last few years (Akçayır & Akçayır, 2017). However due to the relatively emerging nature of these technologies the implications of these tools in education are still largely still being explored. The special collection will include research topics such as, but not restricted to:

1. Reviews of the state of the art of mobile augmented reality (AR) and mobile virtual reality (VR) and immersive reality (XR) in higher and further education
2. Reviews of the key themes in recent mobile learning research in higher and further education
3. Heutagogy and mobile AR/VR/XR in higher and further education
4. Case studies in mobile AR/VR/XR in higher and further education
5. Frameworks for mobile AR/VR/XR in higher and further education

The **methodological theme** for this special collection focuses on research approaches that move beyond simple comparative case studies, and explore the application of Design-Based Research as a methodology for designing authentic mobile learning (Bannan, Cook, & Pachler, 2015).

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Academic development for generic competencies for the unknown future

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This debate focusses on how academic development initiatives can contribute to the development of new competencies essential in future society. The emphasis is on the need for a fundamental transformation of education and training to meet the skills and competencies in demand to increase employability, personal development, social inclusion and active citizenship. Preparing students with adequate competencies required by the socio-economic changes emerged as a result of, amongst others, globalisation and technological progress is a challenge for universities and other HEIs, as recognised by related works. This claim on academic development initiatives raises several questions: What are these "new competencies" needed in our future society? Can universities develop a reliable strategy to enhance some generic digital competencies amongst all students? If we assume that the future is unknown, then, we can argue that also the competencies appropriate for it are unknown. Accordingly is an academic development ambition not self-evident as we might focus on irrelevant topics.

The main question to be discussed is if it is relevant to strengthen the universities academic development with ambition to develop generic competencies for the unknown future.

Keywords: Tertiary education; Academic development; Generic digital competencies; Unknown future

Rationale

Digital competencies are one of the 21st-century skills that every individual must have to increase employability, personal development, social inclusion and active citizenship[7]. Achieving that requires new education strategies from universities. As recognised by the digital agenda for Europe[8], a fundamental transformation of education and training is essential to meet the skills and competencies that are in demand. The challenge thereby for universities is to prepare students with adequate competencies needed for the socio-economic changes resulted by, amongst others, globalisation and technological progress.

Future labour market is often described as equipped with increased automation, business models based on algorithms, big data, artificial intelligence, cloud computing, dexterous robotics, etc. and the competencies on demand are both digital skills and other generic skills such as collaboration and entrepreneurial skills (Fossen & Sogner 2019, Meyer-Guckel et al. 2019). Although there could be a possibility that socio-economic statuses in future might not precisely be predictable by the current trends (Barnett 2019, Jørgensen 2019).

Universities are, by all means, educating students to be adequately skilled for upgraded job profiles, and the labour market is demanding that students should possess diverse skills to be employed. Current political discussions mainly highlight teacher education (Starkey 2019) and students' employability in relation to specific fields when leaving the university. Designing a curriculum and practising a pedagogy suitable for such a task is far from the practices that we readily understand. (Barnett 2019). General digital competence is thus something that extends further from merely using digital tools, which is often a requested competence of university teachers and students. In teacher pre-service education, this wish is heard with a background that students who are trained as teachers should have good knowledge of information technology that they can use in their professional practice and thereby strengthen the pupils' digital skills. We describe general digital competence as digital-related competencies that are desirable by the students leaving the university, for enhancing their general employability and active citizenship.

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[7] New skills agenda of Europe https://ec.europa.eu/jrc/en/research-topic/learning-and-skills

[8]http://publications.jrc.ec.europa.eu/repository/bitstream/JRC101254/jrc101254_digcomp%202.0%20the%20digital%20competence%20framework%20for%20citizens.%20update%20phase%201.pdf

Considering that new skills are essential for each individual in society, there is a visible shortage of supply by the education sector. The universities lack educational offers that convey future competencies that embrace all students (Meyer-Guckel et al. 2019). However, some initiatives are taken to include competencies in existing curricula, i.e., in Australia and New Zealand, students learn critical skills alongside learning how to "leverage robotic process automation". (https://www.universityworldnews.com/post.php?story=20190612130456922)

We are debating the relevance to strengthen the university's academic development with ambition to develop generic competencies for the unknown future.

The attendees will get arguments for and against an ambition to strengthen academic development for generic competences needed in an unknown future.

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Creating low-cost, active and immersive Virtual Reality learning experiences

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This 50-minute experiential session explores the evolving affordances of low-cost Virtual Reality (VR) technologies to create active and immersive learning experiences. As part of the session, you will use your mobile phone with Google Cardboard to explore and evaluate a short, active, immersive VR experience. Next, you will learn how to create simple VR content using the Cardboard Camera mobile application. In the final part of this session, we will collectively, brain storm ideas and discover resources and tools that can be used to further your knowledge and extend your experience in using VR for active and immersive learning.

Keywords: Virtual Reality, VR, Google Cardboard, immersion, active learning

Virtual Reality, immersion and active learning

Given the evolving affordances of Virtual Reality (VR) technologies and spaces, digital learning can now be experienced in ways that promote active and immersive learning. Immersion is a powerful kind of experiential learning as it gives ‘the subjective impression that one is participating in a comprehensive, realistic experience’ (Witmer & Singer, 1998). One key factor in creating immersive experiences, especially those that create a feeling of presence, is the engagement of multiple senses. Dede (2009) calls this ‘sensory immersion’. Virtual Reality which literally means ‘near reality’ (Virtual Reality Society, 2017) offers realistic, sensory immersion experiences through three-dimensional computer-generated virtual environments. That is, immersive VR experiences are simulated digitally to replace the user’s real-world environment. These immersive experiences can provide even higher learning impact by ensuring learners are active in their learning environment. Studies, such as Freeman and colleagues’ (2014) large scale meta-analysis, found the benefits of active learning are strong. As such, active, immersive VR learning has enormous potential to equip learners with the real-world knowledge and practice-oriented skills to succeed in their future careers and in other aspects of life.

