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Practical Lessons in Andragogy and Constructivism: An Exploratory Study of Mature, Part-Time Undergraduate Engineering Learner Experiences of Digital Learning Objects

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Abstract

As higher education pivots towards a digital provision, there is a growing recognition of the potential for technology to enhance learning, teaching and assessment, particularly so in engineering education where technologies manifest as physical artefacts of learning embedded in its epistemological underpinnings. Yet, the literature on mature learners suggests a technological gap associated with age can impede learning. We examine this anomaly with a specific subset of mature learners. We explore, through lenses of andragogy and constructivism, the experiences of mature, part-time engineering students in using technology to enhance learning. A cohort with limited computing skills or familiarity with digital learning were provided with co-created digital learning objects to assist in learning complex engineering software. A thematic analysis of student feedback implied that they perceived their experiences of using these supports with an authentic assessment to be positive. The students reported that co-creation of these supports with faculty encouraged engagement. Furthermore, they felt that the approach taken enhanced achievement of learning outcomes, digital literacy, professional confidence, self-direction and likelihood of engaging further in their education.

Keywords: Digital Learning Objects, Engineering Education, IESVE, Mature Learners, Simulation, Andragogy, Constructivism

Introduction

The literature highlights cognitive, social and psychological challenges faced by mature learners, such as time pressure (Stone & O'Shea, 2013), work-life balance (Abbott-Chapman, 2006) confidence (Willans & Seary, 2011) and alienation (Lynch, 1997). Mature learners, i.e. those who were “23 or over on 1st January” on entry (HEA, 2019, p. 6), represent a broadly defined group in higher education (Figure 1). Considering the technological gap associated with age (e.g. Staddon, 2020), little is written about challenges faced by mature learners in engaging with technology, particularly in engineering education where technology is so pervasive.

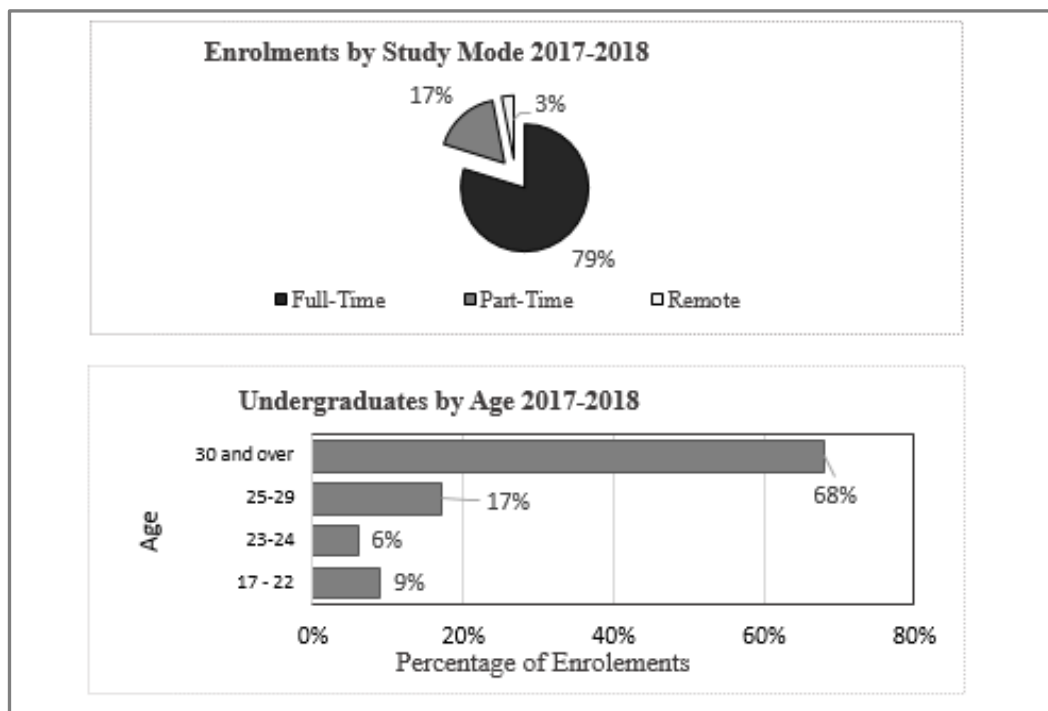


Figure 1: HEA enrolment statistics 2017-2018

Undergraduate engineering students at TU Dublin provide an interesting microcosm in which to explore this topic. As part of their building engineering studies, a cohort of mature part-time students learn to navigate the complexities of industry-standard simulation software. Beeland (2002) suggests that learner engagement and confidence are key factors of motivation to learn. One possible way to assist mature learners with engagement is to provide digital learning

objects (DLOs), i.e. short reusable multimedia objects typically designed to deliver a single learning outcome. Whilst this might appear contradictory to a perceived digital skills gap associated with mature learners, we posit that if the DLOs were to be scaffolded appropriately then they would have an immersive effect of pulling the students into a deeper learning of the software.

In a deviation from traditional methods of teaching engineering simulation software, we describe a novel approach to engaging these students in learning Integrated Environmental Solutions Virtual Environment (IESVE) with the aid of DLOs. IESVE is an energy analysis and performance modelling tool used by engineers to translate complex thermodynamic calculations and construction physics and into easy-to-understand visual information, aiding the design of sustainable buildings that are energy efficient. It offers custom tools designed to address different building performance workflows and can help engineers incorporate sustainable building principles into their building information management (BIM) projects. Whilst remote delivery was not our intention, it became central to our study given the emergency measures introduced during the COVID19 Pandemic. Deconstructing the students' experiences of these resources would be an important step in seeking to understand how learner engagement could be enhanced by using DLOs. In recognising the subjective nature of their experiences, we explore the utility of such resources, posing two research questions.

RQ1: could the co-creation and use of DLOs assist with increasing mature learners' engagement with technologies, such as engineering simulation software?

