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Students' digital technology attitude, literacy and self-efficacy and their effect on online learning engagement

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Abstract

This study utilised students' online engagement, digital technology attitude, digital literacy, and self-efficacy theories to develop and test a model connecting these factors within a regional university in Australia. A field survey collected data from 110 first-year students. AMOS 28 was employed for measurement and structural model path analysis. The study initially examined the impact of students' attitudes and digital literacy on their self-efficacy. Subsequently, the effects of self-efficacy on five dimensions of online engagement were assessed: social, collaborative, cognitive, behavioural, and emotional. The findings indicated that positive student attitudes and digital literacy significantly contributed to self-efficacy, which, in turn, positively affected the engagement dimensions. This suggests that when designing and facilitating online, blended, or technology-enhanced courses in higher education, educators should pay attention to various elements of engagement. The study highlights the importance of considering students' attitudes and digital literacy in fostering self-efficacy and enhancing online learning engagements. Further research and implications for future studies are also recommended.

Keywords: Engagement, Digital technology, Digital literacy, Self-efficacy, Online learning, Students

Introduction

Online learning is no longer a new phenomenon, having been progressively adopted by universities worldwide, beginning in the final decade of the twentieth century. It was introduced as an attractive option for universities seeking to expand their markets by offering flexible alternatives for students wanting to take courses without relocating (McGaughey et al., 2022; Xie et al., 2020). At the same time, online learning and teaching enabled universities to offer increased locational flexibility to staff and to engage staff who remained at a distance but offered otherwise unavailable expertise.

The manner of offering online learning has evolved, beginning with the conversion of distance education courses for internet offering and continuing through the development of Learning Management Systems (LMS), and the emergence of Massive Open Online Courses (MOOCs), until the expansion of online enrolments in higher

education now exceeds traditional modes (Dziuban et al., 2015). For example, Palvia et al. (2018) noted that online enrolments in the USA had increased for 14 consecutive years despite an apparent decline in total university enrolments for reasons including increasing costs and doubts about the cost-effectiveness of higher education for future employment opportunities. They noted similar growth in online education around the world.

According to Australian data, the percentage of domestic students starting their studies in a fully off-campus mode, primarily online, witnessed a rise from 17.5% in 2010 to 21.9% in 2015, with indications of continuous growth (Stone & O'Shea, 2019). Subsequently, this figure experienced a significant surge after 2019 due to the impact of COVID-19 (McGaughey et al., 2022). In addition to students studying fully off-campus, a proportion take courses in a mix of on-campus and off-campus modes (hybrid) selected to support other aspects of their lives. Stone and O'Shea (2019) also noted that students who were more vulnerable and thus needed additional support were more likely to enrol online. They included mature-age and first-in-family students, those with low socioeconomic status (SES) or disability, and those from regional or remote areas or first nations communities.

The already substantial growth of online offerings in higher education received a sudden boost when the COVID-19 pandemic forced campus closures, resulting in essentially all university courses being suspended or forced online (Bond et al., 2021; McGaughey et al., 2022). It "continues to turn—teaching and learning upside down" (Bond et al., 2021, p.1). Reflecting on the growth of online education and the impact of the pandemic potentially normalising online education, Xie et al. (2020) identified the advantages of online education as including flexibility, information accessibility, global reach, equity, innovation, and efficiency. However, they listed major drawbacks that would need to be addressed if online education were to become the 'new normal'. Those included network stability and technological constraints, lack of a sense of belonging and connectedness, presence of distractions, and lack of engagement. These advantages and disadvantages have been widely recognised and researched over the past two decades. Still, there remains more to be learned about what makes online education effective in different contexts and what can be done to improve it.

Although the development of online offerings has expanded the availability of higher education to students who would have difficulty accessing courses otherwise, it is not without its challenges (McGaughey et al., 2022). For example, a study in Australia found that, over eight years, only 46.6% of external or online students completed their qualifications compared with 76.6% of internal students and that online students were 2.5 times more likely to withdraw from the study without completing a qualification (Stone, 2019). Studies from other countries have also noted challenges with online education that must be addressed if the acknowledged benefits are to be maximised (Hurlbut, 2018; Palvia et al., 2018), these include enhancing student engagement (Nkomo et al., 2021). Hence research into factors that may influence the retention and progression of online students has a significant role in ensuring that the wastage of educational resources is minimised and the likelihood of student success is maximised.

This study will start by providing some background information on the key constructs followed by introducing the conceptual framework and hypothesis for the study and

presenting the results and discusion. Finally, implications from the findings of the study will be shared.

Background

In an editorial about interaction in distance education, Moore (1989) noted that the interaction of the learner with the content or subject of study is the essential condition for learning and suggested that the contributions of learner-teacher and learner-learner interaction might support it. The latter two were not easily supported in early distance education that relied solely on printed materials, but the introduction of teleconferencing reduced transactional distance through increased dialogue (Erdoğdu & Çakıroğlu, 2021; Moore, 1993). Online education has extended this development as technological advances have expanded the opportunities for learners to interact with teachers and peers.

Bağrıacık Yılmaz and Karataş (2022) cited a variety of research confirming the benefits of enhanced interaction for encouraging students to persist with courses. In their qualitative study with 40 stakeholders, including dropout students, from four Turkish institutions, they used the model proposed by Rovai (2003), which included four broad factors (and 37 sub-factors) influencing dropout: internal factors related to education, external or non-educational factors, student characteristics, and student skills. Social integration through interaction with other students and instructors notably influenced students' decisions regarding dropout.

As online education has expanded, there has been substantial effort toward enhancing its effectiveness through improving course design to enhance interaction and overcome issues such as those described above. One widely known instructional model is the Community of Inquiry (CoI) (Garrison et al., 2000) which suggests that learning occurs through educational experience in which learners and teachers interact through exhibiting three forms of presence–cognitive, social, and teaching–in combination. The paper also proposed a method for assessing the extent to which each form of presence is manifested in text-based online environments.

Since the CoI was first described, there have been numerous research studies based on the ideas expounded in the model, and courses have been designed to facilitate the effective development of presence to support the educational experience. For example, Shea and Bidjerano (2009) conducted a study with 2159 learners in a multi-institutional online learning network to validate an instrument for measuring teaching, social, and cognitive presence. They concluded that their instrument was effective for the purpose and found that social and teaching presence was positively correlated with cognitive presence, which they interpreted through an epistemic-engagement view that promotes learners as collaborative builders of knowledge.