Recent advances in VR equipment allow for more heightened sensory interaction with the virtual environment. For example:

- VR headsets – a device like a pair of goggles that goes over your eyes. Some of the higher-end headsets (like Oculus Rift) are connected to your computer and cheaper ones (such as Google Cardboard) use your mobile phone clipped into the actual headset.
- VR controllers – a device or gloves that allows for more interaction, and often haptic feedback, within a virtual reality environment. Such as, Occulus touch or gloves.
- VR treadmills – allows the user to physically run and experience more physicality in a virtual immersive environment. Such as, the Omni by Virtuix.

However, designing and creating active, immersive, VR learning experiences can be expensive and challenging. The purpose of this session is to discover low-cost approaches to developing and using VR in learning.

The goal of the experiential session and how it will operate

This 50-minute experimental session aims to show how VR learning experiences can be incorporated into learning in ways that are simple and cost-effective. Attendees need only bring their mobile phone and headset (e.g. ear buds) to access the learning environment and install and use a few mobile applications to create and run the VR content. The session will operate as follow:

1. Introduce participants to the potential of active and immersive learning (5 minutes)
2. Engage participants in a short active and immersive VR learning experience using Google Cardboard (15 minutes)
3. Explore simple ways to use a Google Cardboard Camera to create a VR experience (20 minutes)
4. Collectively brain storm ideas and discover resources and tools that can be used to further your knowledge and extend your experience in using VR for active and immersive learning (10 minutes)

Names and biographies of the organisers/facilitators of the session

Mr Mark Bailye: Mark is a Customer Success Advocate at Blackboard who is actively involved in spearheading and championing the use of new and emerging technologies to transform and enhance the learning and teaching experience in higher education. A thought leader and trusted advisor who provides pedagogical and andragogical insights to drive high quality learning and teaching activities in face-to-face, blended and online learning environments.

Dr Caroline Steel: Caroline is a Senior Strategic Consultant with Blackboard and a passionate higher education specialist with expertise in transforming educational institutions to meet current and future learner needs. She brings expert knowledge and thought leadership in the pedagogical application of new and emerging technologies for learning, teaching, curriculum and assessment for large scale, strategic change initiatives. Prior to joining Blackboard Caroline established a strong reputation in the field of digital learning and teaching as an innovative academic and leader. She retains an adjunct academic position at the University of Queensland.

What attendees will get out of the session?

Attendees will have the opportunity to experience and evaluate a short active, immersive, Virtual Reality learning experience using Google Cardboard VR headsets. They will learn simple ways to use a Cardboard Camera with their mobile phone to create VR content. Finally, they will take away further ideas and resources that can be explored beyond the session to create their own active, immersive VR learning experiences for their own learning and teaching contexts.

Who the session is aimed at?

Learner designers, academics, corporate trainers and those interested in designing low-cost active, immersive, VR learning experiences.

How does the session fit the ASCILITE 2019 theme?

The session fits the conference theme ‘Personalised Learning. Diverse Goals. One Heart.’ because active, immersive, Virtual Reality learning experiences are focused on the use of technologies for sound pedagogical practices that can help equip learners with real-world knowledge and practice-oriented skills to excel in life and their chosen career. Through creating these kinds of learning experiences, learners have more opportunities to learn and practice in simulated real-world contexts.

The session also fits with Theme 1 ‘Visions and explorations in digital learning, pedagogies and spaces as the focus is to take a relatively new and expensive technology (Virtual Reality) and think about how it can be incorporated into pedagogical instruction and learning through the use of simple cost-effective equipment (Google Cardboard + mobile phone) and through guidance via collectively agreed design principles that will mitigate some of the challenges and complexities of designing for active, immersive, VR learning.

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Designing learning analytics visualisations that align to learning design

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In the field of learning analytics there is an ongoing challenge for designers to create visualisations of data and analyses in ways that are meaningful to the audience and can be easily translated into action. The use of learning design as a frame through which to support good visualisation design is a key area of development and exploration gaining momentum in the learning analytics community. However, it has been observed that there is often a lack of thorough evaluation in the development of visualisations across learning analytics systems. In this interactive experimental session participants will be provided with a hands-on experience of effective design of learning analytics visualisations with reference to learning design. Participants will be given an opportunity to work together to develop a visualisation design for a particular learning design scenario, as well as a plan for the evaluation of the visualisation. The session is designed for anyone who has an interest in the design and development of learning analytics visualisations and participants do not need to have a technical background in data visualisation to attend.

Keywords: Learning Analytics, Learning Design, Visualisation

Background

The field of learning analytics has evolved over the past decade to provide many ways of exploring and analysing data about students to improve learning and learning environments. As analyses continue to increase in sophistication it is important that consideration is given to how such analytic outputs are presented to audiences, whether they be teachers, administrators, or students, in ways that promote understanding and action. The field is not short of visualisations of data, but concern has been expressed about the lack of evaluation of these visualisations to ensure that the audience can adequately interpret the data presented and determine the appropriate action or intervention to make (Corrin & de Barba, 2014; Jivet et al. 2018). Often these visualisations sit within online education systems (e.g. Learning Management Systems, Lecture Capture tools, etc.) which attempt to provide generic representations of the data to suit a multitude of contexts and designs. Another trend in this area is the focus on the visualisation of data that is easy to collect and analyse, which can result in the provision of visualisations that are not particularly meaningful to the user.