RQ2: do mature learners typically become more confident in their own abilities by progressing through such DLOs when used with authentic assessment?

Underpinning our study is an assumption that supportive DLOs can motivate learning. Engagement reflects quality of learner participation and is reflected in learner cooperation with

their educators and co-learners. Indicators of engagement include eagerness to participate, motivation, willingness to expend effort and levels of learning activity (Stovall, 2003). As learner engagement in an online setting is challenging to define (Coates, 2007), we explore student perceptions of these indicators. Given that confidence mediates how learners perform (Cretchley, 2007), we also explore the role of the DLOs in improving their confidence. Whilst this study is limited to three cohorts of engineering students, our findings are potentially transferrable across engineering education contexts in which epistemological underpinnings and emphases on technological skills are built on similar notions.

Having outlined the rationale for, and context to the study, the rest of this paper is structured as follows. First, we synthesise three interwoven strands of literature on [i] mature learners, [ii] learning theories and [iii] models that inform technological learning, to conceptualise the learning scenario. Whilst empirical studies of mature learners problematize their success, theories of constructivism and andragogy offer potential solutions. Constructivism posits that knowledge is constructed through learner interactions with their environments rather than passively absorbed. Andragogy addresses the distinct learning needs of adults. We also examine other potentially relevant theories, including transformative learning and reflective learning. The second section of the paper covers the design of our learning intervention. We describe a series of DLOs, compiled as a website, to support three cohorts of engineering students in designing sustainable energy-efficient buildings using IESVE.

The website introduces students to applications of IESVE through instructional videos, examples of simulations and discussion forums, requiring them to perform tasks that emulate typical contexts that they might encounter in professional practice. Engineering students require sufficient technical knowledge and problem-solving skills to be industry-ready. To prepare the students for professional entry, the website provides an authentic assignment so that they can apply what they have learned to their project work. An authentic assignment is

one that requires professional judgment in applying their knowledge and skills to a new situation. We provided a formative assessment in which students develop realistic models of buildings, facilitating them to effectively and efficiently use essential knowledge and critical skills gained from the website to negotiate a task (Figure 2).



Figure 2: Compendium of DLOs at www.bess.ie

In the third section, we outline the data collection process in which an online survey is supplemented by semi structured interviews to garner feedback from students on their experiences of using the DLOs. In the fourth section, we explore the steps undertaken in a thematic analysis of student feedback. Whilst the interviews did not address to saturation, taken in conjunction with the survey data, we identify a set of provisional themes that provide a basis for more in-depth research. The paper concludes with a summary of findings and implications for academic practice.

Mature Learners

Mature learners represent a growing voice in higher education. Mature learners typically return to education of their own accord and manage their studies around work and family

commitments (Cullity, 2006). For returnees, the positive aspects of returning outweigh the barriers. Yet, some carry financial and emotional burdens (Cercone, 2008) or face learning challenges associate with biological aging (Clark, 1999). Notwithstanding, mature learners can benefit from opportunities to harness their life experiences and preferred learning styles (Marschall & Davis, 2012). Given higher education's technological revolution (JISC, 2009) and generational challenges with technology (Salkowitz, 2008), the literature appears fragmented with respect to provision of technological supports, such as DLOs, for mature learners. In seeking guidance on supportive interventions, we reviewed learning theory and empirical studies for how technology might enhance engagement and confidence. Lambert, Erickson, Alhramelah, Rhoton, Lindbeck and Sammons (2014) call for educators to adapt technological instruction for mature learners, more so in engineering where technology is central to learning.

How might learning theories guide us in educating mature learners?

Knowles, Holton and Swanson (2015) advocate four andragogical principles to elicit positive responses to learning, namely [i] co-creation, [ii] authentic learning, [iii] learning related to learners' professional lives and [iv] specificity in content. Constructivism also informs our research. It considers learning to be active, in which meaning is constructed. As learners mature, progression from behaviourist to constructivist learning is recommended. Yet, mature learners are a heterogeneous group comprising diverse genders, ages and cultures (Schuetze, 2014). We also consider transformative learning (Cranton, 2006), which may explain erratic trajectories of personal change in learners. Learner communities help to support learners through change (McKegg, 2005). Action learning and experiential learning also inform our research. Reflection is central to action learning. It relies on learner communities solving problems in real time to enable immediately relevant but enduring learning (Revans, 1982).

Experiential learning is a process of assimilating new experiences into emerging mental structures (Kolb, 1984).

Engaging with Technology

O'Donnell (2010) implies that technology enhances learning. As engineering learners lean towards visual learning (Jackson, Quinn, Lonie & James, 2013), the design of our DLOs is informed by literature on cognitive engagement with visual technologies (McGrath & Brown, 2005). Yet, Hardiman (2011) stresses that we should accommodate for less digitally-literate learners. O'Donnell (2010) shows that digital technology can transform learning when integrated properly. We do not replace traditional lectures with webinars. Rather, we devise DLOs to supplement an authentic assessment in a hybrid delivery.

Enhancing Confidence and Engagement

In seeking to build confidence in students to take-on more complex tasks, we borrow Keller's ARCS model (Keller, 1987), which encourages well-crafted instructional material to allow learners to feel that they can progress in their studies. Keller defines confidence as a belief in succeeding, which can be improved by opportunities that foster senses of achievement and personal control. In seeking to encourage engagement, we adapted Bulger, Mayer, Almeroth and Blau's (2008) approach to digitally monitoring learning activities, focusing on indicators, such as interest (Humber, 2018), effort (Brits, 2016), attention (Xiong, He & Liu, 2019), and motivation (Jones, 2020).

ADDIE Model to Design the Digital Learning Supports

Guided by the ADDIE model (Mayfield, 2011), we developed our DLOs in five phases: analysis, design, development, implementation and evaluation. An analysis was initially carried out to identify the students' prior knowledge of engineering principles for building design. The design of the digital resources then focused on intended learning outcomes and

underlying storyboards. The development phase focused on creating high quality multimedia resources and their organisation on a website. The implementation phase provided a physical delivery of the resources to the students. For evaluation, we solicited qualitative feedback from students and analysed digital activity data to identify possible areas for improvement (Shibley, Amaral, Shank & Shibley, 2011).

