Utilizing a realist evaluative research approach to investigate complex technology implementations: an e-learning lecture capture exemplar

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Abstract

Purpose - This study aims to investigate the effectiveness of a theory-driven realist evaluative research approach to better understand complex technology implementations in organisations.
Approach – An institution wide e-learning implementation of Lecture Capture (LC), within a UK University, was chosen and a realist evaluation framework was used, tailored for educational technology. The research was conducted over 4, increasingly focused, evaluation cycles combining engagement analytics, user interviews and theory to refine what works (or does not work), for whom, in which contexts and why.
Findings - Despite explicit demand and corresponding investment, overall student engagement is lower than expected. Increased student use appears linked to particular staff attitudes and behaviours and not to specific disciplines or course content. The main benefits of LC are; providing reassurance to the majority, aiding revision and understanding for the many, and enabling catch-up for the few. Recommendations for future research are based on some unexpected outcomes uncovered, including; evolving detrimental student behaviours, policy development based on technological determinism and future learner-centred system development for next-generation LC technologies.
Practical implications – The realist approach taken, and evaluation framework used, can be adopted (and adapted) for future evaluative research. Domain specific reference models, categorizing people and technology, supported analysis across multiple contexts.
Originality/value – This study responds to a call for more theory-based research in the field of educational technology. We demonstrate that a theory-driven approach provides real and practical recommendations for institutions and allows for greater insight into the political, economic and social complexity of technology implementation.

1. Introduction

There is a growing scholarly critique admonishing the lack of theory-based research in the field of educational technology, resulting in a general mistrust of such technology (Gunn and Steel 2012; Selwyn, 2014b). Consequently, there is a call for researchers to take a more critical perspective on the use of technology in education (Bulfin et al., 2015). Selwyn and Facer's (2013) research has observed the tension between rhetoric and reality in educational technology scholarship, that is "well able to discuss how educational technology *could* and *should* be used, but less competent and confident in discussing how and why educational technologies are *actually* being used." They state that the research is "ill equipped to support the building of an achievable political or institutional project to realize desirable change." (Selwyn and Facer, 2013, p. 3) The prominence of digital systems in all aspects of Higher Education (HE) also produces an increasingly complex and problematic landscape of data structures and work processes across all boundaries of operations, teaching and research, leading to "[deep] rooted concerns over the social, political and cultural roles of these systems" (Selwyn, 2014a, p. 44).

To address the political and cultural complexity of technologies' use in education, as well as the lack of theory in research, we draw upon realist evaluative research (Pawson and Tilley, 1997) as a catalyst for a new direction of investigative technique. The theory-driven approach has been adapted and refined into an evaluation framework specifically tailored for socio-technical initiatives in education (King, et al., 2016). This research tests the application of the framework to see if it can bring a more critical perspective on the use of technology in education, provide insights into the complex political and cultural landscapes, and address the five factors previously identified as barriers to effective evaluation (King et al., 2014). These are:

- Summative evaluations (of products, projects or process) are premature and can never provide a full understanding of the potential influence and future impact on an initiative.
- Existing software evaluation techniques and technology acceptance models are inappropriate for dealing with complex contextual factors.
- Higher Education is in a rapid state of political and corporate change often requiring quantitative evidence of efficiencies made.
- Complex implementation chains or the iterative nature of agile development means what is being evaluated is always in a state of change.

- The use of inconsistent terminology within higher education, often locally adapted or country specific, is a barrier to synthesis across studies.

1.1 Research objectives and significance of this study

This paper outlines an experiment that tests the evaluation framework to answer the following research questions:

1. Does a realist approach (and the tailored framework) address the factors identified as barriers to effective evaluation of technology in education?
2. Can a theory-driven approach provide real and practical recommendations for organisations?
3. Does this approach provide a greater insight into the political, economic, cultural and social complexity of complex technology implementations in education?

This research makes an original contribution to knowledge in three significant ways. Firstly, realist evaluation is relatively untested in the educational technology domain. Secondly, a tailored realist approach, utilizing domain models to categorize people and technology, has also never been tried. Finally, the experiment comprised an evaluation of a Lecture Capture (LC) initiative at a top 10 University in the UK (The Complete University Guide, 2016) the scale and depth of which are unprecedented in the literature on LC. We demonstrate how a realist approach helps to identify what works, for whom, in which contexts and why, thereby advancing institutional strategies for implementation and policy development. We also adopt a critical perspective on the adoption and use of LC technologies more generally and share insights into how individual, institutional, political and commercial factors interact and contribute to the observed outcomes. We present the findings of this experiment and reflect on the results for the benefit of future evaluative research.

2. Background

2.1 What is realist evaluation?

Realist evaluation was originally developed in the 1990s by Pawson and Tilley (1997) to address the question ‘what works, for whom, in what circumstances, and how?’ in a broad range of interventions. It is a theory-based evaluation methodology and a way of thinking that adopts the philosophy of scientific realism (Bhaskar, 1978). In realist evaluations, it is

assumed that an intervention or programme under investigation does not exist in isolation, that nothing works everywhere for everyone and that context really does make a difference. It assumes that interventions are, in fact, deployed into complex social systems and structures that are 'real' (because they have real effects) and that people respond differently to interventions in different circumstances. Therefore, realist evaluation attempts to understand how an intervention might generate different outcomes (positive and negative) in different circumstances, as consequences of underlying programme mechanisms (i.e. participants' reactions to the mixture of resources provided by the intervention) within particular contexts. Contexts, for example, might be particular types of people, institutional settings or even the wider social, political, economic and cultural setting of the intervention.

In a realist evaluation, the assumption is that programmes are 'theories incarnate' (Pawson and Tilley, 1997). That is, whenever a programme is designed and implemented, it is underpinned by one or more theories about why it is expected to work, even though these may not be explicit. Hypotheses are then developed to determine how, and for whom, to what extent, and in what contexts a programme might work. The evaluation of the programme tests and refines those hypotheses. Evidence is collected in a context (C) + mechanism (M) = outcome (O) configuration and is the analytical unit on which realist evaluation is built. Eliciting, refining and testing CMO configurations allows a deeper understanding of the programme. Most significantly, realist evaluation provides evidence on "why" a programme is working (or not) in particular contexts, something alternative evaluation methods have been less able to do. Creating a shared evidence-base in this way supports the accumulation of knowledge and is one of the organizing principles of evaluation science, as set out in Pawson's realist manifesto 'The Science of Evaluation' (Pawson, 2013). This has provided a blueprint for realist evaluation as a scientific discipline.

2.2 A realist evaluation framework tailored for complex learning technology initiatives

The tailored framework utilised in this research (King, et al., 2016) includes two reference models to help categorize and compare "technical contexts" and "actors" in educational settings. Technical categories, such as "content creation and management" can be used to make comparisons with the capabilities provided by similar technologies. Categorizing people, such as "technology evangelist", helps researchers to make comparisons and collate evidence across department settings to aid analysis and synthesis of findings. Figure 1 shows a process map summarizing the main steps of the framework. Throughout the investigation,

candidate hypotheses were generated as middle-range theories (Merton, 1968) using findings from other LC research, concepts from learning and behaviour theories and technology adoption models.