Although Shea and Bidjerano (2009) did not explicitly examine engagement in their study, they linked the concept of epistemic engagement to cognitive presence with a clear implication that it is a variable worthy of closer examination. Other researchers have investigated the concept of engagement which emerged first in school education. From the 1990s, school engagement attracted interest in improving student achievement and reducing dropout rates (Fredricks et al., 2004; Wilhelm-Chapin & Koszalka, 2020). In their comprehensive review of the topic, Fredricks et al. (2004) discussed three

types of engagement, behavioural, emotional, and cognitive, described in the literature, along with the approaches taken by researchers to measuring engagement. Their review also dealt with research about the expected outcomes of increased engagement in the form of improved achievement and reduced dropout rates and the various antecedents of engagement at school, classroom, and individual levels. They concluded that the concept of engagement warrants a further explanation and identified significant gaps in the literature.

Although Fredricks et al. (2004) review focused on school education, it seems logical to expect that the same broad ideas would apply to online higher education with appropriate contextual adjustments. Meyer (2014) published an extensive review of literature related to student engagement in online learning, focusing on what works and why. Background literature addressed in the review included research based on CoI (Garrison et al., 2000) and transactional distance theory (Moore, 1993). Those ideas were used to support recommendations about effective instructional design for engagement and subsequently to discuss limits to student engagement and how they might be overcome.

In a separate review conducted by Hu and Li in Hu and Li (2017), various studies were examined, and it was found that they presented different perspectives on engagement by attributing two, three, or four dimensions to the concept. This suggests that the understanding and definition of engagement are still evolving and subject to ongoing development in the academic community. Notably, in some instances, these multiple dimensions were found to be interconnected, influencing both one another and students' active involvement in online courses.

Based on a review of relevant research and consultation with international experts in the field, Redmond et al. (2018) proposed an online engagement framework for higher education with five dimensions (Table 1), adding collaborative and social to the behavioural, emotional, and cognitive dimensions described by Fredricks et al. (2004). Although the paper did not include a developed instrument for measuring the proposed dimensions of engagement, it drew upon the literature to identify indicators for each dimension that could be used to develop measurement methods.

There is ample research evidence of a positive relationship between engagement and outcomes in online courses across various factors. Research, including studies by Kahu et al., (2013, 2020), has investigated the differing engagement levels of first-year students in higher education, focusing on how these variations affect retention and success.

Table 1 Online Learning Engagement Framework (Redmond et al., 2018, p. 190)

Engagement	Illustrative indicator
Social	Building community, creating a sense of belonging, developing relationships, and establishing trust
Cognitive	Thinking critically, activating metacognition, integrating ideas, justifying decisions, developing deep discipline understandings, and distributing expertise
Behavioural	Developing academic skills, identifying opportunities and challenges, developing multidisciplinary skills, developing agency, upholding online learning norms, supporting and encouraging peers
Collaborative	Learning with peers, relating to faculty members, connecting to institutional opportunities, and developing professional networks
Emotional	Managing expectations, articulating assumptions, recognising motivations, and committing to learning

Notably, the engagement of first-year students is distinct from other student groups, being influenced by a range of factors such as self-efficacy, sense of belonging, emotions, and overall well-being. Bolliger and Halupa (2018) reported a study involving 667 students enrolled at three private universities in the USA. They used previously published instruments to obtain measures of student engagement, transactional distance, and student outcomes. Student engagement was positively correlated with decreasing transactional distance resulting from stronger interactions with instructors and peers. Student outcomes were positively correlated with student engagement and decreased transactional distance, as indicated by satisfaction with courses and perceptions of progress toward learning goals. Yu (2022) conducted a bibliographic review and meta-analysis of global factors affecting online learning outcomes. After the screening of more than 30,000 results returned by database searches, 47 peer-reviewed journal articles were included for meta-analysis, which found nine factors with significant effects on online learning: behavioural intention, instruction, engagement, interaction, motivation, self-efficacy, performance, satisfaction, and self-regulation. Among those factors, engagement strongly influenced learning effectiveness and had positive relationships with self-regulation, satisfaction, and motivation (Lock et al., 2021). In turn, it was influenced by the difficulty of the material and teacher guidance.

Bote-Lorenzo and Gomez-Sanchez (2017) studied student engagement in a Massive Open Online Course (MOOC) which enrolled almost 27,000 students, of whom 1099 were awarded a certificate on completion of the 15-week course. They tracked the viewing of course videos, completion of comprehension questions, and submission of assignments across 12 weeks, using combinations of those measures to compute a total of 16 measures that were used to detect disengaging students who might be targeted for intervention. Their results suggested that such approaches might successfully guide interventions to increase persistence in online courses.

Theory and hypothesis development

Given the apparent benefits of engagement for increasing student persistence and outcomes, there is value in considering the antecedents of engagement (Fredricks et al., 2004) and what might be done such as attributes of students (Rotar, 2022) to enhance their effectiveness in promoting engagement and consequent student outcomes. Drawing on research that identified self-efficacy as a determinant of success in online learning, (Prior et al., 2016) conducted a study with 151 students enrolled in postgraduate online courses at a business school in Australia. They used structural equation modelling to validate a model in which student attitudes and digital literacy contribute to self-efficacy, which then had positive effects on interactions with the online system and instructor and on peer engagement, conceptualised as involving social and academic interaction with other students.

The central construct in the model developed by Prior et al. (2016), self-efficacy, was initially proposed by Bandura (1977) as determining whether a behaviour would be initiated and how long it would be continued in the face of challenges. Self-efficacy requires both necessary skills and the motivation to use them, in this case, to learn by engaging effectively with content and other participants through an online learning system. Items for measuring self-efficacy were adopted from Shen et al. (2013), as were the items for

the outcome measures of interaction and engagement. Attitude and digital literacy were measured using items adapted from Ng (2012). The attitude items focused on participants' responses to using digital technologies for learning. In contrast, those for digital literacy addressed general capabilities with digital technologies and the capacity to adapt to changing digital technologies. Bali (2016) highlighted that digital literacies go beyond just technical abilities, including a wider understanding of the issues, norms, and mental approaches related to using technology for defined purposes. Bali (2016) also distinguished between digital literacy and skills: digital skills focus on the selection and use of tools, while digital literacy involves more in-depth thinking, such as deciding when to use these tools.