Summary of Literature

In summary, five strands of literature are used to inform our study (Table 1). A strand on mature learners alerts us to their unique challenges and potential approaches to addressing them. Learning theories highlight principles for academic practice. The literature on technology highlights approaches to instructional design and digital pedagogy. A fourth strand of literature explores factors of confidence and engagement. Finally, we apply the ADDIE model as a guiding process for the development of our DLOs, authentic assessment and website.

Literature Review Summary	
Mature Learners	Clark (1999), Cullity (2006), Cercone (2008), Salkowitz (2008), JISC (2009), Marschall and Davis (2012), Lambert et al. (2014).
Learning Theories	Andragogy: Knowles et al. (2015).
	Constructivism: Schuetze (2014).
	Transformative Learning: McKegg, (2005), Cranton (2006).
	Action and Experiential Learning: Revans (1982), Kolb (1984).
Technology	McGrath & Brown (2005), O'Donnell (2010), Hardiman (2011), Jackson et al. (2013), Dixon (2013).
Confidence and Engagement	Keller (1987), Keller & Suzuki (1988), Bulger et al.'s (2008), Brits (2016), Humber (2018), Xiong et al. (2019), Jones (2020).
ADDIE	Mayfield (2011), Shibley et al., 2011.

Table 1: Summary of the Literature Guiding the Study

Research Design and Methodology

As an exploratory study aimed at acquiring an overview understanding, we lean towards a design-science approach to investigating artefacts coupled to their context (Simon, 1996). Philosophically, this study is both interpretive and abductive. We interpret our students' constructions of reality in context, then respond to the learnings these constructions provide. Despite its inherent limitations, we believe this approach offers a basis for later construct validity in more in-depth research.

The design of a learning intervention for a specific context, the impact of which is studied, is consistent with Yin's (2003) case-study approach in which multiple data sources enhance credibility. Hence, our data comes from multiple sources, including: the student survey, follow-up interviews, informal feedback and observation and website monitoring (Figure 3).

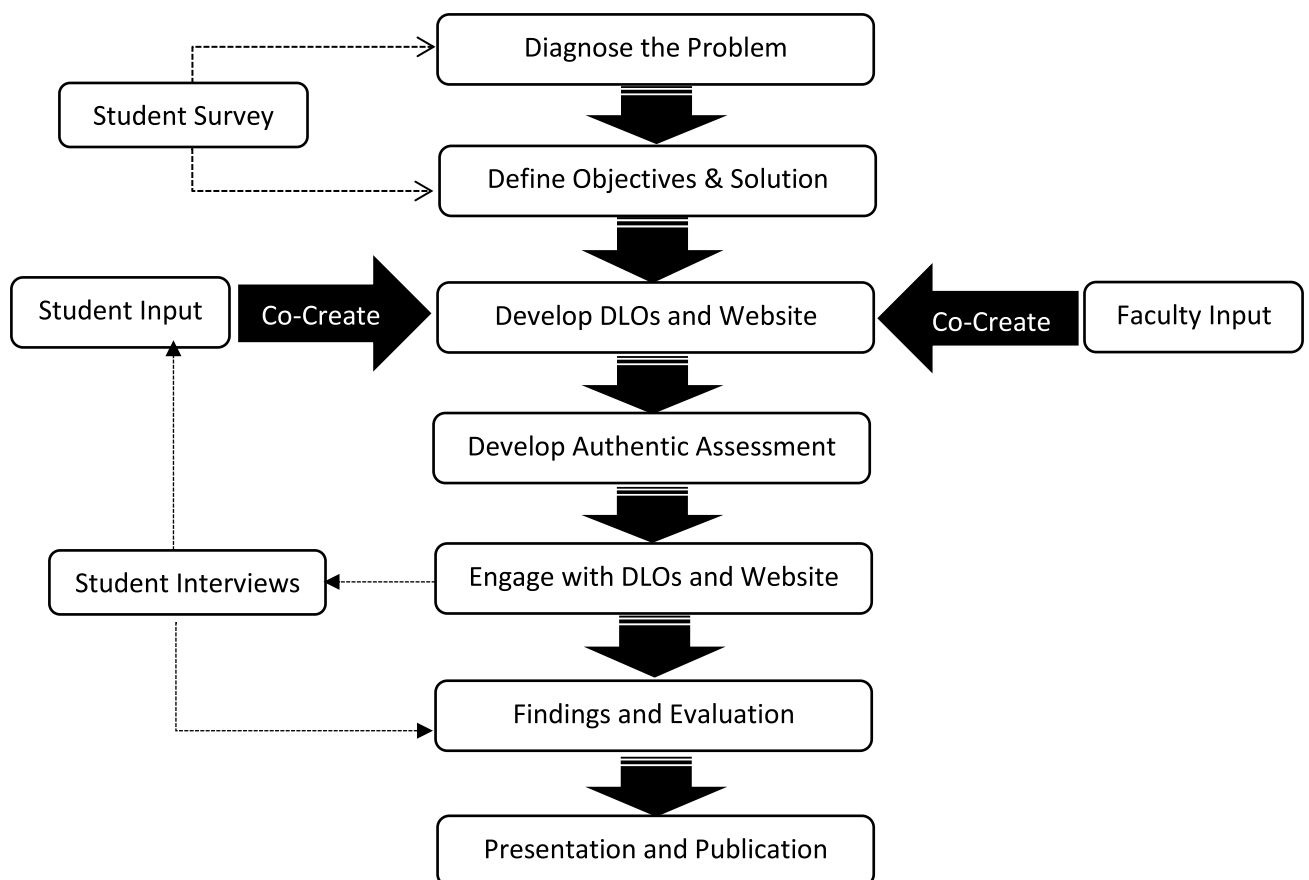


Figure 3: Research Design – Co-Creation of DLOs

We chose the ADDIE model, as a suitable development process, on the basis of its use in instructional design. In the analysis phase, we evaluated, with an adragogical lens, the effectiveness of previous supports. The design artefact was a website hosting curated and co-created DLOs. Once developed, we introduced to students the purpose of each DLO and provided practical instruction. The DLOs included short video guides, answers to frequently asked questions and direction to more resources. The video guides were also translated to PDF format, which students could view or download to read in their own time. In line with Vygotsky's (1978) concept of proximal development, the guides were designed to iteratively develop students' just beyond their current skill level so they could progress at their own pace. The website evolved over the semester based on lecture-student interactions. When introducing the website, students were first given a demonstration, afforded time to navigate through it and were informed of the self-directed learning required.