The important role of learning design in how student data is analysed and presented has long been promoted in learning analytics (Lockyer, Heathcote & Dawson, 2013) and acknowledged via the development of frameworks that bring learning design and learning analytics together (e.g. Authors, 2016). Designing visualisations that reference the underlying learning design creates the potential for visualisations to tell a story that the audience can understand, promoting aspects of the data that are key to informing future action (Echeverria et al., 2018). This requires a careful consideration of the data, design and visual tools which can result in more specialised visualisations for different learning design contexts. Evaluation of these visualisations with the target audience is vital to understanding how the visualisation is interpreted and to refine the visualisation design.

The Experimental Session

The aim of the proposed interactive experimental session is to raise awareness of the issues around the effective design of learning analytics visualisations with reference to learning design. The 50-minute session will begin with a brief overview of key principles related to visualisation design and learning design. A number of learning design scenarios along with key questions for analysis will then be presented to the group as a whole for which visualisations can be designed. The whole group will then be split into smaller groups, based on the interests of individual participants, and each group will be tasked with developing a visualisation design for a relevant scenario. Throughout the process of design groups will be asked to consider:

- What data sources will be required to address the scenarios/questions?
- What visualisations designs could be used to represent this data?
- Does the visualisation require any additional narrative elements to improve interpretation?
- How can the visualisation be evaluated?

Towards the end of the session each group will be asked to share their design and to highlight any significant challenges and/or evaluation ideas. Discussion will be encouraged to generate ideas to address any challenges and constructive feedback will be shared on the presented designs.

Facilitators

The experimental session will be facilitated by Associate Professor Linda Corrin and Dr Aneesha Bakharia who have worked together for a number of years on research and development of learning analytics systems.

Associate Professor Linda Corrin is the Academic Director, Transforming Learning at Swinburne University of Technology. Her research interests include learning analytics, digital literacy, feedback and learning design. Currently, she is working on several large research projects exploring how learning analytics can be used to provide meaningful and timely feedback to academics and students. Her early work on learning analytics dashboards highlighted the importance of providing a learning context to improve students' interpretation of dashboard visualisations. Linda is co-founder of the Victorian/Tasmanian Learning Analytics Network and a co-ordinator of the ASCILITE Learning Analytics Special Interest Group.

Dr Aneesha Bakharia is the Acting Director of Learning Analytics at the University of Queensland. Her work at UQ to date has focused on developing MOOCs for edX platform and blended on-campus courses. Aneesha's PhD research focused on text analytics with case studies in collaborative learning environments. She has also published broadly within the field of learning analytics, developed several well-known learning analytics applications, and has written 10 books on programming and web development.

Intended Audience

This interactive experimental session is designed for anyone who has an interest in the design and development of learning analytics visualisations. Participants do not need to have a technical background in data visualisation to attend. Participants from a variety of roles including learning analytics developers, learning designers, teachers and learning support staff are encouraged to participate and the interactive activities will be designed to take advantage of the different expertise in the room.

The experimental session aligns with the "Data Analytics & Evidence to Improve Teaching & Learning" key theme of this year's ASCILITE conference in that it aims to raise the awareness of participants as to important design considerations for improving how learning analytics visualisations can be designed and evaluated so as to improve teaching and learning.

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Digital History: Unpacking this untapped pedagogical tool

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The goal or idea of the session and how it will operate

Recent literature assumes digital history is a computational method of collecting knowledge about the past (Benjafield, 2017; Smithies, 2013) . However, psychology and history disciplines utilize this method to provide insightful and enriching data. New Zealand based studies recognise this is not a new idea, however implications may be underrated (Phillips, 2013; Smithies, 2013). As a tool, digital history can make key connections between humans, technology and learning. The term digital history is not be confused with digital storytelling which is more complex and involves various forms of media to convey a story.

Participants will be exposed to using digital history as a pedagogical tool in the classroom. The goal is for participants to envision implementation and applicability into their own context. The session will consist of interactive activities and demonstrations. Participants will be involved in the creation of output during the session. Engagement will be in various forms such as discussion and technology usage. This variety of engagement will enable participants to take the seat as student and observer. Dual roles will enable the participants to participate while creating content. This creation can display the application within the classroom and usage in content evolution. Participants will have the opportunity to collaborate on a digital history output that can be used for instruction and learning. Co-creation of content will be the main goal so participants can envision the usage and integration.

Digital history allows humans to share ideas, "human history is in essence a history of ideas" (Välikangas & Sevón, 2010). To this end, humans can be trapped by ideas, notions or experiences. Ideas can be interpreted as commodities for people or organisations rather than actors. Digital history cannot overlook social impact as a critical and conceptual evaluation point (O'Donnell & Henriksen, 2002; Wei, Teo, Chan, & Tan, 2011). Social impact and shared learning within information and communications technology is central to economy and society. It is noted that everyone in the world does not have equal access to automation and technology, therefore digital history may be limited with presence of digital divide (Wei et al., 2011) . However, bridging that gap in the classroom is possible when digital history is used as a collaborative tool.

Names and biographies of the organisers of the session

Darl G. Kolb

Darl G. Kolb is Professor of Connectivity in the Graduate School of Management (GSM), where he explores connectivity on multiple dimensions. Before his academic career, Darl spent ten years as a professional instructor/guide with the Colorado Outward Bound School and the Santa Fe Mountain Center. His experience in experiential education has served him well in designing invigorating learning experiences. His current research is focused on metaphors-in-use www.metaphors-in-use.com He holds a PhD from Cornell University and has been a Visiting Fellow at the University of Sydney and University of Cambridge.