Self-efficacy has been described as "the most central and pervasive mechanism of personal agency" (Bandura, 1997, p. 2) and is based on "beliefs in one's capabilities to organise and execute the courses of action required to produce given attainments" (p. 3). Prior research has identified challenges for retention and progression in online education (Bağrıacık Yılmaz & Karataş, 2022; Hurlbut, 2018; Palvia et al., 2018; Stone, 2019; Stone & O'Shea, 2019) and acknowledged the ameliorating benefits of engagement through interaction. Hence, there is value in exploring the effects of self-efficacy, which is associated with persistence in facing challenges (Bandura, 1977), on engagement in online learning. Paetsch and Drechsel's (2021) study highlights the crucial role of digital self-efficacy in shaping pre-service teachers (PSTs) intentions to integrate digital learning resources and technology into their future teaching practices. They define "digital technology attitude" as a range of personal evaluations towards digital technology, which can span from negative to positive. This attitude, influenced by beliefs, emotions, and past experiences with digital technology, forms a persistent and broad viewpoint. Research from Falloon (2020) and Paetsch and Drechsel (2021) emphasises the importance of a positive attitude towards digital technology for its effective use in teaching and learning. The shift to online teaching, amplified by the COVID-19 pandemic, underscores the importance for learners to adopt a positive attitude towards employing digital technology efficiently in various digitally-driven settings, as highlighted by Paetsch and Drechsel (2021).

This study builds on the model developed by Prior et al. (2016) by investigating the effects of self-efficacy on engagement using the online engagement framework proposed by Redmond et al. (2018) using the conceptual model shown in Fig. 1. Self-efficacy is adopted as the central construct with the same drivers, attitude and digital literacy, but with the outcome measures based on the five dimensions of online engagement. The model gives rise to seven hypotheses to be tested using structural equation modelling.

H1. Students' positive learning attitude contributes positively to self-efficacy in online learning

H2. Digital literacy contributes positively to digital technologies self-efficacy in online learning

H3. Self-efficacy positively predicts student online social engagement

H4. Self-efficacy positively to predicts student online cognitive engagement

H5. Self-efficacy positively to predicts student online behavioural engagement

H6. Self-efficacy positively to predicts student online collaborative engagement

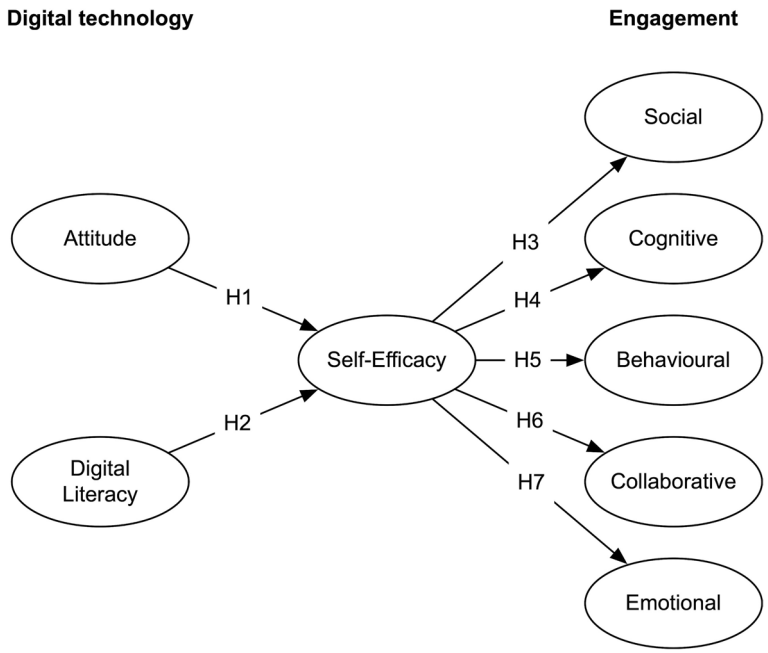

Fig. 1 The conceptual model for the study

H7. Self-efficacy positively to predicts student online emotional engagement

Methods

A survey method was employed in this study to gather responses from PSTs regarding their agreement with various items (see Tables 3 and 4). Data were collected after an ethics application was approved by the relevant university and school authority (Ethics approval number: ETH2021-0029). The survey items encompassed a range of statements designed to gauge the PSTs' opinions, attitudes, beliefs, or perceptions on topics relevant to the research objectives. By using a survey approach, we aimed to gain insights into the collective views and perspectives of these future teachers, thereby contributing valuable data to the study's overall analysis. Further details regarding the participants, survey instruments utilised, and the methods employed for data analysis are elaborated in the subsequent section.

Participants

Study participants (N = 110) were all undergraduate PSTs enrolled in the first semester of their predominantly four-year degree programs. An email inviting responses to the online survey was sent to PSTs in the third week of their first semester of study. The survey was open for 12 weeks. The survey included questions to elicit basic demographic data and a collection of Likert scale items using a 5-point scale (Strongly disagree = 1 to Strongly agree = 5). Groups of items for each of the constructs represented in the conceptual framework (Fig. 1) were developed based on items from previous studies that had demonstrated robust validity and reliability. In the present study, the validity and reliability of the instruments were assessed and documented in the results section.

Table 2 displays the demographic data of 110 participants who took part in the study. Regarding gender, 79.3% of the participants were female, while 16.2% were male, and 3.60% did not specify a gender. In terms of age, the majority of participants fell into the 15–25 years category, constituting 43.2% of the total; 26–35 years old accounted for 26.4%; 19.1% were in the 36–45 years group, and 10.9% were 46 years and above. We adopted an age scale starting at age 15 with equal intervals for categorical purposes, although it is worth noting that higher education typically commences at age 18.

When it came to study status, 44.5% of the participants were enrolled full-time, taking four courses per semester, while 53.6% were part-time students, undertaking fewer than four courses per semester. Regarding the programs they were enrolled in, 51.8% were pursuing a Bachelor of Education (Primary) (4 years), 28.2% were in the Bachelor of Education (Secondary) (4 years) program, and 15.5% were undertaking the Bachelor of Education (Early Childhood) (4 years). Only 1.80% were enrolled in the Bachelor of Early Childhood (3 years) program. As for the participants' current mode of study, 73.0% were taking all their courses online, while 13.5% were mainly on-campus with just one course being face-to-face. Additionally, 9.90% had balanced hybrid courses (about 50:50), and 1.80% were primarily studying online with only one course in a face-to-face setting.