In the development phase, an informal presentation style was used in the creation of the video guides. The guides were hosted on a website and the URL was made available to the students at the beginning of the semester. Guided by Clarke's (2011) principles for effective use of technology in blended learning, all resources were supplemental to classroom teaching and the prescribed authentic assessment. During the evaluation phase, we tracked student access to, and engement with the DLOs using website analytics (Figure 4).

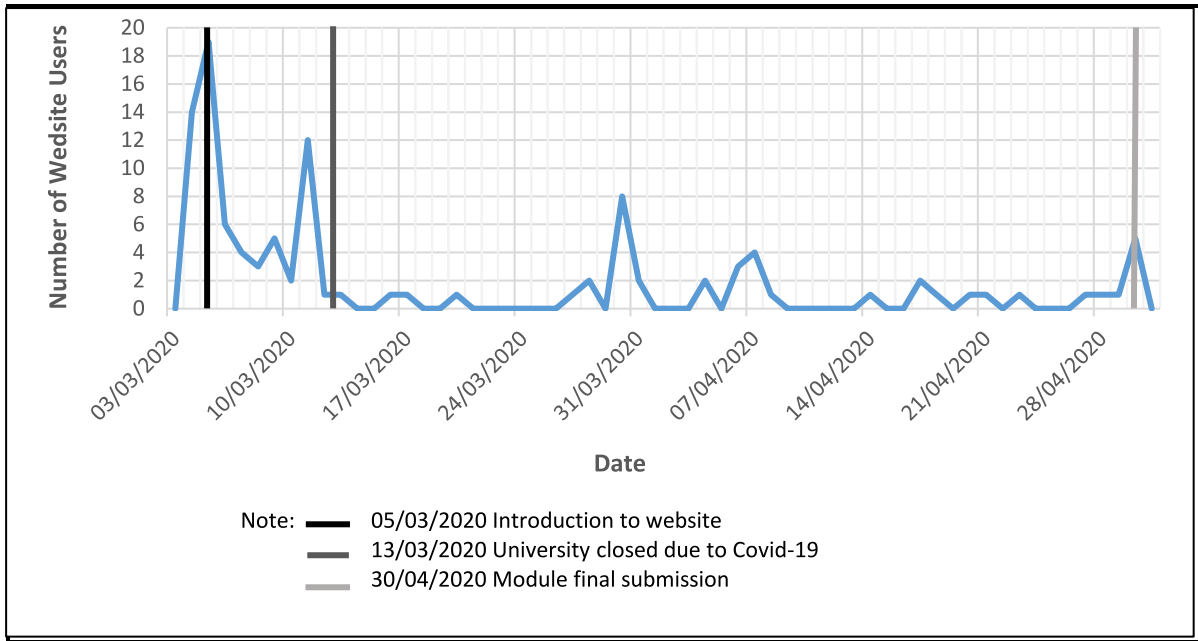


Figure 4: Active Users of Website 1st March 2020 - 30th April 2020

Student Participants

Participation was open to 42 students from TU Dublin's Building Engineering degree programmes. All students received an information sheet and consent form prior to participation. Twenty students participated in an initial survey, eighteen male and two female. Seven respondents were from Cohort 1, ten from Cohort 2 and three from Cohort 3 (Table 2).

ID*	Cohort**	Background Information			Used Website
		Age	Current Position	Education	
SR ₁	1	23 - 25	Operations Manager	Leaving Certificate	✗
SR ₂	1	26 - 30	Plumbing trade	Apprentices	✗
SR ₃	1	31 - 35	Maintenance of HVAC	Leaving Certificate, Apprenticeship	✗
SR ₄	1	31 - 35	Trade	Apprentice	✗
SR ₅ IP ₁	1	31 - 35	Employee	Junior Certificate	✗
SR ₆	1	41 - 45	Project Management	Years in Management	✗
SR ₇ IP ₂	1	41 - 45	Company Director	Leaving Certificate, Apprenticeship	✗
SR ₈	2	23 - 25	Process Technician	Leaving Certificate. NQF L6	✓
SR ₉	2	23 - 25	Contractor	Leaving Certificate	✓
SR ₁₀	2	26 - 30	Mechanical Foreman	Apprentices	✓
SR ₁₁	2	26 - 30	Engineering Manager	Electrician	✓
SR ₁₂	2	31 - 35	Construction - Planner	Leaving Certificate. Apprenticeship	✓
SR ₁₃	2	36 - 40	Consultancy	Level 7	✓
SR ₁₄	2	36 - 40	Employee	Apprenticeship	✓
SR ₁₅	2	41 - 45	Employee	Leaving Certificate	✓
SR ₁₆	2	51 +	Contractor	Qualified plumber	✓
SR ₁₇	2	51 +	Employee	Junior Certificate. Apprenticeship	✓
SR ₁₈	3	31 - 35	Consultancy	Leaving Certificate, Apprenticeship	✗
SR ₁₉	3	36 - 40	Trade	Apprenticeship	✗
SR ₂₀	3	36 - 40	Engineering Consultant	Level 6 Certificate	✗

* SR denotes survey respondent. IP denotes interview participant

** Cohort 1 – Year 2 of NQF L6, Cohort 2 Year 3 – NQF L 6, Cohort 3- Year 1 NQF L7

Table 2: Survey Participant Profile

Employed full-time, participants had a diverse range of academic achievements, employment contexts and digital literacy. Of the 20 students who completed the survey, only 10 students, all from Cohort 2, engaged with the DLOs. Consistent with other asynchronous approaches (e.g. Ahmad, Doheny, Faherty & Harding, 2013), these students progressed through the resources at their own pace. Video tutorials proved beneficial to those who required visual as

well as oral explanations. Two students were interviewed after the DLOs were made available. They were asked about their progress and the impact of the intervention and to summarise their experiences of using the DLOs (see Table 3).