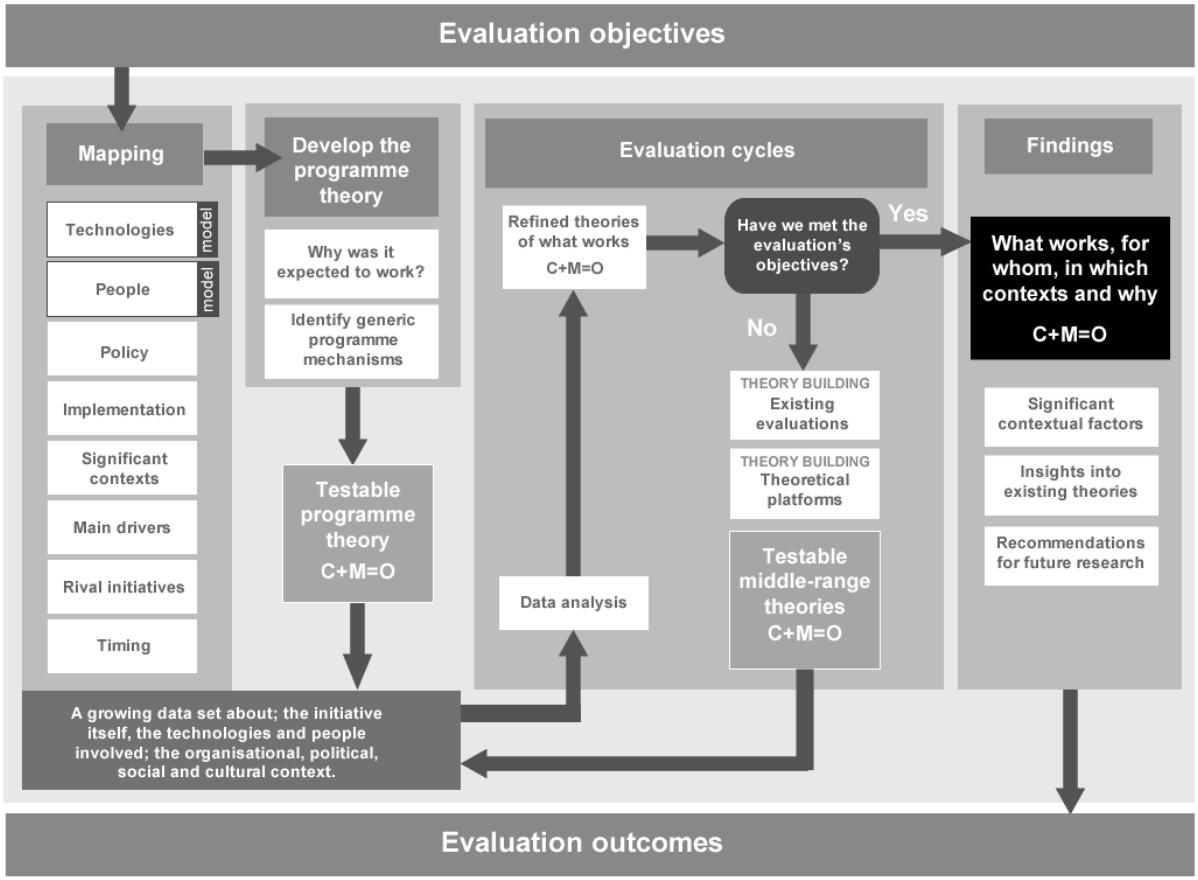

Fig 1. Process map summarizing the main steps within the tailored realist evaluation framework

2.3 Research strategy

2.3.1 Rationale for choosing lecture capture

There were several reasons why LC was chosen as the topic for the experiment.

- It is technically complex: LC (sometimes referred to in the literature as Web Based Lecture Technologies) is an umbrella term used to describe the capturing of lecture content (video, audio and slides). It is a combination of integrated technologies that include hardware, server software, desktop applications and audio-visual devices.
- It is a widely used and established technology: LC and retrieval tools have been classified in 2015 as firmly established as a mainstream technology in education (Lowendahl, 2015).
- There is limited rigorous research of its impact on education: A recent review of the LC literature states, "although research to date has used large samples of students from

> a variety of disciplines and institutions [and years], many studies are descriptive, based on self-reports and have few links to learning theories to explain findings." (O'Callaghan et al., 2015, p. 11).

Timing was also an important factor for the institution itself. The system had several proactive and vocal proponents but many staff remained unconvinced of the technology and its benefits, which was not an uncommon view (Bond and Grussendorf, 2013). This was juxtaposed with an increasing pressure from the student body for widespread use across all courses. Ongoing evaluation was needed not only to justify any further investment but to understand whether the new university policy had either encouraged staff uptake or bolstered resistance (Woodley et al., 2013). It was also important to determine if the requirements of different disciplines, compounded by the varying preferences of lecturers, were being met by a universal policy or if this was inculcating a "one-size-fits-all model of lecturing" (Dona, et al., 2016). Realist evaluation was an appropriate approach in this instance because there was ad hoc usage of the system at department level, that anecdotally seemed to work for some, but real evidence of what was working (or not), for whom, in which circumstances and why still needed to be understood.

2.3.2 Post-evaluation review

A review of the evaluation (also known as meta-evaluation) was undertaken to help answer the overall research questions. Meta-evaluation is seen as a professional obligation for evaluators that is needed in all types of evaluation, whether programme, project, product, theory or personnel (Stufflebeam, 2001). The overall quality of the evaluation was reviewed based on a checklist derived from international educational evaluation standards (Yarbrough et al., 2011). An assessment of whether the evaluation had adhered to realist principles and standards (Wong et al., 2016) was also undertaken. This is deemed essential in the publication of results from realist evaluations, as adhering to these standards "will lead to greater consistency and rigour of reporting and make realist evaluation reports more accessible, usable and helpful to different stakeholders" (Wong et al., 2016, p. 16).

The evaluation findings were also compared with results from existing LC studies to validate the study and determine its significance. Finally, a critical reflection was made on the strengths and weaknesses of the tailored evaluation framework, as both a practical tool for institutions and a research approach that can provide greater theoretical insight than alternative modes of investigation.

3. The experiment: testing the framework to evaluate a lecture capture initiative

3.1 Preliminary mapping

The evaluation commenced in July 2015 and continued over a period of nine months. Information regarding the technical set up, support provided and resources available was gathered through interviews with technical providers, the Head of E-Learning and from responses to questions via emails from system owners and support staff. Information on the technology itself was gathered from the vendor's website and the system manual. Resources and general information about the intervention were gained from a search of the institution's website and committee papers.

The practice of capturing live lectures, using video or LC technologies, had been slowly introduced into teaching practice in 2009 by a small group of evangelists on a new history programme and on a distance learning programme in engineering. Since then, its use has grown organically and has been adopted by new staff on an ad hoc basis, encouraged mainly by word of mouth. Over the years it has been promoted at LC events, organized by a group of early adopters from a variety of departments acting as LC mentors. In 2014/15 there were 25 teaching rooms equipped with fixed devices and 70 with software capture technology for LC.

The first University LC Policy (2014/15) mostly comprised guidelines for staff on their use of LC. It articulated the institution's strategic approach to LC which strongly encouraged the use of LC based on the assumed benefits for students. These benefits included being able to review content at their own pace, supporting note-taking and dealing with pronunciation challenges (Barokas et al., 2010; Folley, 2010; Toppin, 2010), and would be especially beneficial for lower achievers in larger classes (Owston et al., 2011). The policy also addressed the perceived barriers, for example, intellectual property and copyright, and provided a list of guidelines and information relating to technical support. It was intended that this policy would be communicated to staff by the most senior member of teaching staff within each School to provide an authoritative steer on its use.

Data about system usage was obtained via the LC administration system. This raw data set was merged and analyzed with course specific information from other databases. Over six years of usage almost a third (32%) of all courses or events captured were for the academic year 2014/15 (353 out of 1096). After manual categorization, 272 (77%) were linked to at least one taught module being delivered either at a programme level or at a department level.