Table 2 Demographic data of the participants (N = 110)

Demographic variables	N	%
Gender		
Female	88	79.3
Male	18	16.2
N/A	4	3.60
Total	110	99.1
Age		
15–25 Years	48	43.2
26–35 Years	29	26.4
36–45 Years	21	19.1
46 and above	12	10.9
Total	110	100
Study status		
Full-time (4 courses per semester)	49	44.5
Part-time (fewer than four courses per semester)	59	53.6
Total	108	98.2
Program enrolled		
Bachelor of Early Childhood (3 y)	2	1.80
Bachelor of Education (Early Childhood) (4 y)	17	15.5
Bachelor of Education (Primary) (4 y)	57	51.8
Bachelor of Education (Secondary) (4 y)	31	28.2
Total	107	97.3
Current mode of study		
Mainly on-campus (all but one course is face-to-face)	15	13.5
Mixture of on-campus and online/hybrid (about 50:50)	11	9.90
Mainly online (all but one course is online)	2	1.80
Online (all courses are online)	81	73.0
Total	109	98.2

Construct measures

The study adopted items from previously published research for all eight construct variables shown in the model (Fig. 1). Items for digital technologies attitudes, digital literacy, and self-efficacy for digital technologies were drawn from Prior et al. (2016). Items for dimensions of online engagement were based on Redmond et al. (2018).

Prior et al. (2016) studied the relationships among their selected variables as they related to learning behaviour in online distance education. They adopted items from Ng (2012) for measuring digital technologies attitudes and digital literacy and Shen et al. (2013) for self-efficacy for digital technologies. They measured digital technologies attitudes using seven items evaluating the degree of positivity toward digital technologies used for online learning. Their digital literacy scale comprised nine items focused on digital skills for online learning, such as the ability to learn digital technologies to solve technical problems easily. Finally, self-efficacy for digital technologies was assessed using an eight-item scale.

For this study, a few items were omitted because they did not fit the context (undergraduate teacher education versus postgraduate business education). Others were excluded when factor loadings were less than 0.5 (Hair et al., 2017). The remaining items had factor loadings above 0.50 and $\alpha > 0.70$ in the final measurement model (Table 3). As a result, the final instrument had 17 items across three subscales: digital technologies attitude (N = 5), digital literacy (N = 7), and self-efficacy for digital technologies (N = 5).

The online learning engagement framework for higher education proposed by Redmond et al.(2018) and comprising five dimensions (Table 1) was adopted to measure

Table 3 Factor loading for digital technologies attitude, digital literacy, and self-efficacy for digital technologies

Item	Loading
Digital technologies attitude α = 0.81	
1. Course leaders should use more digital technologies in their teaching of my classes	0.574
2. I am more motivated to learn when using digital technologies	0.775
3. Digital technologies make learning more interesting	0.731
4. I learn better when using digital technologies	0.628
5. I like using digital technologies for learning	0.736
Digital literacy α = 0.88	
1. I am familiar with issues related to web-based activities (e.g., cyber safety, search issues, plagiarism)	0.510
2. I have good digital technologies skills	0.826
3. I have the technical skills I need to use digital technologies to demonstrate my understanding of what I have learned	0.740
4. I know about a lot of different digital technologies	0.759
5. I keep up with important new digital technologies	0.813
6. I learn new digital technologies easily	0.818
7. I know how to solve my own technical problems with digital technologies	0.588
Self-efficacy for digital technologies α = 0.77	
1. I am able to complete an online course and achieve a good grade	0.573
2. I am able to successfully complete all of the required online activities	0.811
3. I am able to keep up with a course schedule	0.662
4. I am able to create a plan to complete the course assignments	0.660
5. I am able to adapt my learning styles to meet course expectations	0.571

student engagement in this study. They recommended the framework as an "audit tool or point of reference" (p. 196) and identified multiple indicators for each dimension. Therefore, the survey for this study included five items aligned to indicators for each of the five dimensions. However, only four items from each construct with factor loadings higher than 0.50 were included in the analysis (Hair et al., 2017), with the results shown in Table 4.

Results

Analysis followed a two-step procedure as recommended by Hair (2010). After the measurement model was evaluated, and the causal structure implied by the proposed model was assessed.

Measurement validation

Confirmatory Factor Analysis (CFA) using AMOS version 28 was undertaken to determine the reliability and validity of the measurement approach. Preliminary reliability analyses (see Table 5) revealed that the composite reliability scores of all the constructs were above the minimum threshold (CR > 0.70). The fit of the CFA for the study conducted is acceptable, with $\chi 2 = 889.552$, $df = 598$, $\chi 2/df = 1.488$, $p < 0.01$)

Table 4 Factor loading for online learning engagement dimensions

Item	Loading
Social Engagement α = 0.75	
1. I am able to seek help from the course leader when needed	0.763
2. I prefer online courses that develop a sense of community among participants	0.562
3. A good online course is one in which I have a sense of belonging	0.701
4. I enjoy developing relationships with other participants during an online course	0.591
Emotional Engagement α = 0.79	
1. I work best when I know clearly what to expect at each stage in an online course	0.732
2. It is helpful when the introduction to an online course explains clearly what prior knowledge is assumed	0.703
3. Online courses should provide for students with different circumstances and needs	0.602
4. I learn more effectively when an online course makes it clear what I need to do to succeed	0.756
Collaborative engagement α = 0.72	
1. Working with other students in an online course helps me to learn more effectively	0.636
2. Interacting with teaching staff in an online course helps me to succeed with learning	0.640
3. I appreciate when an online course alerts me to wider opportunities at the university	0.545
4. Getting to know other students in an online course is an aid to building my professional network	0.696
Behavioural engagement α = 0.70	
1. I appreciate opportunities to check my learning through quizzes and other activities	0.583
2. Online courses should include support for developing broader academic skills	0.567
3. I make an effort to support and encourage other participants in an online course	0.629
4. A well designed online course offers opportunities for regular interaction with other participants	0.620
Cognitive engagement α = 0.81	
1. An online course should challenge me to ask questions about what I am learning	0.672
2. A well designed online course explains how important concepts of the course are connected	0.780
3. I enjoy online courses that deepen my understanding of discipline content	0.700
4. I appreciate opportunities to check my learning through quizzes and other activities	0.709