Cohort	Engagement with students prior to administering survey	Completed Surveys	Engagement with students prior to interview	Completed Interviews
1	We met with the cohort at the beginning of semester. We explained our research and emailed the cohort a link to the survey. An email reminder was sent two weeks later.	7/13 (54%)	Four students agreed to participate in follow-up interview later the in semester. All interviews had to be cancelled due to Covid19.	0
2	We engaged with this cohort over two weeks. We introduced the cohort to IESVE and www.bess.ie . We explained our research and emailed the cohort a link to the survey, with an email reminder two weeks later.	10/18 (56%)	We invited students from this cohort by email to a follow-up interview later in the semester. Two students agreed to participate.	2/18 (11%)
3	A colleague informed the group of the online survey. We emailed the cohort a link to the survey with an email reminder two weeks later.	3/11 (27%)	We invited students from this cohort by email to a follow-up interview later in the semester. None offered to participate.	0/11
Total		20/42 (48%)		2/ 42 (5%)

Table 3: Summary of Student Participation

Data Collection and Analysis

We gathered data via an online survey and two follow-up interviews. The purpose of the survey and interviews was twofold: [i] to inform design of the DLOs, and [ii] to gain an insight into the students' experiences of the www.bess.ie website. The survey comprised 25 questions with prepopulated answer choices using a Likert scale. Most questions were structured with a

comment section for respondents to explain their answer choice. A final open question asked students to suggest how we might improve their experience of computer aided courses.

Two students were interviewed after using the DLOs. Whilst the interviews did not address saturation, they provided a basis for provisional thematic formation, offering a sense of the kinds of issues that might arise in the coding. Both interviews lasted 45 minutes and were recorded and transcribed. During the interviews, we questioned participants on key aspects of the research questions, such as their perceptions of utility of the DLOs. We solicited their opinions of computer aided courses and whether or not the DLOs provided were beneficial and fit-for purpose. We explored obstacles to using the DLOs and how students felt the supports helped to reduce cognitive load (Mayer & Moreno, 2003). Informed by initial impressions post-interview, we undertook a thematic analysis of the transcripts and survey responses. A first step involved open coding, whereby chunks of text were allocated a descriptive code, reflecting participant responses. We then annotated coded text extracts with our interpretation. A second step involved clustering open codes into fewer categories. In a final step, we aggregated the codes further into conceptual themes.

In discussing our findings, we first summarise the thematic formations in diagrammatic format without reference to prior literature. We then give a detailed narrative of participant responses in the context of the research questions, weaving in illustrative quotes to strengthen the credibility of the themes. Finally, we map themes to the literature, highlighting opportunities for further research.

Results

Given the relatively broad definition of mature learners (HEA, 2019), we wanted to gain a better understanding of our student demographics. Our survey respondents ranged from 23 years to 50 years and over, 45% of them being in their thirties (Figure 5).



Figure 5: Age Profile of Respondents

All respondents were in full-time employment within the building engineering industry, supporting themselves financially whilst engaging in their part-time studies. All reported that they prioritised work commitments over their studies. All indicated that they worked at least 31 hours per week, and 14 of the 20 (70%) indicated that they worked in excess of 41 hours per week, suggesting that work pressures affected their studies. In addition, some students noted family responsibilities (Table 4).

		Mature Students Age Range (Years)							Total
		23 - 25	26 - 30	31 - 35	36 - 40	41 - 45	46 - 50	51 +	
Age Ranges of Children (Years)	None	3		4	1	1			9
	0 - 5		2	1	3			1	7
	6 - 10		1			1			2
	11 - 15			1		2			3
	16 - 20					1		1	2
	21 - 25							1	1
	26 +							1	1

Table 4: Ages of Children of Respondents

The most common reason provided for challenges associated with being a mature student related to balancing work, life and education commitments (Figure 6).