Patricia R. Hubbard

Patricia Hubbard is a Professional Teaching Fellow and PhD student in the Graduate School of Management at the University of Auckland, New Zealand. She has previously been a Chief Financial Officer at a large school district in the United States and an adjunct professor at Montana State University (USA). Patricia has been involved in delivering a number of university courses in the areas of management, organisation, accounting, computer applications, website design, human resources and professional development. She has worked in various consulting capacities creating strategic, business, leadership, management, technology and marketing plans. This has spanned several industries such as education, financial services, telecommunications, social media technology, retail, real estate and non-profit organisations. Patricia is passionate about university studies, programme development and student achievement. She also brings an international perspective to enhance the employability of graduates and build up programme opportunities. She is an advocate of life-long learning and enjoys having the opportunity to be actively involved in the community.

What attendees will get out of your session

At the conclusion of the session, participants will have an understanding of:

- The actual practice of digital history;
- Why this technique can be of value in teaching and learning;
- How to integrate digital history in the classroom;
- What benefit it can have for students, teaching and learning;
- Examples to show the technique and how to deepen student understanding;
- Implementing the ideas and curriculum integration.

Who the session is aimed at

The target audience is anyone at the conference that would like to know more about the technique of digital history. As a method to engage students and relate to previous experience to scaffold on existing structure. Attendees will be seeking a new way to encourage students to be lifelong learners and identify past experiences to reflect upon. Participants will want to gain connection to utilizing new ways in the classroom to build global citizens through sound pedagogical practices grounded in technology and experiential learning.

How the session fits the ASCILITE 2019 theme

Digital history provides instructors motivation to engage learners in a different way. Developing our learners to excel in their chosen career requires understanding of where they start. Each learner brings a diverse motivation for learning, this method begins to bridge the gap in knowledge sharing. Once we can wrap curriculum and goal development around this digital history, we can aim to equip students with knowledge for future success. A chance to connect with the students and utilize their knowledge and skills to move forward. Furthermore, it explores an emerging digital technology that can be incorporated into instruction and learning. Thus, creating a unique learning space for students to design a new way of exploring.

Inspiring students to actively engage in the learning opens up the possibilities. Real world application becomes embedded in the instruction and learning while including students in the design process thinking. This tool can provide the space for students to express creativity and help drive learning design. This session will aim to explore a pedagogical area of digital learning that can be trialed in various learning spaces. This exploration will solicit sharing and experimentation to be taken away by participants.

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E-Portfolios: How to showcase your professional self

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The goal or idea of the session and how it will operate

The goal of the session is to introduce the participants to the idea of using an e-portfolio (e-pf) platform in order to enhance a graduate's chances of success at interview. Students need to create an overarching narrative of their past experiences so that they can plan their future careers (Graves & Epstein, 2011). An e-portfolio gives the students a frame to recognise common themes in their experiences. Students can revisit and revise the e-portfolio frequently due to the electronic medium, empowering them and their future (Buyarski, Aarom, Hansen, Hollingsworth, Johnson, Kahn, Landis, Pedersen & Powell, 2015). Naturally, each e-pf will be unique to the student but the e-pf itself can be seen as a unifying platform that allows the student individual expression while being accessible to all. Self-authorship, reflection and meaning making all attribute to the creation of the e-portfolio and the unique aspects (Buyarski et al., 2015). The session will be instructive and interactive and will consist of demonstration, video use, role-play and reflection. The participants will be shown the technology, examples of its use in action and then asked to use the platform in a role-play situation. The attendees will, therefore, experience how the e-pf idea works and will be able to reflect upon whether they think it would be useful for their own educational contexts.

Names and biographies of the organisers of the session

Kevin Kempin

Kevin Kempin is a Professional Teaching Fellow and has been teaching on the Professional Development, Business Communications and Marketing courses within the University of Auckland (UoA), New Zealand for the last few years. Within that time, as Course Director, Kevin has redesigned and led the development of the Business Masters' Professional Development modules for the Business School, UoA.

Kevin is an experienced teacher who has received awards for innovation in teaching and curriculum development. Over the last 35 years, Kevin has worked in a variety of teaching and leadership roles which span national and international tertiary institutions, business schools and B2B industries. Key roles have included National Sales Manager (UK) within the publishing B2B sector, 'Academic Communications' tutor for INSEAD (France) and Curriculum Leader at Unitec, New Zealand. Kevin has a particular interest in student autonomy, programme development and teacher training.

Patricia R. Hubbard

Patricia Hubbard is a Professional Teaching Fellow and PhD student in the Graduate School of Management at the University of Auckland, New Zealand. She has previously been a Chief Financial Officer at a large school district in the United States and an adjunct professor at Montana State University (USA). Patricia has been involved in delivering a number of university courses in the areas of management, organisation, accounting, computer applications, website design, human resources and professional development. She has worked in various consulting capacities creating strategic, business, leadership, management, technology and marketing plans. This has spanned several industries such as education, financial services, telecommunications, social media technology, retail, real estate and non-profit organisations. Patricia is passionate about university studies, programme development and student achievement. She also brings an international perspective to enhance the employability of graduates and build up programme opportunities. She is an advocate of life-long learning and enjoys having the opportunity to be actively involved in the community.

What attendees will get out of your session

At the conclusion of the session, participants will have an understanding of:

- Why e-portfolios are used by graduates;
- How to integrate e-portfolios into their courses;
- Ideas of how participants might use e-portfolios;
- A student's view of the experience;
- The pros and cons of the tool;
- Implementation ideas and curriculum integration.