Table 5 Correlations, mean, standard deviations, average variance extracted and composite reliability

	Factor	1	2	3	4	5	6	7	8
1	Attitude	1							
2	Digital Literacy	0.569*	1						
3	Digital efficacy	0.489*	0.311	1					
4	Social	. 281	0.168	0.406*	1				
5	Cognitive	0.315	0.266	0.477*	0.508	1			
6	Behavioural	0.423	0.347	0.675*	0.880	0.894	1		
7	Collaborative	0.357	0.217	0.414*	0.963	0.746	0.965	1	
8	Emotional	0.210	0.326	0.447*	0.401	0.928	0.807	0.555	1
M		3.70	3.77	3.95	3.86	4.22	4.10	3.94	4.41
SD		0.56	0.65	0.49	0.60	0.54	0.52	0.58	0.48
AVE		0.50	0.54	0.44	0.44	0.51	0.36	0.40	0.50
CR		0.82	0.89	0.79	0.75	0.81	0.70	0.73	0.79

*Correlation significant at the 0.05 level. Notes: All values are significant at $p < 0.05$, $N = 110$, where *M* Mean, *SD* standard deviation, *AVE* average variance extracted, *CR* composite reliability

(Kline, 2011). The model has a comparative fit index (CFI) of 0.840, a Tucker Lewis index (TLI) of 0.822, and an incremental fit index (IFI) of 0.846, with each of these figures representing an acceptable fit as they approach a score of one (Byrne, 2012; Kline, 2011). The root mean standard error of approximation (RMSEA) score is 0.067, indicating a good fit since it is within the recommended range of 0.05 to 0.08 (Byrne, 2012; Kline, 2011). The inter-construct correlations suggest that discriminant validity is present in most cases since most scores do not exceed the threshold of 0.8 (Fornell & Larcker, 1981) (see Table 5).

Further analyses showed that the AVE for four of the eight final constructs satisfies the suggested minimum threshold of 0.50 (Fornell & Larcker, 1981; Hair, 2010). However, some constructs (self-efficacy, social, behavioural, collaborative) have AVE values below the threshold. This is acceptable for two reasons. The composite reliabilities are higher than 0.6 (Fornell & Larcker, 1981) and the study was conducted for the first time employing a new model (El-Tah & Jaradat, 2018; Lee, 2012; Ping, 2009). Hence, the measurement model is an acceptable fit to the data from the sample and the seven-factor model, and it is possible to identify the relations between each pair of constructs.

Causal structure analysis

Structural equation modelling in AMOS version 28 was used to test the relationships among the constructs. The hypotheses proposed above focus on the direct relationships between constructs in the model (Fig. 1). Confirmatory factor analysis established that the fit indices for the model fell within the accepted range in social science studies. The results for subsequent path analysis are shown in Table 6.

The model (Fig. 1) posited two factors, attitude and literacy, affecting self-efficacy for digital technologies. The results indicated a significant effect of digital technologies attitude on self-efficacy for digital technologies ($\beta = 0.349$, $t = 2.016$, $\rho < 0.005$),

Table 6 Causal structure analysis results

Hypothesis	*β*	Standard error	*t*-value	Decision
H1: Efficacy < – Attitude	0.349	0.080	2.016*	Accept
H2: Efficacy < – Literacy	0.122	0.049	0.989	Reject
H3: Social < – Efficacy	0.773	0.840	3.168*	Accept
H4: Cognitive < – Efficacy	0.838	0.651	3.156*	Accept
H5: Behavioural < – Efficacy	1.060	0.587	3.127*	Accept
H6: Collaborative < – Efficacy	0.894	0.746	3.083*	Accept
H7: Emotional < – Efficacy	0.743	0.533	3.106*	Accept

(N = 110), * t-values are significant at $p < 0.05$

thus supporting hypothesis one. However, the analysis showed that the effect of digital technology literacy on self-efficacy for digital technologies was positive but not significant ($\beta = 0.122$, $t = 0.989$, $\rho = 0.369$); hence, hypothesis two was not supported.

The study also assessed the impact of self-efficacy for digital technologies on various dimensions of online learning engagement. Self-efficacy for digital technologies appeared to have positive effects on the five dependent engagement constructs. PSTs' self-efficacy for digital technologies significantly affects social engagement ($\beta = 0.773$, $t = 3.168\_p < 0.005$), cognitive engagement ($\beta = 0.838$, $t = 3.156$, $p < 0.005$), behavioural engagement ($\beta = 0.1.060$, $t = 3.127$, $p < 0.005$), collaborative engagement ($\beta = 0.894$, $t = 3.083$, $p < 0.005$) and emotional engagement ($\beta = 0.743$, $t = 3.106$, $p < 0.005$). These results supported hypotheses four, five, six and seven.

Discussion

Self-efficacy has been studied in various contexts as it is an important factor for successful students learning and performance results. This study examines two crucial sets of self-efficacies in the context of digital technologies and online learning in higher education. These relationships are framed in seven hypotheses (see Fig. 1). The study explores the roles of digital technology attitude and literacy in achieving digital technology self-efficacy in online learning and the effects of digital technology on self-efficacy on online learning engagement behaviours. Each is discussed in the following section.

Digital technology attitude, literacy, and self-efficacy

One of the focuses of this study was exploring the roles of digital technology attitude and literacy in achieving digital technology self-efficacy. There is a general recognition that attitude and digital literacy have important learning influences that impact self-efficacy in online learning in higher education (e, g, Barton & Dexter, 2020; Prior et al., 2016). For example, Prior et al. (2016) findings from an online survey of Australian postgraduate business students showed that positive student attitude and digital literacy significantly contribute to self-efficacy.