The remaining 23% were made up of other events such as workshops or training and were excluded from further analysis. From the 272 taught courses using LC, there were 2146 individual captures, amounting to around 2672 hours of content that could each be specifically linked to one cohort of students and to one of 124 distinct staff users from 20 academic departments. These were split between undergraduate first year (22%), second year (26%), third year (19%) and postgraduate (23%) courses. The remaining 10% covered foundation, placement or fourth year teaching modules. This dataset was used throughout. A full 2014/15 lecture attendance dataset was also used which comprised 447,287 records of attendance and a subset was extracted for the modules that used LC, comprising 88,278 records for further analysis.

3.1.1 Evaluation questions, objectives and focus

The evaluation set out to answer the following questions for the institution:

1. Was the LC initiative working as expected?
2. Were some departments more successful in their use of LC than others?
3. How and when was the LC technology most effective?
4. Were there any unanticipated disadvantages to the use of LC?
5. What more could be done to improve uptake and support embedding of LC into everyday teaching and learning?

3.2 Initial programme theory

Two programme theories, or hypotheses, were generated and expressed as CMO configurations, based on the assumptions underlying the institutional LC policy (i.e. the reasons it was expected to work). The generic programme mechanism of *encouragement* and Rogers' (2003) theory of diffusion of innovations were used as conceptual platforms.

- *Theory A* - The establishment of an institutional policy on LC (*context*) will allay concerns perceived as barriers to adoption, such as an impact on attendance (*mechanism*). Therefore, a critical mass will be reached to enable a tipping point in staff adoption (*outcome*).
- *Theory B* - A policy advocated by senior teaching staff in each department (*context*) will encourage more staff to adopt LC (*mechanism*) and the anticipated pedagogic benefits will be realized for more students (*outcome*).

3.3 Evaluation cycle 1: outcomes relating to the context of department and prevalence of local champions

Staff uptake and viewing numbers

Staff usage data were grouped by department and these were categorized as having distinguishing features, such as time of first adoption in relation to the introduction of the policy, or notable staff types (using the framework's reference model). For example, notable staff types included: the "early innovators", senior teaching staff acting as local "policy protagonists", and staff in the LC mentor network acting as "technology evangelists".

Department usage was analyzed using overall number of staff users, number of captures per staff member, frequency of staff use, and the average number of cohort viewers per lecture and per staff member across all their courses. Out of 20 departments, 13 used LC on seven or fewer modules. Of these 13, five were categorized as having staff who were in the LC mentor network as the only distinguishing feature and eight were categorized as having no distinguishing features. 12 out of 143 staff (8%) used LC on four or more courses and account for almost a quarter of usage during 2014/15 on 63 courses (23%) out of 275. These prolific users were from departments that had both LC mentors and the most senior member of teaching staff using LC.

Student uptake and viewing patterns

Student viewing patterns (proportion of students viewing and proportion of the total duration watched) were analyzed depending on the year of study, subject discipline, the timetable slot of the captured lecture, and the semester and week number of the lecture. Also analyzed were the distribution of viewing patterns around the mean within each department, to see if departments who used lecture capture more had more consistent viewing patterns across all courses. As a starting point and to help analyze the results, theories were generated based on the LC literature, for example, that viewing differs depending on the stage students are at in their degree journey (Drouin, 2014).

The overall viewing figures were generally lower than expected. The 2146 captures were classified by the percentage of the cohort viewing against the average amount watched. Table 1 shows the detailed distribution, from 443 (21%) that were never watched by anyone to two captures that were watched by >=90% of the cohort for between 60 and 70 minutes on average.

Captures classified by amount watched	Captures classified by the % of cohort viewers													Count	% of total
	0%	[0, 5%)	[5, 10%)	[10, 15%)	[15, 20%)	[20, 30%)	[30, 40%)	[40, 50%)	[50, 60%)	[60, 70%)	[70, 80%)	[80, 90%)	>=90 %		
0s	443	9	1	2										**455**	21
[1s, 30s)		4												**4**	0
[30s, 1m)		12	4	1										**17**	1
[1m, 2m)		34	4	6	1	1								**46**	2
[2m, 5m)		47	12	4	2	1								**66**	3
[5m, 10m)		46	40	12	3	6	2	1		1		1	2	**114**	5
[10m, 15m)		46	43	19	9	11	2	3	1	4		1	3	**142**	7
[15m, 20m)		58	63	24	19	16	4	4	3	1			3	**195**	9
[20m, 25m)		31	49	38	34	34	13		2	2		3	6	**212**	10
[25m, 30m)		35	50	31	30	32	16	13	1	9	2		6	**225**	11
[30m, 35m)		18	27	26	29	42	12	8	1	2			2	**167**	8
[35m, 40m)		27	18	21	14	29	16	8	2		1	1		**137**	6
[40m, 45m)		13	21	11	9	24	4	11	5	1	1		4	**104**	5
[45m, 50m)		12	10	12	5	13	8	5	5	2	4	1	1	**78**	4
[50m, 55m)		9	11	9	10	14	12	7	3		1		5	**81**	4
[55m, 60m)		5	8	4	2	14	5	1	1				2	**42**	2
[60m, 70m)		4	4	6	4	7	9	3					2	**39**	2
[70m, 80m)		3	2	1	1	2	2	1						**12**	1
[80m, 90m)			1	1										**2**	0
[90m, 100m)		1												**1**	0
>=100 m		4						2		1				**7**	0
Count	**443**	**418**	**368**	**228**	**172**	**246**	**105**	**67**	**24**	**23**	**9**	**7**	**36**	**2146**	
% of total	21	20	17	11	8	12	5	3	1	1	0	0	2		

Table 1. Distribution of captures categorized by the amount watched and the proportion of cohort viewers

For those lectures that had viewers, adding all the captured lecture content together (2672 hours), 28% (748 hours) of the content had been watched by at least one person, leaving 72% that had never been watched by anyone. The following calculations were made by excluding captures with no viewers or those with less than 30 seconds of viewing duration. Regarding the proportion of students viewing, the University's average per capture was 14% of the associated cohort. However, department averages did not follow a normal distribution around the mean for the University and varied wildly within departments too. Out of 18 departments, the number of students viewing varied from an average of 3% to 70% of the cohort, with the most common (mode) per capture between 0 and 5%. Regarding the proportion of each capture watched, the University average was 35% (~28 minutes) and viewing habits clustered around this mean, with the most common duration viewed (mode) per capture being 25 – 30 minutes overall. (Most captures were around ~80 minutes long as additional time had been added before and after each timetabled session). However, like the wide variation in number of viewers, the differences in the proportion of content watched showed large variation, with department averages ranging from 11% to 49%.

To see whether length of the lecture had an impact on viewing habits, further analysis showed that for sessions between 30 and 80 minutes long (948), the average proportion of the lecture watched was 43% (~23 minutes), the most common duration viewed (mode) 25 – 30

minutes. For sessions that were longer than 80 minutes (311), the average proportion watched dropped to 34% (~34 minutes), most commonly 35 – 40 minutes. With regards to the number of viewers, lectures between 30 and 80 minutes long received on average 13% of the cohort (14 students out of an average cohort size of 111), most commonly 0-5%. For lectures longer than 80 minutes, the average number of viewers was 19% of the cohort (13 students out of an average cohort size of 67), most commonly 5-10% of the cohort.

Most significantly, the department capturing the most content, 546 captures (26%) during 2014/15, had an average proportion of viewers that was lower than the University average (12% compared to 14%) and had their mode proportion watched much lower too (15 – 20 minutes compared to 25 – 30 minutes). The most watched lectures (i.e. watched by at least 50% of the associated cohort) constituted 6% of captures. These 99 captures were from 16 modules across 8 departments.