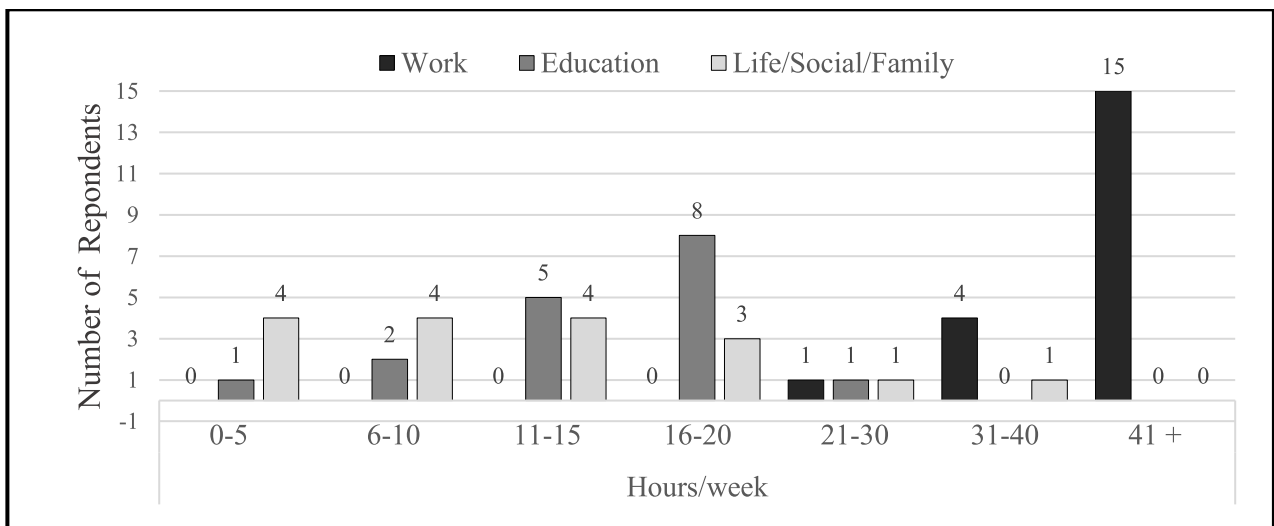


Figure 6: Hours per Week spent on Work, Life and Education Commitments

14 respondents indicated that they had a neutral to extremely positive experience of prior education. All had attained a national Junior Certificate or Apprenticeship. 15 survey respondents (75%) indicated that the module learning environment was positive. When digital literacy skills and prior online experience were examined, 11 respondents (55%) considered their proficiency level to be acceptable with 78% confirming that they engaged with technology on a regular basis. Exposure to technology in the form of digital media at home was a factor for those who had children who used technology for communicating socially. There was little

conclusive evidence of a digital divide between participating students of different ages or class groups. With only 33% agreeing with the “I lack IT skills” survey statement, 66% suggests that they felt that they had adequate skills. One student stated, when made aware of the IESVE software to be taught, reacted:

“It’s great, I’m going to learn software” [IP₁].

Whilst students indicated that they tend not to use online resources, Cohort 2 students indicated that they felt that DLOs were effective in supporting their learning needs. “I feel confident when engaging with new technology” was a survey question where only two students disagreed strongly.

Analysis and Discussion of Findings

A thematic analysis was carried using Braun and Clarke’s (2006) approach resulting in the systematic identification (Gioia, Corley & Hamilton, 2013) of six themes from 114 initial codes (Figure 7).

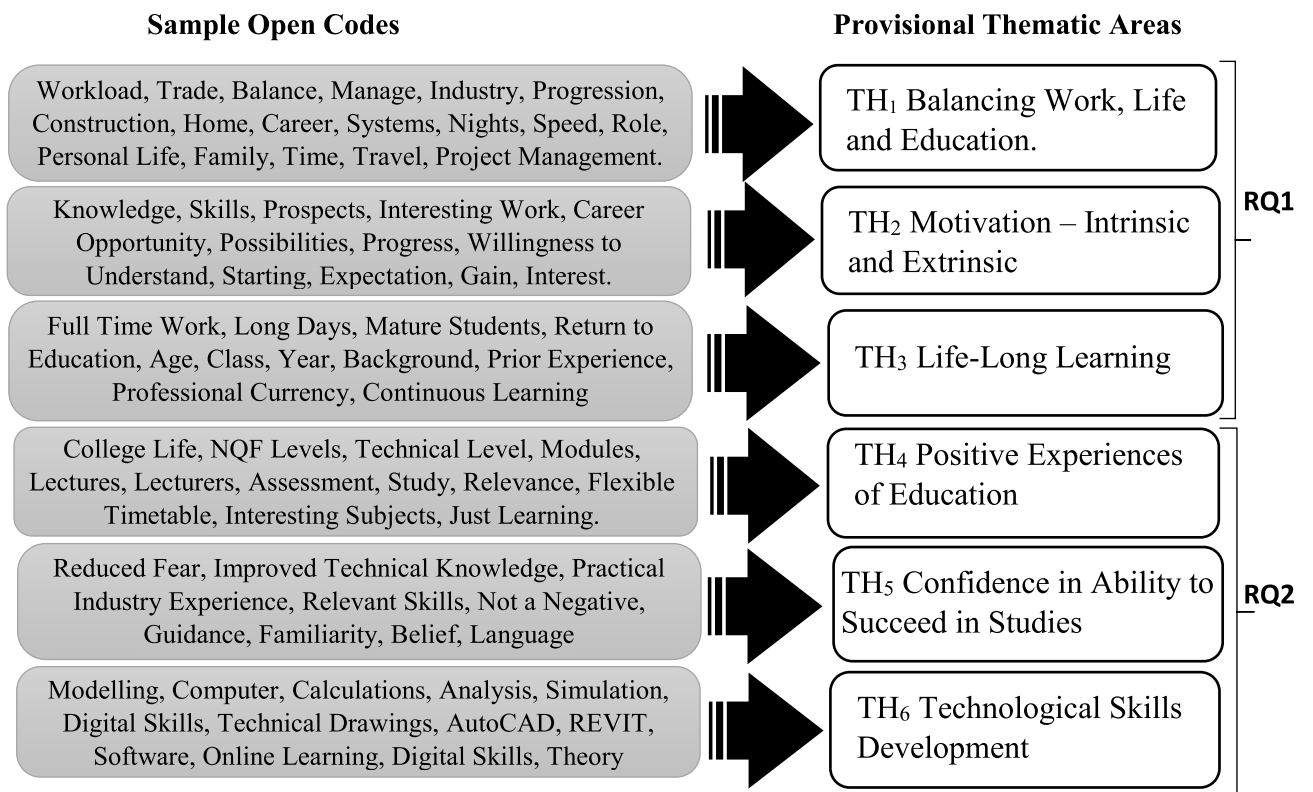


Figure 7: Theme Formation

We used a summative approach to quantify codes, aggregate them into themes to infer their prominence in the data. Rather than being purely procedural, our analysis was systematic and flexible with the number of codes and sources indicative of relative importance (Figure 8).