The current study showed that a positive student digital technology attitude significantly contributes to digital technology self-efficacy; however, the effect of digital technology literacy on self-efficacy for digital technologies was positive but not significant. The result showing that the effect of positive digital technology literacy on digital technology self-efficacy is not significant could be due to various reasons. First, the use of

digital technologies is part of everyday life; hence, the set of skills integrating digital literacy is expected to be important in online learning. However, digital technology literacy can arguably be broad (Spante et al., 2018). It can include using technologies to retrieve, assess, store, produce, present and exchange information and to communicate and participate in online learning (Spante et al., 2018). In the current study, students might associate digital technology literacy with only some aspect of it, resulting in an insignificant influence on their digital technology self-efficacy. Second, digital technology literacy can be formed by students' earlier experiences with using digital devices successfully or not (Hammer et al., 2021). Third, participants of the current study are first-year undergraduate students who have no rich prior experience in using digital technologies in online learning in higher education which might influence their digital technology literacy rating.

Similarly, Belshaw (2013) argued that questions remain regarding the connection between the basic knowledge and literacy developed using a device and the conscious and unconscious decisions one makes when using digital technology. This could be described as having digital technology literacy. In conclusion, although several studies showed that positive student digital technology attitudes supported self-efficacy (Barton & Dexter, 2020; Bonnes et al., 2020; Prior et al., 2016), in this study, however, this may not be the case when considering undergraduate students with little prior online learning experience.

Similar to other studies (e.g., Bonnes et al., 2020; Prior et al., 2016), the current study results showed that students' digital technology attitudes contribute positively to their digital technology self-efficacy. Therefore, as attitude implicitly guides action, a positive attitude should be encouraged to enhance students' confidence to learn online, which requires integrating digital technologies.

Online engagement and digital technology self-efficacy

The second set of hypotheses in the current study focused on the influence of self-efficacy on students online learning engagement. This study's results showed a positive relationship between all five engagement constructs and self-efficacy for digital technologies. Several studies showed similar results (e.g., Barton & Dexter, 2020; Prior et al., 2016; Singh et al., 2022). However, the current study redefined engagement concerning the five dimensions discussed below.

Social engagement

Social engagement is centred around relationship building and a sense of belonging. It also reduces students' feelings of isolation, a common factor amongst online learners. The data from this study indicated that four of the five indicators of social presence had suitable factor loadings, suggesting that digital technologies' self-efficacy positively affects learner engagement. This finding supports the hypothesis that self-efficacy positively influences student online social engagement. Items with high loadings include seeking help when needed, developing relationships, and a sense of community and belonging within the student cohort. The item removed was related to participants in online courses benefiting when they are seen as having lives outside of class.

The participants in this study revealed that social engagement and students' digital technology self-efficacy contributed to their ability to complete an online course successfully. While investigating the success of Rural Students in Elite Universities, Zeng et al. (2022) also found that students' learning benefits from social engagement. Kim et al. (2015) found other benefits of social engagement, who found that social interactions and feelings of connectedness strongly correlated with student motivation. In contrast, Bowden et al. (2021) found that although social engagement is necessary for learning experiences, it does not provide conditions for student success.

Cognitive engagement

Cognitive engagement is related to a deep understanding of the discipline, enabling students to integrate ideas from previous knowledge into new knowledge. This type of engagement is often considered the most important type of engagement (Bowen, 2005), where students are intellectually engaged in the course. It is related to concepts such as critical thinking, metacognition and sustained engagement with activities, discipline knowledge and deep learning. With a Cronbach's alpha coefficient of 0.81 indicates reliability of the items. Of the five types of engagement, this had the highest level of internal consistency.

The data analysis confirms hypothesis 4 that digital technology self-efficacy positively contributes to cognitive engagement. The four items with the highest alignment to cognitive engagement were related to asking a question, explaining concept connections, deep discipline knowledge, and the ability to check learning. The item which was removed was I learn best when online courses encourage me to think about how I learn. This is surprising given it is directly linked to metacognition. Researchers have found relationships between metacognition and engagement. For example, Wang et al. (2021) suggested metacognition is a strong predictor of positive student engagement, while Redmond et al. (2018) review of cognitive engagement supports the links between metacognition and cognitive engagement. Dunn and Kennedy (2019) also found correlations between technology-enhanced learning and cognitive engagement, impacting academic achievement.

Behavioural engagement

Behavioural engagement is related to a student's active participation in course based and extracurricular activities by adhering to norms and rules. It may also be referred to as skills engagement, agency engagement, academic engagement, and self-regulated behaviours (Redmond et al., 2018). Data from this study confirm hypothesis 5, digital technology self-efficacy contributes positively to student online behavioural engagement. Items with strong positive correlations related to checking for understanding, developing academic skills, supporting peers, and regularly online interaction with others. The item removed was Online courses should include information to assist participants with behaving appropriately. As instructors, we see the benefits of this type of information, but it appears that students do not.

The authors found a dearth of research at the intersection of behavioural engagement, self-efficacy and digital technologies. Perhaps this is because researchers avoid reporting on negative results. In one of the few studies that did report, Dunn and Kennedy

(2019) found no correlations between technology-enhanced learning and behavioural engagement.

Collaborative engagement

Collaborative engagement refers to connecting with and collaborating with others, such as peers, faculty, or industry, to develop personal and professional networks. It might also be referred to as professional engagement, campus environment, and learning with peers (Redmond et al., 2018). These networks support professionals they are studying and beyond their initial teacher education experience. The results from this data set confirm hypothesis 6, that digital technology self-efficacy contributes positively to student online collaborative engagement.

The four items with strong correlation were related to working with peers, interacting with teaching staff, communicating university opportunities, and building a professional network. The item with a low correction was Working on projects with other students in an online course develops critical professional skills. This is surprising given universities and employers' desire to build skills in collaboration such as communication, teamwork, active listening, relationship management and social and cultural awareness as crucial employability skills (Australian Industry & Skills, Committee, 2022). Perhaps PSTs perceive that they will be 'going it alone' in the classrooms and will not have the opportunity to work with others. As a result, there is no motivation to do so to develop these interpersonal and professional skills, or that collaborative professional skills are not valued by them. The Australian Institute for Teaching and School Leadership (AITSL) (2021) revealed that collaboration is critical for teachers to assist them in collecting evidence or data, understanding new data, interpreting the data, and considering the implications of the data findings for their future practice.