Key findings from cycle 1

The data show that, since the introduction of the policy, staff usage has increased significantly but in pockets and spread unevenly across the university. Having a LC mentor within a department (from the university's LC Mentor Network) did not lead to an increase in staff usage. The tipping point in wider adoption within a department appeared to be linked to the use by certain key staff. Uptake within departments appeared to follow Roger's diffusion of innovations model if the early adopter was a senior member of teaching staff who was advocating the University policy at department level (Rogers, 2003).

The programme theory A proved to be working as expected. However, the outcome of Theory B showed that the number of student users and a consistency in viewing habits did not increase with the number of staff users. In fact, for the department with the most staff users and lectures captured, students' use was lower than the university's average. After significant analysis, it was found that although first years were the least engaged with lecture capture, positive viewing outcomes (high number of viewers and high proportion of each lecture viewed) did not appear to correlate with year of study, department, course, or timetable slot but rather to certain members of staff from across the University.

3.4 Evaluation cycle 2: lecturer contexts and mechanisms linked to positive viewing outcomes

Out of 124 staff users who could be linked to specific cohorts, there were 16 who had significantly higher than average number of viewers and higher than average proportion of

their lectures watched across all their courses, compared to their own department's average. These took place on 20 courses in total: six business and economics, nine science or engineering and five social sciences. An individual email was sent to these staff inviting them to answer an online questionnaire to elicit evidence about their experience, attitudes and behaviours which may have contributed to this outcome. A high response rate to the survey, 15 (94%) was received and additional data were collected from follow up correspondence.

Evidence on LC from previous studies was used to generate survey questions; for example, that certain types of teaching approach or content type made a difference (Danielson et al., 2014) or an increase in students' use occurred when additional materials were provided online to accompany the LC (Moes et al., 2013). We also used a behavioural model, developed and validated within the discipline of implementation research (which is the study of methods to promote the uptake of research findings into routine practice) to generate questions. The model, the Theoretical Domains Framework (Cane et al., 2012), provides behavioural categories to support evidence-based behaviour-change interventions. These categories were used to generate questions regarding: professional identity, social influences, beliefs about capabilities and consequences, intentions and goals.

Qualitative responses were themed and analysed against middle range theories generated from two behavioural theories. Ajzen's (2012) theory of planned behaviour was used to generate the following hypothesis: Staff who felt that LC provision was a desirable norm for students (*context*) and they believed in their own ability and ease-of-access to utilize the technologies provided (*mechanism*) resulted in the consistent capture of all their courses (*outcome*). Schon's (1987) reflective practitioner theory was used to generate the following hypothesis: staff who frequently reflect on their own practice (*context*) and are keen to incorporate the LC technology into new ways of teaching (*mechanism*) resulted in a necessity for their students to view their sessions due to their chosen pedagogic approach (*outcome).*

Key findings from cycle 2

A significant outcome from cycle 1 has become the context for further investigation in cycle 2. That is, for staff who have received positive viewing patterns by their students across all their courses (compared to the rest of their department), the following refined theories were found to explain why. Staff who are in departments where LC is used widely and firmly embedded in practice (*context*) or are the first to use LC in their department (*context*) and who thought that LC was the desirable norm (*mechanism*) captured all sessions across all their modules (*outcome*). These staff were all very experienced teachers. Those with no

professional teaching status or department teaching role (*context*) found that LC required little effort on their part (*mechanism*), received positive viewing outcomes (high number of viewers and high proportion of each lecture viewed) with little change to teaching practice (*outcome*). Those that had a professional teaching status and a department teaching role (*context*) were influenced by student requests and had a desire to improve their course for a variety of non-standard situations (e.g. distance learning, students with English as a second language) (*mechanism*) also received positive viewing outcomes (*outcome*). Vocal students who directly expressed to these staff how valuable LC was (*context*) have reinforced the opinions of these staff on the benefits of LC (*mechanism*), which gave them the intention to continue with LC in the future (o*utcome*). Those staff new to using LC this year (*context*) have not felt the need to consult support resources and ask for pedagogic advice (*mechanism*) and therefore have some doubts about their expertise with LC (*outcome*). Staff using LC between two and six years (*context*) have not felt the need to ask for pedagogic advice but have looked for technical help from system documentation (*mechanism*) and are therefore extremely confident in their personal expertise with LC (*outcome*). These staff feel motivated to provide their students with additional teaching resources (*context*), so tell their students on a regular basis that the lectures are available online (*mechanism*) and often check the viewing figures to see if they are (*outcome*). A few of these more motivated staff (*context*) have personally reviewed their own LC content and viewing figures to review aspects of their teaching and to ensure students are watching (*mechanism*), resulting in alterations and enhancements to their pedagogy (*outcome*).

3.5 Evaluation cycle 3: LC use and attendance outcomes

Some staff in the survey raised concerns about a reduction in their students' attendance, which prompted further analysis in cycle 3. This analysis included viewing outcomes based on attendance patterns and to determine if the teaching week of the live lecture (*context*) made a difference to the use of the recordings. Figure 2 shows LC viewing patterns based on the week of delivery of the live lecture. All lectures delivered in Semester 1 had a lower than average proportion of content viewed out of the total duration. Those delivered in Semester 2 (weeks 1 – 11) had a higher than average proportion viewed, with peak rates for lectures delivered in Semester 2, week 5. There is a similar pattern for the number of viewers, which tracks below the average and trends downwards in Semester 1 but with a leap in viewers in Semester 2, week 1, dropping twice in week 6 and 10, and peaking in week 8 (the last week of

term before Easter), probably because students had more time to view the lectures over the holiday.