Who the session is aimed at

The target audience is anyone at the conference that would like to know more about practical, technological and collaborative ways to engage students to be better global citizens and to increase their chances of the ability to represent their skills and achievements upon graduation. Attendees will be seeking an innovative way to encourage students to be lifelong learners and reflect upon experiences.

How the session fits the ASCILITE 2019 theme

Bird (2007) used narrative construction to influence concepts of ourselves in story form. This session is influenced by narrative and sense-making theory in relation to the e-portfolio. Students draw on narrative construction to create their e-portfolio and historical experiences. Aligning to the theme, this session focuses on the learner's needs and analysing that need through the use of an e-portfolio. Diversity amongst students drives a need to diversify teaching practice to accommodate past experiences. E-portfolios offer students a practical tool to capitalise on their experiences and move forward in their chosen career. This session will demonstrate the outcomes that can be created with the use of an e-portfolio tool. A tool such as this is not a snapshot in time but a continuing project. Students can use this platform to continue to track new learning and upskilling as they progress towards their career. Reflection is good pedagogical practice for students and e-portfolios allow this to deepen and continue. Real-world knowledge can be applied within the tool on an individual basis to show personalised learning and diversity in experiences. In a sense, the e-portfolio can be the "One heart" that beats to guide students to pursue their passions and dreams.

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Playtesting "The Sausage Factory"

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Australia

"Laws are like sausages; it is better not to see them being made" – Otto Von Bismarck

While ASCILITE aims to enable and share "high quality research, innovation and evidence-based technology-enhanced practices in tertiary education" (ASCILITE, n.d.), this frequently takes the form of evaluations and discussions of the pedagogical impact of Technology Enhanced Learning (TEL) and commonly addresses the perspectives of the teaching and researching academic (Bayerlein & McGrath, 2018). We rarely explore the perspectives and practices of the institutional staff tasked with practically implementing and integrating education technologies in increasingly complex educational ecosystems (Ellis & Goodyear, 2019), the education technologists and ICT teams. Perhaps there is a perception that, like laws, it is better not to see education technology implementations being made. Given the frustrations frequently expressed about the speed and cost of these implementations however, understanding more about the finer details of how they work - the "sausage factory" - would seem beneficial to people working with TEL in many areas.

The goal of the session and how it will operate:

This experimental session will enable attendees to participate in a 'playtest' of a branching scenario-based interactive video game called "The Sausage Factory" that is currently being developed by the Monash Education Innovation team in conjunction with the ASCILITE TELedvisors SIG. The purpose of the game is to increase understanding of the complexity of education technology implementations by guiding players through key decision points in the process from product identification to the start of piloting (Wang & Paper, 2005). This will, hopefully, in turn lead to more beneficial collaborations and more effective project planning by providing deeper understanding of the factors that influence these projects. This session would be best suited to a 50 min period to encourage discussion.

The playtest will involve having participants play the game collectively, by voting on decisions raised in short multi-media scenarios involving two or three key stakeholders addressing a key issue or factor in an education technology implementation. These include compatibility with existing enterprise systems, planning for support, network and security issues, privacy, intellectual property, budgetary priorities and licensing, to name but a few (Kenny, 2004). Participants will use an online polling tool to vote for the best decision at the end of the scenario after being given an opportunity to ask questions. These questions will replicate the availability of links to additional information in the game. Decisions made by participants will have an immediate impact on the project in the game by determining the next scenario shown, as well as affecting scores relating to cost, time taken, reputational impact, pedagogical impact and project engagement.

At the end of the game, the facilitators of the session will foster discussion of the themes and issues raised in the game, as well as gathering feedback on the effectiveness of the scenarios and the gameplay that will be used to develop further iterations.

When completed, the game will be released freely under a Creative Commons By Attribution, Non-Commercial licence.

How the session fits the ASCILITE 2019 theme:

While this session and game is centered around the activities of the people who implement and support the education technologies used in institutions, it is worth remembering that their ultimate goal is to provide students with the best possible learning experience, which aligns with the overall theme of ASCILITE 2019. There are many secondary factors that shape how this is achieved and this session aims to shed some light on some that are less well understood.

In terms of the specific conference streams, it would sit well in Stream 2: Practices and Challenges in Technology Enhanced Learning, as it will help raise understanding of the technological factors that influence the ways that TEL takes "root in a meaningful, scaled or sustainable manner"

Who the session is aimed at:

The primary audience for this session is people working in roles that don't ordinarily have much to do with the behind the scenes decision making involved in making education technology available in an institution. These would mainly be academics involved in TEL research and using TEL in teaching, learning designers and leaders of TEL support units. It would be useful to also have learning technologists and IT people in the session to bring their particular insights to assist in developing the game.

What attendees will get out of your session:

Attendees should get two things from the session: a deeper understanding of the complex factors that influence the implementation of education technology in an institution and an opportunity to share their thoughts about the strengths and weaknesses in this process.

Session organisers

Colin Simpson, Monash – Educational Technologist

Colin Simpson is a Senior Education Technologist in the Monash Education Innovation team at Monash University. He has worked as a Learning Technologist, Education Designer and Academic Developer since 2003 at the Canberra Institute of Technology, ANU, Swinburne University and has been at Monash since May 2019. Colin is a TELedvisors SIG co-convener and is a PhD candidate in Education at the University of Sydney.

Kate Mitchell, Victoria University – Learning Designer

Kate has worked as a learning designer and previously was responsible for La Trobe's digital learning strategy. Her most recent research was a Master of Education examining vocational educators' perceptions of eLearning, its barriers and its enablers. Kate is a TELedvisors SIG co-convener and co-founder and runs the journal club for the SIG.