Emotional engagement

Emotional engagement relates to a student's motivations, emotions, or attitudes toward the learning environment. This includes the people in the environment, teachers and peers, the content, the activities, and the institution. Results from the data indicate that the following four of the indicators had high loadings: 'I work best when I know clearly what to expect at each stage in an online course'; 'It is helpful when the introduction to an online course explains clearly what prior knowledge is assumed'; 'Online courses should provide for students with different circumstances and needs'; 'I learn more effectively when an online course makes it clear what I need to do to succeed'. The item removed was 'I am comfortable expressing my feelings in an online course'. Affective indicators, including the expression of emotion or feelings, are a key part of the development of a CoI (Sung & Mayer, 2012).

Self-efficacy for digital technologies appeared to positively affect the emotional engagement of participants in this study which supports hypothesis seven. Positive emotional engagement has been aligned with behaviours such as self-regulated learning, problem-solving, behavioural intent and student satisfaction (Luo et al., 2019). Positive correlations have also been found between technology-enhanced learning, emotional engagement, and academic achievement (Dunn & Kennedy, 2019). In contrast, Sun

and Rueda (2012) found no correlation between emotional engagement and computer self-efficacy.

Implications, limitations, and future research

Teacher self-efficacy is critical because it positively affects students, including improved learning outcomes (Caprara et al., 2006; Pfitzner-Eden, 2016). In this study, self-efficacy for digital technologies appears to predict the students' engagement with all five elements of the online engagement framework (Redmond et al., 2018). This follows Redmond et al's. (2018) suggestion for a redefined perspective on engagement, moving beyond the conventional focus on face-to-face interactions. They proposed expanding the traditional model, which includes three components of engagement (behavioural, emotional, and cognitive), to encompass five elements: cognitive, behaviour, collaborative, emotional, and social.

Several implications fall out of these results: (i)educators who teach in higher education in online or blended modes should consider all engagement elements in their learning design; (ii) educators must consider their involvement in students online engagement as they facilitate their students' online learning; (iii) those involved in teacher education need to build the knowledge and skills of teacher for explicit and effective online engagement for students; (iv) the participants in the study were first year PSTs and during the initial stage of their program, students may not fully comprehend the scope of their lack of knowledge. As they progress through their teacher education program, their exploration of new technology tools, teaching and learning methodologies for the digital age, and considerations for digital literacy are likely to evolve and adapt. The dynamic nature of their educational journey will lead to changing perspectives and a deeper understanding of these aspects. Therefore, a thorough understanding of the unique characteristics of first-year students is crucial. It can help in pinpointing the factors that contribute to disengagement, and potentially lead teacher educators to identify strategies that can break the cycles of disengagement (Kahu et al., 2020). Finally, these results raise the importance of engagement for online learners in higher education, especially those new to online learning. It is critical they are supported and experience successful learning outcomes if we wish them to continue their studies in the online mode.

This study has limitations. It has limited generalisability of the findings because of the participant's nature and small sample size within a regional university in Australia. In addition, the results are based on self-reports, so details about why some factors contributed to self-efficacy more than others would require additional qualitative data from focus groups, in-depth interviews, or a deep dive into the participants' online interactions. Having said that, Henrie et al. (2015) and Vongkulluksn et al. (2020) revealed that self-reporting cognitive engagement with technology might be the best way to reveal these relationships, especially when compared to teacher-reported or tool-centric measures. Ultimately, participants who completed the online survey would have a propensity toward having digital literacies, which may influence the data.

Identifying the causal relationship between online learning engagement dimension could benefit future studies. The low AVE for some of the constructs is considered one of the limitations of this study. Hence, the study should be further tested with large data for replication. Future studies could also test it within other disciplines, universities, and

cultures. Items from the online engagement framework with a low loading might indicate that they should be permanently removed from the scale. However, a much larger cohort of participants across undergraduate and postgraduate students and instructors in different disciplines and universities should occur before their removal.

Conclusion

Self-efficacy has been researched extensively because of its significant effects on students' learning and performance. This study examines the influence of digital technology attitude and efficacy on digital literacy and the influence of digital technology on student online learning engagement. It contributes to the field through it's quantitative exploration of the five elements of online engagement and the unique intersection between engagement, attitude, digital literacy and self-efficacy.

This study's findings supported that digital technology attitude significantly positively affects self-efficacy. However, contrary to other studies' findings, this study's results did not support the assumption that positive digital technology literacy contributes to positive students' digital technology self-efficacy. This result might have two implications: (i) although digital technology attitude and literacy have an important influence on student digital technology self-efficacy in online learning in higher education, their digital technology efficacy could be varied due to earlier experiences with using digital devices either successfully or not and their understanding of the definition of digital technologies. Therefore, the influence of experiences and a broader definition of digital technology efficacy should be recognised in the online learning environment. (ii) positive digital technology self-efficacy plays a critical role in the online learning environment. Hence, factors that contribute positively to it should be encouraged, including a positive digital technology attitude.

This study showed that positive digital technology self-efficacy plays a critical role in online learning engagement. Students' online engagement is considered a strong predictor of students' learning achievements; as a result, engagement has been rigorously researched in various contexts. This study explored digital self-efficacy's effect on five dimensions of online learning engagement, expanding beyond the typical focus on three types in prior research. The results showed that self-efficacy for digital technologies appears to predict the students' engagement with all five elements. This result implies that as educators in higher education design and facilitate online, blended or technology-enhanced courses, attention should be paid to all five engagement elements.

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Availability of data and materials
The datasets generated during and/or analysed during the current study are available from the corresponding author upon reasonable request.

Declarations

Competing interests
The authors declare that they have no competing interests.

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References

Australian Institute for Teacher and School Leadership. (2021). *Collaborative teaching: sharing best practice*. Retrieved March 2023 from https://www.aitsl.edu.au/research/collaborate/collaborative-teaching-sharing-best-practice

Australian Industry and Skills Committee. (2022). *Collaboration skills*. Retrieved March 2023 from https://nationalindustryinsights.aisc.net.au/national/collaboration-skills#:~:text=Skills%20that%20enhance%20collaboration%20include,and%20social%20and%20cultural%20awareness.