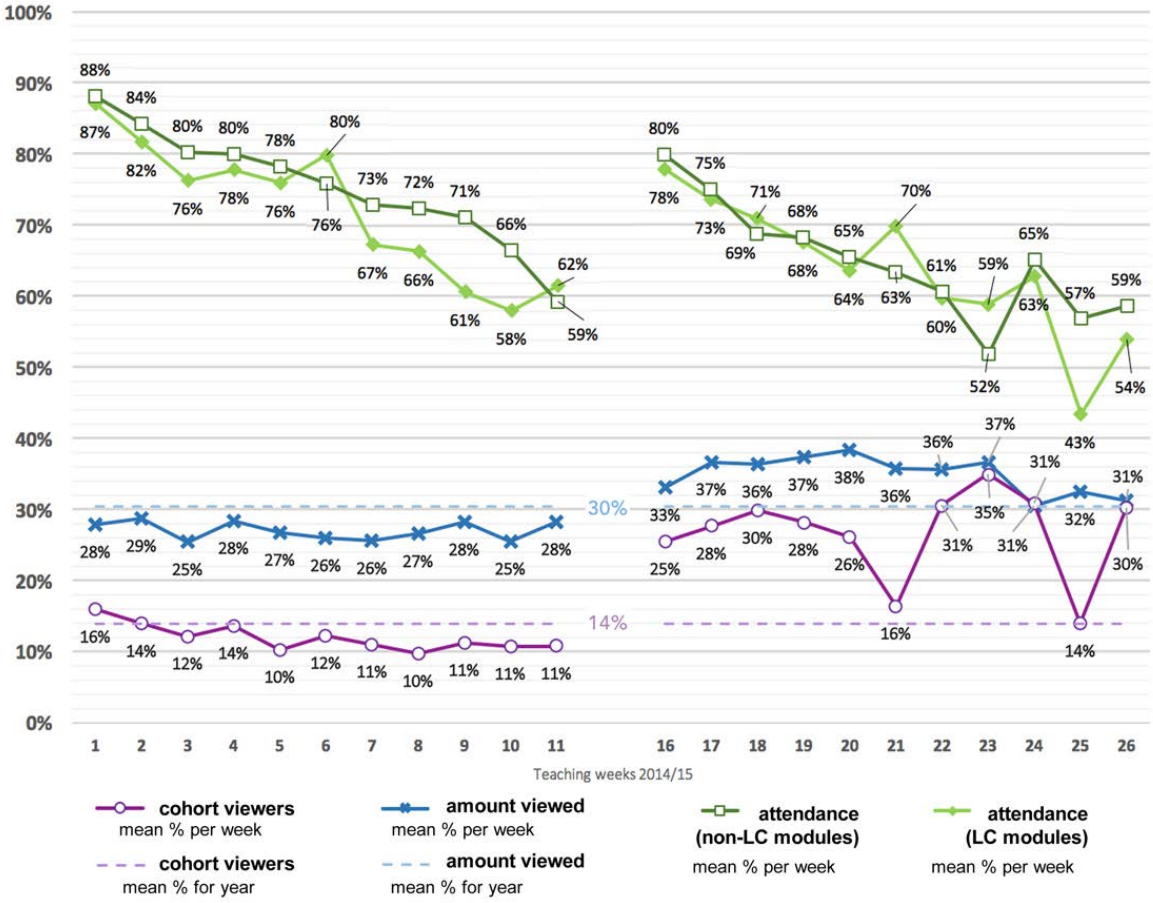

Fig 2. Comparison of viewing and attendance patterns per teaching week 2014/15

Attendance data for the whole of 2014/15 were mapped in a similar way (figure 2). The full dataset comprised 447,287 records of attendance and a subset was extracted for the modules that used LC, comprising 88,278 records (20%) with variation by week between 12% and 28%. Attendance percentages were compared for each of the 22 main teaching weeks of the year, using the z-statistic. In 17 of the 22 weeks included, reported average attendance was lower for those lectures with lecture capture and, in 13 of those weeks, the difference was statistically significant at the 1% level or better (i.e. $p<0.01$). In the five weeks for which reported average attendance was higher for those lectures with lecture capture (Semester 1, weeks 6 and 11; Semester 2, weeks 3, 6 and 8), the differences were all statistically significant at the 1% level or better. The overall average attendance was 71.9% for modules that did not use LC compared to 68.5% for those that did ($p<0.001$).

Key findings from cycle 3

More lecture content is watched by more students in Semester 2 than in Semester 1. As LC use increases throughout the year, attendance in lectures decreases. For those modules that use LC, average attendance during the year is less than for those modules who do not use LC.

3.6 Evaluation cycle 4: student contexts and mechanisms linked to negative viewing outcomes

Overall, student use was lower than expected, despite explicit demand. Therefore, it was decided to focus on why students were not using LC, as the reasons why students might use it are widely reported (Barokas et al., 2010; Folley, 2010; Owston et al., 2011; Toppin, 2010).

Potential contexts and mechanisms linked to students' lack of engagement with lecture capture were generated from existing studies and theories on technology adoption. Cilesiz's (2015) theory of acculturation was used to generate the following potential contexts: students lack the knowledge and awareness of themselves as independent learners (*context*), confusion about the need for recorded lectures (*context*), disillusionment about the quality and usefulness of the recorded lectures (*context*). The unified theory of acceptance and use of technology (Venkatesh et al., 2003) was used to generate the following potential contexts and mechanisms for lack of use (*outcome*): expected effort required to view a LC is high (*context*), the LC would always be easily available in the future (*context*), viewing is negatively influenced by peers who do not watch LC (*mechanism*) or that there was a future intention to use the captures but they had not yet accessed them (*mechanism*).

A semi-structured student interview protocol was piloted with a recent graduate and a current student prior to them being carried out with 30 student participants. The sample size selected was based on recommendations by the National Centre for Research Methods (Baker and Edwards, 2012), in the context of student interviews. Participants were selected randomly across five campus locations at different times of day and days of the week. Participation was voluntary and the interviews were recorded and transcribed later. A follow-up online survey was conducted specifically to elicit preferred revision aids. A large hall of residence was selected as a target group to advertise the survey more easily and encourage respondents from a wide demographic. Responses from 72 students were received, studying within 16 departments in all year groups (from foundation year to taught postgraduate).

From the students interviewed, those who did use the LC material tended to use it for catch-up purposes, either because they were not there during the lecture or to review key sections they missed first time. Some reasons for catch-up use were legitimate while many

were for personal reasons. For example: “I’ve got an early lecture [at 9am] then my next one starts at 2pm, so I just get up at ten and it’s on there so I just get up and watch it in my house”.

Key findings from cycle 4

Using data on usage and results from the student interviews and online survey, the following refined theories were developed to explain why students’ engagement with LC is lower than expected, despite explicit demand.

Students were unaware whether LC was available to them (*context*) and they felt no incentive to try and find out about it (*mechanism*) so they did not engage with LC at all (*outcome*). Students have a specific learning style and revision method (*context*) and LC does not fit with their personal learning style and they prefer to use other sources (*mechanism*) so LC is not used due to personal preferences (*context*). The captures are hard to find for each module and some are poor quality (*context*), however they would like to use LC but have found it difficult to access and /or have been dissatisfied with the poor quality of the recording (*mechanism*) therefore LC is not used as much as it would be if the technical implementation was improved (*outcome*). Finally, knowing that LC is available (*context*) gives them reassurance that it is there if they need it for catch up (*mechanism*), therefore they have the intention to use it in the future if they miss the lecture (*outcome*).

4. Discussion

4.1 Lecture capture evaluation outcomes and recommendations

Was the LC initiative working as expected?

The initiative worked as expected in some respects but not in others. The introduction of the LC policy had encouraged an increase in staff numbers using LC but this had not translated into an increase in student viewers. In fact, the department having the greatest number of staff users (and lectures captured) had a lower than average number of viewers and amount of content viewed. The fear that LC would mean a drop in attendance was still perceived even by the most successful staff users and neither the policy nor the data collected on LC use has helped to alleviate that fear.

Our findings show an average of 14% of the cohort using LC across the institution. However, although this number is lower than expected, a specific target had not been set by the institution as a measure of success. From our revision aids survey, 33% of respondents

found video recordings of lectures ‘very useful’ although a higher proportion of students cite alternative revision methods (exam papers, lecture slides and revision lectures) as ‘most useful’. Therefore, by using this insight, it could be expected that around a third of students would make use of LC for revision purposes if improvements were made such as increasing the number of captures available, providing a consistent way to access to captures online, putting in place supporting resources for students or mitigating the technical issues caused by user error (such as microphones not being switched on).

Were some departments more successful in their use of LC than others?

The tipping point, in wider adoption by staff within a department, appeared to be linked to the use of LC by certain key individuals, specifically the most senior member of teaching staff actively advocating the university’s LC policy as an active LC user themselves. However, positive viewing outcomes (high number of viewers and high proportion of each lecture viewed) did not appear to correlate with year of study, department, course, or timetable slot but rather to certain members of staff from across the University. Our staff survey supports previous studies which found that these staff use LC because they believe that students expect them to (Chang, 2007) and to accommodate students who cannot attend lectures in person for valid reasons (Gosper et al., 2008, p. 24).

How and when was LC technology most effective?

The effectiveness of LC can be viewed in several ways:

- Providing *reassurance* to the majority.
- Aiding *revision and understanding* for the many.
- Enabling *catch-up* for the few.

Digital technologies play an important role in supporting the pragmatic issues of ‘doing education’ (Selwyn, 2014a). Our results show that the major benefit of LC is to provide reassurance for students that it is available for catch up (if they missed a lecture), even though most may have never engaged with it previously. This concurs with a recent survey of 1658 students across two Australian Universities (Henderson et al., 2015) that showed that almost half (46.9%) found the most beneficial use of technology was for organizing and managing the logistics of study. Fourth most useful was technology for ‘reviewing, replaying and revising’ (27.9%), most often for catch up having missed the live class.