Wendy Taleo, Charles Darwin University – Learning Technologist

Wendy completed her Master of Arts in Online and Distance Education this year. She supports academics in developing their teaching practice with technology and is part of the LMS team providing administrative support, user acceptance and testing and blended training on new products and features. Her research interests lie in multimodality of student-created work and TEL assessment design. She has been involved with TELedvisors since its inception and a SIG leader for the past year.

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Decisions, dialogues, dilemmas: the drama of technological innovation in higher education

Colin Simpson	Wendy Taleo	Dr Henk Huijser	Kate Mitchell	Lindsay Rattray	Penny Wheeler
Monash University Australia	Charles Darwin University Australia	Queensland University of Technology Australia	Victoria University Australia	Navitas Australia	Australian Catholic University Australia

A sales representative from the New Shiny Tool company approaches the Pro-Vice Chancellor (Innovation) at a mega-conference, or an academic comes to their Associate Dean Learning and Teaching to request the installation of an ideal small plug-in for the learning management system. Is this how innovation in higher education happens? What might happen next? In this experimental session, we will, with the help of the session audience, chart the characteristics of a robust innovation project and map some institutional case studies against this benchmark to foster greater understanding about the complexity of change and the implementation of new technologies for learning and teaching. Decision points and the perspectives of the decision-makers will be acted out in rapid scenarios, highlighting the choices available at each stage.

Keywords: change management, innovation, implementation, ICT, TEL, educational technologies

Perspectives on innovation

The processes that universities use to implement new technologies for learning and teaching, research and administration have been refined by decades of experience and in symbiosis with the corporatisation of the sector. This history might lead to expectations that innovation in higher education proceeds smoothly along a rational path, but its progress can be uneven and surprising. Institutional strategies, the tools available for planning and communication, the people involved at each stage of the implementation, and the choices that they make, all contribute to the drama of innovation.

To exemplify these complex interactions, this experimental session will enact a set of scenarios depicting phases in the implementation, in a higher education setting, of ‘New Shiny Tool’ (a very large TEL platform) and ‘Tiny Integrated Plug-in'. Stakeholders are introduced via dialogues that present choices and branching points in the implementation timeline, and strategy, people, processes and enablers (Margherita & Petti, 2010) feature as factors in managing change. The dilemmas that the scenarios depict will resonate with ASCILITE attendees who are veterans of technology projects but also, we hope, interest fresh recruits to the academic environment.

The facilitators for this session are members of ASCILITE’s TELedvisors SIG, and represent the perspectives of learning designers, educational technologists and academic developers on technological implementation and change in universities: we also welcome and will make use of other perspectives on innovation from the session audience. University staff with responsibility for any components of technological change and innovation (leaders and managers, academics, ICT professionals, business leads, as well as TEL professionals) will be able to identify with the issues raised in the scenarios and expand on them from their own experience.

Session scripts and choices

Short scenarios of key events in implementation case studies will be used to:

1. articulate the strategies, enablers, motivations and perspectives of each decision-maker and actor
2. involve the session audience in a workplace narrative where they can contribute their own insights and add to the scholarly conversation
3. experiment with drama and mapping as tools for reviewing project progress and failure.

The scripts for the scenarios have been extracted from anonymised stories from the TELedvisors SIG and from innovation case studies such as Wang and Paper (2005), University of Central Lancashire (2013), Porter et al. (2016), and Bayerlein and McGrath (2018). Several of these authors write from the stance of their own role, whether that be as Executive, project manager, course coordinator, academic, or ICT manager: according to Snyder (2013, quoted in White, 2017), the viewpoints of actors within complex systems provide important perspectives.

Discussion and live polling: With each short scenario, the session attendees will be invited to consider the aims, motivations, emotions, and priorities of the different people and roles involved. A combination of discussion and technology (Flux polling tool) will be used to enable the audience to effectively participate in the session.

Mapping: As the diverse goals of the stakeholders and the enabling issues and barriers are identified through the scenarios and by the attendees, we will add them to a timeline of key events. This mapping will show relationships with stakeholders over time and highlight tension points that appear and may delay implementation.

The session is constructed around two aspects of this year's theme for the ASCILITE conference, **diverse goals** and **one heart**. It has been claimed (Maloney & Kim, 2019) that universities and their staff represent a much wider set of goals and objectives than even the most diversified of corporations, objectives that can perhaps all be brought under the university's expressed mission of care for learners ("one heart"). As Philip Uys (2010) noted, however, care for students might be compromised when large-scale technology implementations exacerbate structural issues such as the educator's budget of effort between research and teaching, reducing the transformative possibilities of technology for learners, teachers and the institution. We will be in part guided by our session attendees as to how these concerns might be balanced through innovation.

Audience takeaways

Attendees will contribute to the development of an implementation map which can be shared and used in charting the progress of a complex project. The session organisers also hope that, through experiencing different personas, we and our attendees will learn more about and have greater empathy for the perspectives of others in our institutions.

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ITE non-academic entry evaluation using SimLab

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Murdoch University requires all Initial Teacher Education (ITE) candidates to respond to a 5-minute SimLab interaction with the aim of teaching a topic of choice, learning something about each avatar and concluding, by asking questions to confirm understanding of the information discussed. A rubric, addressing 4-criteria, is used to evaluate student success. A demonstration of SimLab and preliminary research data that explores the effectiveness and predictive validity of simulation as an on-entry performance assessment are the foci of this work.