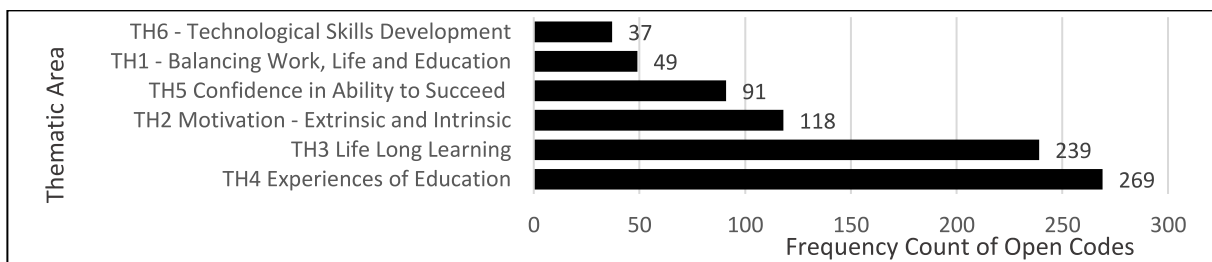


Figure 8: Thematic Areas Identified in the Data

RQ1: The Role of DLOs in increasing Engagement

Two thematic areas contribute to understanding the role of DLOs in increasing engagement. First, student feedback suggested that DLOs provided flexibility to their learning, facilitating a delicate balance of commitments to work, personal life and studies. Second, whilst the students appeared motivated by their studies, the DLOs served to crystallise the relationship between effort and outcome by catalysing a concrete sense of progress in their skills development.

TH₁ Balancing Work, Life and Education

Whilst events that trigger adults to return to education are diverse, circumstances related to family or job account for most of the reasons cited by mature learners (Sewall, 1986) studies. The students reported that time away from employment is as a key issue.

"Trying to juggle full time work, family/spouse, life, assignments, and college. Time management is a huge thing, need to really want to do it to succeed". [SR₁₇].

When questioned on whether students contemplated withdrawing, some students indicate that they had, not just from technology, but in fact from the course in general. Reasons given were fear of the unknown, poor communication and a lack of empathy from administrators.

"I just kind of got sick of timetable changes and poor communication and the attitude of not really caring about us or understanding what we are doing." [IP₂].

The main barrier that prevents the integration of technology tools was time. The students' ability to manage their time was a key challenge cited by the interviewees,

"A bit more time maybe to play around ...time management, number one ... yes, really, time management is the, time is the key, you know, the biggest issue" [IP₁].

This was also reflected in the balancing of studies with family and work commitments.

“I don't know what happened I think I let the Christmas get away from me this year. It's, I just found it with family and things but I just I didn't put as much effort as I had” [IP₁].

However, we found that students viewed the asynchronous nature of the DLOs as a significant aid in being able to cope with greater time commitments.

“... and I find it easier that way ... to dip in and out” [IP₁].

TH₂ Motivation – Intrinsic and Extrinsic

Pailsi and Quiros (2014) suggest that mature learners are more motivated by intrinsic factors, e.g. quality of life, than by external factors, such as higher salaries. Our analysis indicates that reasons for motivations for returning to education varied with age (Table 5). Whilst those under 35 wanted to enhance their career prospects, those over 35 appeared more intrinsically motivated.

Age	Reasons reported for returning to Education
23 - 25	<i>“To gain a formal qualification in the industry and personal development” [SR₁]</i> <i>“To pursue a career job that I can progress in” [SR₈]</i> <i>“To get a good job” [SR₉]</i>
26 - 30	<i>“To progress in my career” [SR₂]</i> <i>“Excel in myself” [SR₁₁]</i> <i>“To gain more knowledge in the area I work” [SR₁₀]</i>
31 – 35	<i>“To find work that is interesting and I enjoy” [SR₃]</i> <i>“I'd like more options for my future ... I am interested in learning more” [SR₅]</i> <i>“To better myself in my career” [SR₁₂]</i>
36 - 40	<i>“Enhance the design skills I already have” [SR₁₃]</i> <i>“To get off my tools and use IEVE to design heating ventilation systems” [SR₁₄]</i> <i>“I wanted to get into the design aspects ...” [SR₂₀]</i>
41- 45	<i>“To remove the need to rely on a rule of thumb” [SR₆]</i> <i>“I would ultimately like to get a Level 7 qualification in building ...” [SR₇]</i>
45+	<i>“Kids are reared ... I always wanted to further my technical education” [SR₁₆]</i> <i>“To keep up with the latest technology ...” [SR₁₇]</i>

Table 5: Reasons for Returning to Education Versus Age Profile

Whether extrinsic or intrinsic, students appeared to be motivated to develop their skills in IESVE and, in many cases were willing partners in the co-creation of the DLOs. They viewed any mechanism that could accelerate their progress along the learning curve as beneficial. In this respect, the DLOs appeared to further their motivations to learn.

RQ2: The Role of the DLOs in improving Confidence

The DLOs appeared to play a role in developing learner confidence. First, they contributed to a positive education experience, in which students could derive tangible value. Second, in enabling skill development, the DLOs when combined with the authentic assessment nurtured the students' confidence directly in their own abilities to achieve the learning tasks. Third, the DLOs provided a concrete sense of skills progression, which fed directly into motivations for returning to education.

TH4 Positive Experiences of Education

The context in which this study was undertaken services a need for progression opportunities for people in technical-vocational areas. An unsurprising finding, therefore, relates to the prominence of TH4, in which providing positive educational experiences in student feedback:

“I have moved into a new role at work and am enjoying the change/challenge that it brings, a direct result of returning to education” [SR₂₀].

An interesting observation was that the students could see the value in the DLOs and their authentic assessment and, by extension, in their education more generally.

TH5 Confidence in Ability to Succeed in Studies

Two sub-themes emerged: [i] an initial lack of confidence in returning to education, and [ii] improved confidence in learning the course' technology requirements, particularly IESVE. The students reported that practical nature of the www.bess.ie website reinforced learning and improved their confidence in using IESVE. They valued the connection between content and

course materials. Usability and the practical nature of the resources were vital to engagement with 60% of survey respondents indicating that the website was intuitive and easy to follow. Paradoxically to their lack of confidence in returning to education, students indicated that they felt confident about their digital proficiency (see Table 6).