The proportion of each lecture viewed increases only slightly as the lecture duration increases. From our data, for sessions between 30 and 80 minutes long, the most common

length watched was 25 – 30 minutes, increasing slightly to 35 – 40 minutes for sessions that were longer than 80 minutes (up to 180 minutes). This supports other studies that suggest only small numbers of students watch more than 30 minutes or all the recording (Toppin, 2010; Barokas et al., 2010), as students often look for specific parts of recordings, repeat them or skip sections.

Were there any unanticipated disadvantages in the use of LC?

The data show an interconnection between the availability of LC and a drop in attendance, which supports previous studies (Drouin 2014; Leadbeater et al., 2013; Traphagan et al., 2010;). Responses from students confirm that they have the intention to use it in case they miss a lecture and some have gone on to use it after an absence. However, some report intentionally missing lectures because they know that LC is available. To mitigate against the negative potential of habitual LC use as a replacement for lecture attendance, it is recommended that Cilesiz's (2015) process of acculturation model is used. This requires designing a deliberate mix of physical and virtual learning experiences, and an evolution in the processes of student socialization and development. Incorporating LC material successfully in a blended way will combat the feelings of discontentment, anxiety and demoralization that may occur in three of the four stages of acculturation (ignorance, disillusionment and crisis), if students get into the habit of using LC as a replacement for lecture attendance. In addition to this, more research is needed to understand why there is less student engagement with LC when it is more widely available. This is particularly significant as institutions move towards the mandatory capture all lectures and introducing policies where staff must actively opt-out instead.

What more could be done to improve uptake and support embedding of LC into every day teaching and learning?

Based on the framework's taxonomy of roles (King, et al., 2016), students should be treated as the "primary users" of LC (as main beneficiaries of the content generated) and the staff seen as "secondary users" of the system and the intervention re-designed accordingly. For example, the technical implementation needs to provide online access in a consistent way and provide consistently signposted routes to support. Advocacy activities should raise awareness and promote the pedagogic benefits of LC (e.g. for revision and to aid understanding of content) and discourage using it for habitual catch-up due to absence. Deep approaches to learning (Entwistle, 2000) can be achieved by instructing students on how to use LC content to monitor their own understanding and seek meaning outside the delivered curriculum, for

example by enabling them to take ownership of the content (download) and personalizing it for their own benefit (annotate and modify).

Practical support for lecturers should address the biggest quality issue, which technical staff say is, “presenters putting the microphone on mute by accident”. As well as providing online software documentation to support enhanced technical capability, staff should also be shown the tactics to adopt to ensure positive student engagement and should be encouraged to monitor and evaluate this for themselves. For example, staff should advocate the benefits and use of LC, particularly in Semester 1, and communicate the pitfalls of habitual catch-up. Previous research has found that the adoption of new technology requires teachers to perceive the benefits in its pedagogical use (Sugar et al., 2004; Trondeur et al., 2016) and our survey supports this. Ultimately, staff need to perceive the benefits themselves of using this technology and reflect on their own goals in its use, for example by advocating discipline specific requirements in any universal policy (Dona, et al., 2016). Gathering feedback from students will help to galvanize their opinion on the predominant usefulness of the technology for their discipline, their cohort, their own pedagogical style and personal development.

Scaling up to universal implementation of LC across all courses should be considered carefully as our evidence shows that a lower than expected number of students are engaging with the facility when department use is high. It could be concluded that LC is not worth the large sums invested when implementing at scale, pParticularly if storage costs are borne by the institution. A pay-per-view model may be more financially beneficial. However, some further technical developments (or a review of the capabilities of alternative systems) could be made to try and improve engagement by all users and address quality and support issues, for example automated course set-up.

To maximise the utility of usage data, the development of a dashboard, that integrates LC analytics with other datasets, would be beneficial. For example, lecturers able to visualize and interrogate data sets that compare LC use with attendance in their class, would provide them with valuable insights into circumstances where mitigating action might need to be taken. Most importantly, automated usage analytics would make the task of re-evaluation much easier. Re-evaluation would be essential for assessing whether usage patterns and attitudes had subsequently improved, and why.

4.2 Recommendations for future LC research and technology development

Evolving student behaviours: Deliberate non-attendance or disengagement from LC

Further realist research is recommended to investigate the following middle-range theories: In departments that have been using LC for many years on most courses (*context*), students have adopted the habit of deliberate non-attendance with the intention to catch up using LC (*mechanism*), therefore attendance has suffered because of LC (*outcome*). Also, using Cilesiz's (2015) acculturation model, when a student has all their lectures available to catch-up and revise (*context*) they feel overwhelmed by the amount of content available for revision (*mechanism*) and choose only to watch on an ad-hoc basis and not in any great depth (*outcome*).

Technological determinism, marketisation and decision-making practices

The main driver behind the initiative was the number of requests, from student representatives to senior management, specifically for "Lecture Capture technologies" in the context of academic reticence and scepticism. Universities need to compete in a global marketplace and be seen to react to student demands made public through national student surveys. Many believe that LC helps make their institution more competitive (Greenberg and Nilssen, 2009). However, the potential negative impact on the relationship between the institution and staff needs to be further researched as a significant context. As one lecture capture study highlights, "the importance of considering lecturers as people with their own needs, whose feelings about the way they do their work are important." (Bond and Grussendorf, 2013). Secondly, the impact of multi-million pound investments and global marketing by corporate LC technology companies creates a significant economic context. These vendors hope to "capitalize on the coming necessary sea change in higher-education." (Revolution.com, 2013) However, to what extent are these technologies determining the sea change themselves? Therefore, 'students as consumers' (*context*), 'marketisation' (*context*) and 'technological determinism' (*context*) merit further analysis to determine their significance in relation to decisions that are made (*mechanism*) to adopt (*outcome*) and then ultimately adapt (*outcome*) to the technology "products" that institutions are presented with.

A recent exploratory case study by Leonard et al. (2016) concurs with this and highlights how a lecture capture implementation affects and is affected by academics' professional values in the context of the wider socio-economic environment and organisational decision-making. The study identifies the 'vicious' or 'virtuous' accumulation cycles (an aspect of actor-

network theory in relation to information systems (Cecez-Kecmanovic et al., 2014)) that manifests in an institution's use of LC technologies. Leonard et al. present a useful conceptual model that can be used in future realist evaluations, to explore the way in which technology affects and is affected by members of an organization with diverse professional values (Leonard et al., 2016).

Alternative developments as learner-centred technologies

Our evaluation suggests that students should be considered as the "primary users" of LC as the main beneficiaries of the content, however traditional lectures are not designed for online delivery. As soon as the lecture is digitized, we can assume that Mayer's (2006) cognitive theory of multimedia learning applies. The "coherence", "signaling" and "segmenting" principles in this theory state that people learn more deeply when extraneous material is omitted, when cues are added that highlight the organisation of essential material and when the message is presented in learner-paced segments rather than a continuous unit. Therefore, technologies that capture the audio and on-screen presentation only (and automatically chunk this content based on intelligent editing) may be more effective for learners and therefore perceived as a better-quality learning resource.

Future developments should also draw upon the American Psychological Association's (APA) Learner-Centered Psychological Principles (APA, 1997) and their implications for online learning (McCombs, 2005). Much research has been undertaken to explore the value of learner-centred technology solutions (Bransford et al., 2000) and the technology functions required for intelligent tutoring in an online environment (Woolf, 2010) such as artificial intelligence, machine learning and adaptive systems. During the technology mapping phase of our evaluation, the storage and cataloguing components of LC were classified within "repositories and knowledge management". Therefore, future developments should build upon the capabilities that these generic types of systems bring, for example, enhanced cataloguing functionality with sophisticated search and retrieval features for both formally classified and socially tagged video content. These features will improve the discovery of the captures and also distinct sections within them.