Keywords: Simulation, Teaching, Evaluation, Avatars

Introduction

To be first implemented in 2019, the Australian Institute for Teaching and School Leadership (AITSL) requires an on-entry non-academic evaluation for all ITE candidates *(https://www.aitsl.edu.au/deliver-ite-programs/standards-and-procedures)* that is "*consistent with engagement with a rigorous higher education program, the requirements of the particular program and subsequent success in professional teaching practice"* (Standard 3.2).

The technology

The SimLab technology (formerly known as TeachLive) offers a unique blend of virtual reality technology and live human performance that creates powerful and immersive learning simulations for pre-service teachers. SimLab technology is used AS the classroom not IN the classroom and offers a safe learning environment (Figure 1).

Figure 1. SimLab™ Virtual Classroom

The technology offers a 'real time' mixed reality learning environment, with classroom pupils being represented by avatars that respond in real time. A human looped 'interactor' manipulates five avatars in a similar manner as a 'puppeteer'. Each avatar is personalised in form, voice, and persona and their identities are cognitively and behaviourally modelled on the work of psychologist William Long's (1989) categorisation of adolescent personalities. Research shows that users of the technology actually become empathetic to the emotions, abilities and circumstances of the avatar (Dieker, Rodriguez, Lingnugaris-Kraft, Hynes, & Hughes, 2014).

Murdoch University has positioned itself to be a leader in simulation, being the first in the southern hemisphere to introduce mixed reality learning environments into initial teacher education (ITE) to practice and prepare its graduates as they transition into the workforce.

In response AITSL Standard 3.2, Murdoch University, requires the applicant to successfully respond to a 5-minute SimLab experience. There are four evaluation criteria for judging dispositions. The applicant must achieve success in at least 3 of the 4 criteria:

1. Language and discourse: Classroom appropriate words, Comprehension, Coherence, Clarity, Fluency
2. Improvisation: Initiative, Resourcefulness, Timely, Appropriate responses
3. Rapport building: Interpersonal skills, Engagement, Active listening, Questioning skills, Caring
4. Teaching self-efficacy: Presence, Command, Attentive, Awareness, Organisation.

A live demonstration of SimLab and specifically the Initial Teacher Education (ITE) 5-minute non-academic entry evaluation process will be a feature of this session. Participants will view the purpose designed rubric used to evaluate student success. Preliminary research data that explores the effectiveness and predictive validity of simulation as an on-entry performance assessment are the foci of this work.

Research design and preliminary result

Eighty-seven initial teacher undergraduate students (f = 60, m = 27) formed a surveyed sample to investigate perceptions of the utility of SimLab as a tool for entry evaluation.

First, we tested the correlations of the seven variables, as identified by AITSL as key capabilities associated with successful teaching: motivation to teach, strong interpersonal and communication skills, willingness to learn, resilience, self-efficacy (self-confidence), conscientiousness and organisational and planning skills, to assess the size and direction of the linear relationship between the variables. Next, we employed multiple regressions to test the predictive utility of each of six variables on criterion variables: motivation to teach, resilience and self-confidence in a two-step hierarchical process.

The linear relations between the variables under investigation were found to be strongly, positively and significantly correlated. Motivation to teach, $r = .70$, and self-confidence, $r = .68$, $p < .01$ were most significantly and positively associated with conscientiousness. Resilience was most strongly associated with willingness to learn, $r = .57$, $p < .01$.

The findings of the hierarchical multiple regressions (Models presented at ASCILITE, 2019) indicate for the outcome variable of 'self-confidence' that conscientiousness was a strong and positive predictor followed by resilience. When all the disposition variables were analysed, 'organisational and planning skills', and 'interpersonal and communication skills' also significantly accounted for variance in the model for self-confidence. The outcome variable 'motivation to teach' was most significantly predicted by 'resilience' and 'conscientiousness'.

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PechaKucha Presentations

PechaKucha titles	Presenter(s)	Track
Significance of Integrating Technology for Inquiry (NTeQ) Model as a Constructivist Teaching Style in Classrooms	Amit Ahuja	2
Getting the balance right: soft vs hardcopy materials	Saher Ali and Mark Schier	2
Building OER Capabilities in the ASEAN Region	Melody Chin and Nawang Purwanti	6
Video Assessment with Live Question and Answer, experiences in a large undergraduate subject	Matthew Dyki and Maggie Singorahardjo	2
Teacher presence in a learner experience transformation	Mais Fatayer and Anna Stack	2
Game On - PENopoly in Action	Jamie Fulcher and Ingrid D'Souza	2
Use of E-learning in Peyton’s Four-Steps-Approach: Locating the Posterior Ledge on Facial Computed Tomographic Scans	Shu Lin Doreen Goh, Shuen Yin Celine Yoong, Yu Cong Wong, Cowan Ho, Elijah Zhengyang Cai and Thiam Chye Lim	1
Seeking evidence of learning in MOOC discussions	Catherine Gunn, Claire Donald and Jenny McDonald	4
Evaluating the Behavioural Intention to Use Mobile Microlearning among Polytechnic Students	David Kwok, June Lim and Li Yin Lim	1
Capture and Keep: pre-lesson eModules improve student retention, engagement and performance in a first year STEM course	Nicole Masters, Joanne Hobson, Anita Jones and Theresa Ashford	2
Learning and teaching with holograms: Incorporating the HoloLens in medicine and health science education	Christian Moro, Mona Izzeldin, Zane Stromberga and Petrea Redmond	1
Pushing Past the Bottleneck: Using Decoding the Disciplines framework for online learning design	Hafizah Osman, Lei Guo and Swee Kit Alan Soong	2
Combining Student Cohorts within LMS Course Sites: Issues of Access and Equity	Tammy Robinson and Carol Miles	1
Virtual Reality for Environmental and Cultural Sustainability Education – A pilot project enlisting VR for situated experiential education in secondary schools	Christian Schott, Andrea Milligan, Stephen Marshall, Jonathan Flutey and Alan Proctor Thomson	1
3 years on: A School’s Transition to Technology Enhanced Learning (TEL)	Rebecca Scriven and Michelle Pedlow	2
The use of the ‘Course Information Viewer’ for horizontal and vertical mapping	Popi Sotiriadou and Danielle Logan	2
Ask an iGuide: piloting a drop-in peer digital mentor service	Vanessa Todd	3
A CLaS on its own: Connected Learning at Scale	Carmen Vallis, Peter Bryant and Elaine Huber	1
Greek Teachers as Designers of Technology-Enhanced Learning Scenarios: A social network analysis study	Panos Vlachopoulos	2
Teaching Business Ethics in a Simulated Trading Environment	John Watson, Amale Scally and Kym Brown	6