		How do you rate your digital literacy skills?									
		Very Poor					Extremely Good				
Scale		1	2	3	4	5	6	7	8	9	10
Survey Response		0	1	2	2	4	0	3	6	0	2

Table 6: Perceived Level of Digital Literacy

TH₆ Technological Skills Development

Although the least prominent of the themes, TH₆ suggests that the DLOs had a role in facilitating skills progression. Both students interviewed expressed satisfaction with their computer aided courses and retrospectively acknowledged the benefits of the DLOs in skill development and in articulating the relevance of those skills. They noted that the DLOs were intuitive and easy to navigate, that their content was not too challenging and that they would use the resources again, requesting additional videos and pdf instructions. In this respect, we believe that the blend of lectures and DLOs was successful. The website was well received and viewed positively by the students (Figure 9).

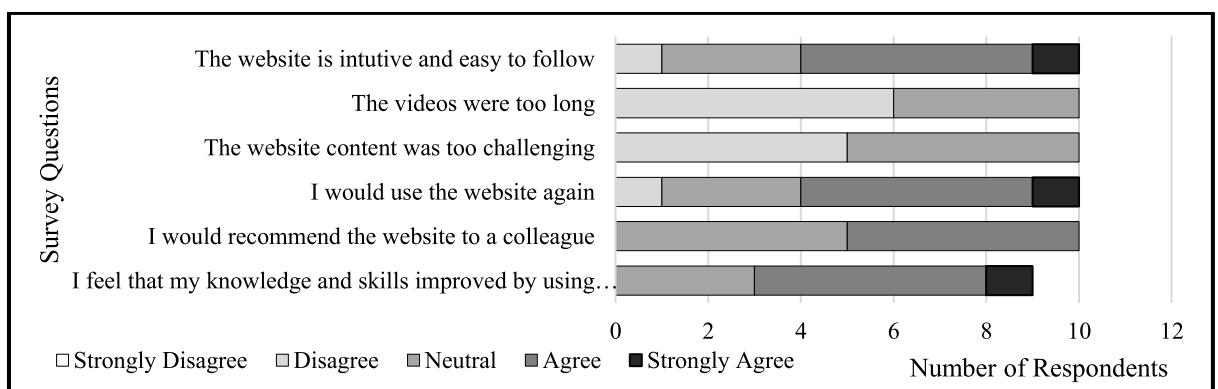


Figure 9: Responses to Building Engineering Software Support (BESS) Website

TH₃ Lifelong Learning

Whilst not contributing directly to answering RQ1 or RQ2, an additional theme of lifelong learning surfaced from the data. We explored the students' learning journeys in terms of routes to learning, family environment and prior education. Their motivation to learn appeared to be influenced not just by current circumstances but also by previous educational experience (Table 7).

	My educational experience to date has been ...									
	Very Poor					Extremely Good				
Scale	1	2	3	4	5	6	7	8	9	10
Survey Response	0	0	1	4	1	2	2	7	0	0

Table 7: Rating of Prior Educational Experience

Lifelong learning appeared to bring benefits to the students and to their employers. In responding to whether it had been worth returning to education, there was a resounding “yes”. In returning to the literature, we find that all the thematic areas in this study surface in the literature on mature learners. However, TH₁ Balancing Work, Life and Education appears to be largely emergent with little reference in the literature, apart from literature on mature learners (Table 8). This theme warrants further investigation to articulate a conceptual basis for the work-life-learning balance.

		THEMATIC AREAS					
		TH ₁ Balancing Work, Life Education	TH ₂ Motivation – Intrinsic & Extrinsic	TH ₃ Lifelong Learning	TH ₄ Positive Experiences of Education	TH ₅ Confidence to Succeed in Studies	TH ₆ Technological Skills Development
LITERATURE	Mature Learners	✓	✓	✓	✓	✓	✓
	Learning Theories		✓	✓	✓	✓	✓
	Engaging with Technology		✓			✓	✓
	Confidence and Engagement		✓	✓	✓	✓	✓

Table 8: Alignment Between Thematic and Literature

Concluding Remarks

For many institutions, mature learners are part of a new normality. Our study lends credence to the idea that mature learners become more intrinsically motivated with age. In particular, we advocate for industry-relevant skills development to be a consideration in designing DLOs. We find that integrating DLOs into a computer-aided course can enhance engagement and confidence. The students perceived that the www.bess.ie website accelerated their learning of IESVE. Website analytics indicated that DLO usage continued beyond the final assignment. Hence, we recommend that DLOs be used as a key tool in supporting the current COVID19 impacted learning environment.

Students who used the DLOs were successful in achieving the learning outcomes. The co-created DLOs and authentic assessment provided scaffolding to the IESVE student project work. Well-designed DLOs can, therefore, accelerate learning and facilitate learners to progress at their own pace. The website is limited to learning the basics of IESVE and not appropriate to advanced topics. We anticipate that more DLOs will be developed and expect that more students will engage.

Educators need to endeavour to connect with mature learners and to support their learning in an adaptable and encouraging environment. Whilst technology was an inherent aspect to our study, TH₆ Technological Skills Development was the least prominent theme. Implied in this, is our belief that our intervention reduced perceptions of technology as a concern, alleviating anxiety and fostering confidence. TH₃ Lifelong learning surfaced prominently. This may be in part due to the broad definition of a “mature student”. A comparative analysis of attitudes across student age groups could build on the conclusions reached in this study. Likewise, we recommend further follow-up with students who did not use the DLOs to allow for contrasting with the students in this study.

The study's limitations derive from its exploratory nature and qualitative methods. Yet, we took an approach appropriate to the context and research questions. Our findings are possibly transferrable to other engineering education contexts, despite the inherent bias in the participant voice.

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