4.3 Strengths and limitations of the evaluation

The collection and analysis of system usage data were very time consuming due to the complex and large dataset. Detailed usage on a per student basis was not collected and the distinction between staff and student viewers was not determined. The method of capture

(fixed installation or software) was not differentiated, neither was the type of recording (audio only, slides and audio or full capture).

5. Conclusion

This paper presents the results of an experiment to utilize and validate a tailored realist evaluation framework, which is novel in the educational technology domain. The experiment comprised an evaluation of a Lecture Capture (LC) initiative the scale and depth of which is unprecedented in the literature on LC. We also adopt a critical perspective on the adoption and use of LC technologies more generally and share insights into how individual, institutional, political and commercial factors interact and contribute to the observed outcomes. The research concluded with a post-experiment meta-evaluation to help reflect on the following research questions.

5.1 Reflection

Can a theory-driven approach provide real and practical recommendations for institutions?

After preliminary training and utilising realist principles and published standards (Wong et al., 2016), the evaluators found the framework (figure 1) straightforward to use in practice. The overall quality of the realist approach was found to be good when assessed using international evaluation quality standards (Yarbrough et al., 2011). One area for improvement was identified as the need to incorporate stakeholder communication and feedback at the end of each evaluation cycle. The inclusion of this step would help beneficiaries of the evaluation to understand better the theory-driven approach, and therefore the rationale for practical recommendations that had been derived from the evidence collected within each cycle. Several of these recommendations were easily and quickly incorporated into the LC initiative; either as tactics to encourage wider adoption, requirements for additional technical functionality or improved design.

Does this approach provide a greater insight into the political, economic, cultural and social complexity of technologies' use in education than existing evaluation methods?

We believe this approach has provided a greater insight into the complex factors at play in higher education with regards to the adoption, use and adaption to specific educational technologies, in this case LC. Our evaluation has identified three significant political, economic and cultural contextual factors that would warrant future research: the marketization

of higher education, the impact of global marketing and investment by corporate educational technology companies, and the institution's decision making with regard to gathering and acting upon staff and student requirements.

Does a realist approach (and the tailored evaluation framework) address the factors identified as barriers to effective evaluation?

Existing LC research tends to be very narrow in focus and few describe an overall 'evaluation' methodology or look at organizational or contextual factors that might contribute to their observed outcomes. Sloan and Lewis (2014) describe LC research as fitting into four categories:

- Showing ways in which LC 'can' and 'should' be used.
- Reports on early experiences, often including assessments of staff and student perceptions (the largest category of research).
- Relating to students' learning styles with a few linked to learning theories.
- Linking LC use to objective measures of learning.

Our research, however, evaluated the two theories underpinning the initiative, i.e. the reason it was expected to work, rather than a snapshot of LC practice or technology at a point in time. This realist approach enabled consideration of the wider strategic and organizational setting of the LC initiative. This provided a level of abstraction that helped gather evidence about wider influences and theories of potential future impact of the programme and its linked policy. We looked for reasons for positive and negative outcomes linked to specific contexts (not just learning) and have highlighted some important areas for future LC research regarding potentially detrimental evolving student behaviours, such as deliberate non-attendance or disengagement from LC when it is widely available. These are outcomes that are not so achievable in narrowly focused summative evaluations.

The framework (figure 1) incorporates the use of middle-range theories and we used the unified theory of acceptance and use of technology (Venkatesh et al., 2003) as a conceptual platform to understand technology acceptance. Our research found that 'intention to use' was just as beneficial an outcome as 'actual use' in terms of positive student perceptions. This contributes to our understanding of technology acceptance models and theories by suggesting that a 'behavioural intention' is a valid technology acceptance goal as is 'use behaviour'. The framework provides the tools to help map the complex issues of rapid change and the variety in contexts: people's volitions, political and organizational contexts and the timing of implementation stages. It also requires providing evidence in the form of CMO configuration

chains rather than qualitative statements or anecdotal evidence often presented in research regarding perceptions of LC. The use of the reference models provided (King, et al., 2016), categorizing technologies and actors in educational settings, has proven advantageous. It has enabled detailed contextual comparisons by determining abstract roles across various departments and helped to differentiate the multitude of technologies and their expected capabilities within distinct domains. It is recommended that future research utilize the tailored evaluation framework (and reference models), to aid the synthesis of findings across multiple institutions, and begin to establish a shared evidence base of what works in complex technology implementations in education. Overall, we have demonstrated that a realist approach begins to significantly address the barriers to effective evaluation and contributes to a more rigorous theory-based research methodology in the educational technology domain.

6. References

Ajzen, I. (2012), "Theory of Planned Behaviour". Vol. 1, in Van Lange, P. A. M., Kruglanski, A. W., and Higgins, E. T., (Ed.) *The Handbook of Theories of Social Psychology*, Sage, London, pp. 438-459.

APA Work Group of the Board of Educational Affairs (1997), *Learner-Centered Psychological Principles: A Framework for School Reform & Redesign*, American Psychological Association, Washington, DC.

Baker, S. E. and Edwards, R. (2012), "How many qualitative interviews is enough?" Review paper, National Centre for Research Methods. Available at: http://eprints.ncrm.ac.uk/2273/ (accessed 20 April 2016).

Barokas, J., Ketterl, M., Brooks, C. and Greer, J. (2010), "Lecture capture: student perceptions, expectations, and behaviors. *eds J. Sanchez & K. Zhang, Digital Media*, pp. 1-8, available at: http://www2.inf.uos.de/papers_pdf/2010_02.pdf (accessed 20 April 2016).

Bhaskar, R. (1978), *A Realist Theory of Scienc,* Routledge, London.

Bond, S. and Grussendorf, S. (2013), "Staff attitudes to lecture capture", London School of Economics and Political Science, available at: http://eprints.lse.ac.uk/54870/ (accessed 2 July 2017).

Bransford, J., Brophy, S. and Williams, S. (2000), "When Computer Technologies Meet the Learning Sciences: Issues and Opportunities", *Journal of Applied Developmental Psychology*, Vol. 21 No.1, pp. 59-84.

Bulfin, S., Johnson, F. N. and Bigum, C. (Eds.). (2015), *Critical Perspectives on Technology and Education,* Palgrave Macmillan, Basingstoke.

Cane, J., O'Connor, D. and Michie, S. (2012), "Validation of the theoretical domains framework for use in behaviour change and implementation research", *Implementation Science,* Vol. 7 No. 1, p. 37.

Cecez-Kecmanovic, D., Galliers, R. D., Henfridsson, O., Newell, S. and Vigden, R. (2014), "The Sociomateriality of Information Systems: Current Status, Future Directions," *MIS Quarterly*, Vol. 38 No. 3, pp. 809-830.

Chang, S. (2007), "Academic perceptions of the use of Lectopia: A University of Melbourne example. In ICT: Providing choices for learners and learning", paper presented at Ascilite, Singapore, 1 December 2007.

Cilesiz, S. (2015), "Undergraduate students' experiences with recorded lectures: towards a theory of acculturation", *Higher Education*, Vol. 69 No.3, pp. 471-493.

Danielson, J., Preast, V., Bender, H. and Hassall, L. (2014), "Is the effectiveness of lecture capture related to teaching approach or content type?" *Computers and Education*, Vol. 72, pp. 121-131.