Pre-Conference Workshops

The following Pre-Conference Workshops were offered at ASCILITE 2019.

1. Developing and Implementing a Digital Assessment and Feedback System
   Kwang Cham, The University of Melbourne, Australia
   Anthea Cochrane, The University of Melbourne, Australia
   Rebecca Wong, The University of Melbourne, Australia
   Elaina Kefalianos, The University of Melbourne, Australia
   Megan Keage, The University of Melbourne, Australia
   David Kelly, The University of Melbourne, Australia, and
   Thomas Mathew, The University of Melbourne, Australia

2. Professional development for learning analytics: approaches, challenges and opportunities
   Linda Corrin, Swinburne University of Technology, Australia
   Hazel Jones, Griffith University, Australia, and
   Cassandra Colvin, The University of Queensland, Australia

3. Contextualizing universal design for instruction (UDI): Modeling inclusive practice within your teaching
   Miriam Edwards, The University of Melbourne, Australia, and
   Meredith Hinze, The University of Melbourne, Australia

4. Designing authentic assessments to assure student success, employability, and academic integrity in the online environment (and other teaching modes)
   Keith Foggett, University of Newcastle, Australia and
   Carol Miles, University of Newcastle, Australia

5. Teacher Learning and Technology-enabled Pedagogy
   Abdy Taminsjah, MonsoonSIM
   Sidharta Gunawan, MonsoonSIM, and
   Ong Chin An Alex, MonsoonSIM

6. Reimagining IAL’s Tech-enabled Learning Journey
   Alena Yap, Institute for Adult Learning, Singapore, and
   Yim-Teo Tien Hua, Institute for Adult Learning, Singapore

Conference Poster Presentations

Poster Viewing	Presenter(s)	Track
Effects of mobile-app learning diaries vs online training on specific self-regulated learning components	Jaclyn Broadbent, Matthew Fuller-Tyszkiewicz and Ernesto Panadero	4
Artificial Intelligence feedback for teachers in training: a Pilot study	Chris Dann, Subrata Chakraborty and Gnana Bharathy	1
Surveying the digital literacy landscape through the student lens	Mary-Louise Edwards, Lisa Kruesi, Andrea Phillips, Kathryn Frame, Tania Celeste, Kathy Ryan and Kwang Cham	3
Dialogical feedback; enhanced by technology	Cedomir Gladovic	2
Learning Design as a multi-tool for professional development, educational development, reporting, and evaluation	Mikkel Godsk, Rikke Frøhlich Hougaard and Annika Büchert Lindberg	1
Optimising Learning Design for Short Form Course Design & Development	Paul Goldacre	1
Early career teachers flipping their classroom: Implications for teacher education	Steve Griffiths, Chris Campbell and Christine McDonald	1
The role of cloud computing in providing learning environments for university courses	Eva Heinrich	2
Scaffolding the learning of data analysis using individualized homework assignments	Adrian Lee and Rui Lin Koh	1
Reflective teaching practice: A case study on the use of learning analytics to inform learning design in a large first-year course	Steve Leichtweis, Marion Blumenstein and Mark McConnell	4
Developing, using, and refining technology enhanced problem-based learning. Supporting postgraduate students in an accelerated nursing programme to think like a nurse in Aotearoa	Rachel Macdiarmid, Eamon Merrick and Rhona Winnington	2
Augmented Reality for Improving University Student's Stroke Education	Christian Moro, Emma Finch and Jessica Smith	1
Data Warehouse – A Strategic Asset in Higher Education	Benny Ng and Aung Soe Thant	2
Simulation training and learning for the acquisition and maintenance of dental skills proficiency in Doctor of Dental Surgery first year students	Anu Polster and Kwang Meng Cham	1
To see the water, we dive in: Two academic developers' experience on becoming online facilitators	Kiruthika Ragupathi and Swee Kit Alan Soong	1
Engaging engineering students using a 3D open pit mine model integrated into a learning management system	Pablo Riveros and Italo Onederra	1
SNAPSHOT OF A DAY IN STARLab: Showcasing a Flippin' Teaching Success Story	Amale Scally and Wayne Huf	2
Applying student voices in the evaluation of current blended learning initiatives	Karen Sutherland, Ginna Brock, Sherelle Norman, Prudence Millear, Terri Downer, Tim Strohfeldt, Nicole Masters, Sharon Louth, Kerry Rutter, Retha de Villiers Scheepers and Ali Black	2
Grant me a wish	Diana Taylor, Madelon Heperi and James Taylor	1
Personalisation of the student learning experience: The impact of lecture choice and student digital learning literacy on learning and performance	Amanda White and Elaine Huber	3