Dona, K. L., Gregory, J. and Pechenkina, E. (2016), "Lecture-recording technology in higher education: Exploring lecturer and student views accoss the disciplines", *Australasian Journal of Educational Technology*, DOI: https://doi.org/10.14742/ajet.3068

Drouin, M. A. (2014), "If You Record It, Some Won't Come Using Lecture Capture in Introductory Psychology", *Teaching of Psychology*, Vol. 41 No.1, pp. 11-19.

Entwistle, N. (2000), "Promoting deep learning through teaching and assessment: conceptual frameworks and educational contexts", Paper presented at TLRP Conference, Leicester, available at: http://www.etl.tla.ed.ac.uk/docs/entwistle2000.pdf (accessed on 12 February 2016).

Folley, D. (2010), "The Lecture is Dead Long Live the e-Lecture", *Electronic Journal of e-Learning*, Vol. 8 No. 2, pp. 93-100.

Gosper, M., Green, D., McNeill, M., Phillips, R., Preston, G. and Woo, K. (2008), "The impact of web-based lecture technologies on current and future practices in learning and teaching", available at: http://www.cpd.mq.edu.au/teaching/wblt/overview.htm (accessed on 13 February 2016).

Greenberg, A. and Nilssen, A. (2009), "The new imperative for lecture capture systems in higher education", *Wainhouse Research, LLC, Duxbury, MA, USA*.

Gunn, C. and Steel, C. (2012), "Linking theory to practice in learning technology research", *Research In Learning Technology*, Vol. 20.

Henderson, M., Selwyn, N. and Aston, R. (2015), "What works and why? Student perceptions of 'useful' digital technology in university teaching and learning", *Studies in Higher Education*, pp. 1-13.

King, M., Rothberg, S., Dawson, R. and Batmaz, F. (2014), "The need for evidence innovation in educational technology evaluation", in *Global Issues in IT Education proceedings of the International Conference in Southampton, UK, 2014*, Southampton Solent University, Southampton, pp. 9-23.

King, M.R.N., Rothberg, S.J., Dawson, R.J. and Batmaz, F. (2016), "Bridging the edtech evidence gap: A realist evaluation framework refined for complex technology initiatives", *Journal of Systems and Information Technology*. Vol. 18 No. 1, pp. 18-40.

Leadbeater, W., Shuttleworth, T., Couperthwaite, J. and Nightingale, K.P. (2013), "Evaluating the use and impact of lecture recording in undergraduates: Evidence for distinct approaches by different groups of students", *Computers & Education*, Vol. 61, pp. 185-192.

Leonard, J., Albores, P. and Higson, H. (2016), "Virtuous or vicious cycle? Inscribing diverse professional values in lecture capture systems", In AMCIS 2016: Surfing the IT Innovation Wave - 22nd Americas Conference on Information Systems. Association for Information Systems.

Lowendahl, J. (2015), "Hype Cycle for Education, 2015", Gartner Inc. available at: https://www.gartner.com/doc/3090218/hype-cycle-education- (accessed on 3 January 2016).

Mayer, R. E. (2006), "Ten research-based principles of multimedia learning", *Web-based learning: Theory, research, and practice*, pp. 371-390.

McCombs, B. L. and Vakilia, D. (2005), "A learner-centered framework for e-learning", *Teachers College Record*, Vol. 107 No.8, pp. 1582-1600.

Merton, R. K. (1968), *Social theory and social structure*, Simon and Schuster.

Moes, S. and Young, C. (2013), "Which types of lecture capture, knowledge and instruction clips could improve the quality of learning outcomes?" In *ICERI2013 Proceedings of the 6th International Conference of Education Research and Innovation, Seville*, 2013, IATED, pp. 5053-5062.

O'Callaghan, F.V., Neumann, D. L., Jones, L., and Creed, P. A. (2017), "The use of lecture recordings in higher education: A review of institutional, student and lecturer issues", *Education and Information Technologies*, Vol. 22 No.1, pp. 399-415.

Owston, R., Lupshenyuk, D. and Wideman, H. (2011), "Lecture capture in large undergraduate classes: Student perceptions and academic performance", *The Internet and Higher Education*, Vol. 14 No. 4, pp. 262-268.

Pawson, R. (2013), *The Science of Evaluation - A Reaslist Manifesto*, Sage, London.

Pawson, R. and Tilley, N. (1997), *Realistic Evaluation*, Sage, London.

Revolution.com (2013), "Echo360 and Revolution Growth Selected as Venture Deal of the Year", available at: http://revolution.com/press-release/echo360-and-revolution-growth-selected-as-venture-deal-of-the-year/ (accessed 15 March 2016).

Rogers, E. M. (2003), *Diffusion of innovations*, 5th. New York: Free Press, New York, NY.

Schon, D. (1987), *Educating the Reflective Practitioner*, Josey-Bass, San Francisco, CA.

Selwyn, N. (2014a), *Digital Technology and the Contemporary University*, Routledge, London.

Selwyn, N. (2014b), *Distrusting educational technology: critical questions for changing times.* Routledge, London.

Selwyn, N. and Facer, K. (2013), *The Politics of Education and Technology: Conflicts, controversies, and connections.* Palgrave Macmillan, New York, NY.

Sloan, T. W. and Lewis, D. A. (2014), "Lecture Capture Technology and Student Performance in an Operations Management Course", *Decision Sciences Journal of Innovative Education*, Vol. 12 No. 4, pp. 339-355.

Stufflebeam, D. (2001), "The Metaevaluation Imperative." *The American Journal of Evaluation, Vol.* 22 No. 2, pp. 183–209.

Sugar, W., Crawley, F. and Fine, B. (2004), "Examining teachers' decisions to adopt new technology", *Educational Technology and Society*, Vol. 7 No.4, pp. 201-213.

The Complete University Guide (2016), "University League Table 2017", available at: http://www.thecompleteuniversityguide.co.uk/league-tables/rankings?y=2017 (accessed on 12 March 2016).

Toppin, I. N. (2010), "Video lecture capture (VLC) system: a comparison of student versus faculty perceptions", *Education and Information Technologies*, Vol. 16 No. 4, pp. 383–393.

Traphagan, T., Kucsera, J. V. and Kisha, K. (2010), "Impact of class lecture webcasting on attendance and learning", *Educational Technology Research and Development*, Vol. 58 No. 1, pp. 19-37.

Trondeur, J., van Braak, J., Ertmer, P. A. and Ottenbreit-Leftwich, A. (2016), "Understanding the relationship between teachers' pedagogical beliefs and technology use in education: a systematic review of qualitative evidence", *Educational Technology Research and Development*, pp. 1-21.

Venkatesh, V., Morris, M. G., Davis, G. B. and Davis, F. D. (2003), "User Acceptance of Information Technology: Toward a Unified View", *MIS Quarterly* (MIS Research Center, University of Minnesota), Vol. 27 No.3, pp. 425-478.

Wong, G., Westhorp, G., Manzano, A., Greenhalgh, J., Jagosh, J. and Greenhalgh, T. (2016), "RAMESES II reporting standards for realist evaluations", *BMC Medicine*, Vol. 14 No. 1, p. 96.

Woolf, B. P. (2010), *Building intelligent interactive tutors: Student-centered strategies for revolutionizing e-learning*, Morgan Kaufmann, Burlington, MA.

Woodley, C., Funk, R. and Curran, L. (2013), "Directives and Academics: educational developers, technology and the right support" Paper presented at THETA: The Higher Education Technology Agenda

Conference, Holbart, available at: http://eprints.utas.edu.au/16322/1/THETA_2013_Woodley_16322.pdf (accessed on 13 April 2016).

Yarbrough, D. B., Shulha, L. M., Hopson, R. K. and Caruthers, F. A. (2011), *The Program Evaluation Standards: A guide for evaluators and evaluation users*, (3rd ed.), Sage, Thousand Oaks, CA.