Bağrıacık Yılmaz, A., & Karataş, S. (2022). Why do open and distance education students drop out? Views from various stakeholders. *International Journal of Educational Technology in Higher Education, 19*(1), 28. https://doi.org/10.1186/s41239-022-00333-x

Bali, M. (2016). Knowing the difference between digital skills and digital literacies, and teaching both. Retrieved 22 Nov 2023 from https://www.literacyworldwide.org/blog/literacy-now/2016/02/03/knowing-the-difference-between-digital-skills-and-digital-literacies-and-teaching-both.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191–215. https://doi.org/10.1037/0033-295X.84.2.191

Bandura, A. (1997). *Self-efficacy: The exercise of control*. Freeman.

Barton, E. A., & Dexter, S. (2020). Sources of teachers' self-efficacy for technology integration from formal, informal, and independent professional learning. *Educational Technology Research and Development, 68*, 89–108. https://doi.org/10.1007/s11423-019-09671-6

Bolliger, D. U., & Halupa, C. (2018). Online student perceptions of engagement, transactional distance, and outcomes. *Distance Education, 39*(3), 299–316. https://doi.org/10.1080/01587919.2018.1476845

Bond, M., Bedenlier, S., Marín, V. I., & Händel, M. (2021). Emergency remote teaching in higher education: Mapping the first global online semester. *International Journal of Educational Technology in Higher Education, 18*(1), 1–24. https://doi.org/10.1186/s41239-021-00282-x

Bonnes, C., Leiser, C., Schmidt-Hertha, B., Rott, K. J., & Hochholdinger, S. (2020). The relationship between trainers' media-didactical competence and media-didactical self-efficacy, attitudes and use of digital media in training. *International Journal of Training and Development, 4*(1), 74–88. https://doi.org/10.1111/ijtd.12171

Bote-Lorenzo, M. L., & Gómez-Sánchez, E. (2017, March). Predicting the decrease of engagement indicators in a MOOC. In *Proceedings of the Seventh international learning analytics & knowledge conference* (pp. 143–147).

Bowden, J.L.-H., Tickle, L., & Naumann, K. (2021). The four pillars of tertiary student engagement and success: A holistic measurement approach. *Studies in Higher Education, 46*(6), 1207–1224. https://doi.org/10.1080/03075079.2019.1672647

Bowen, S. (2005). Engaged learning: Are we all on the same page. *Peer Review, 7*(2), 4–7.

Byrne, B. M. (2012). *Structural equation modelling with Mplus: Basic concepts, applications, and programming*. Routledge.

Caprara, G. V., Barbaranelli, C., Steca, P., & Malone, P. S. (2006). Teachers' self-efficacy beliefs as determinants of job satisfaction and students' academic achievement: A study at the school level. *Journal of School Psychology, 44*(6), 473–490. https://doi.org/10.1016/j.jsp.2006.09.001

Dunn, T. J., & Kennedy, M. (2019). Technology enhanced learning in higher education; motivations, engagement and academic achievement. *Computers & Education, 137*, 104–113. https://doi.org/10.1016/j.compedu.2019.04.004

Dziuban, C. D., Picciano, A. G., Graham, C. R., & Moskal, P. D. (Eds.). (2015). *Conducting research in online and blended learning environments: New pedagogical frontiers*. Routledge. 10.4324/9781315814605.

El-Tah, Z. K. R., & Jaradat, M.-I.R.M. (2018). The big five personality traits and their relationship with the intensity of using Facebook: A developing country perspective. *International Journal of Business Information Systems, 27*(4), 512–537. https://doi.org/10.1504/IJBIS.2018.090290

Erdoğdu, F., & Çakıroğlu, Ü. (2021). The educational power of humor on student engagement in online learning environments. *Research and Practice in Technology Enhanced Learning, 16*(1), 1–25. https://doi.org/10.1186/s41039-021-00158-8

Falloon, G. (2020). From digital literacy to digital competence: The teacher digital competency (TDC) framework. *Educational Technology Research and Development, 68*, 2449–2472. https://doi.org/10.1007/s11423-020-09767-4

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39–50. https://doi.org/10.1177/002224378101800104

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*(1), 59–109. https://doi.org/10.3102/00346543074001059

Garrison, D. R., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education, 2*(2), 87–105. https://doi.org/10.1016/S1096-7516(00)00016-6

Hair, J. F. (2010). *Multivariate data analysis: A global perspective* (7th ed.). Pearson Education.

Hair, J. F., Matthews, L. M., Matthews, R. L., & Sarstedt, M. (2017). PLS-SEM or CB-SEM: Updated guidelines on which method to use. *International Journal of Multivariate Data Analysis, 1*(2), 107–123. https://doi.org/10.1504/IJMDA.2017.087624

Hammer, M., Scheiter, K., & Stürmer, K. (2021). New technology, new role of parents: How parents' beliefs and behavior affect students' digital media self-efficacy. *Computers in Human Behavior, 116*, 106642. https://doi.org/10.1016/j.chb.2020.106642

Henrie, R. R., Halverson, L., & Graham, C. R. (2015). Measuring student engagement in technology-mediated learning: A review. *Computers & Education, 90*, 36–53. https://doi.org/10.1016/j.compedu.2015.09.005

Hu, M., & Li, H. (2017, June). Student engagement in online learning: A review. *2017 International Symposium on Educational Technology (ISET)*, 39–43. https://doi.org/10.1109/ISET.2017.17

Hurlbut, A. R. (2018). Online vs. traditional learning in teacher education: A comparison of student progress. *American Journal of Distance Education, 32*(4), 248–266. https://doi.org/10.1080/08923647.2018.1509265

Kahu, E. R., Picton, C., & Nelson, K. (2020). Pathways to engagement: A longitudinal study of the first-year student experience in the educational interface. *Higher Education, 79*, 657–673. https://doi.org/10.1007/s10734-019-00429-w

Kahu, E. R., Stephens, C., Leach, L., & Zepke, N. (2013). The engagement of mature distance students. *Higher Education Research & Development, 32*(5), 791–804. https://doi.org/10.1080/07294360.2013.777036

Kim, Y., Glassman, M., & Williams, M. S. (2015). Connecting agents: Engagement and motivation in online collaboration. *Computers in Human Behavior, 49*, 333–342. https://doi.org/10.1016/j.chb.2015.03.015

Kline, R. B. (2011). Convergence of structural equation modeling and multilevel modeling. In M. Williams & W. P. Vogt (Eds.), *The SAGE Handbook of Innovation in Social Research Methods*. SAGE Publications Ltd. 10.4135/9781446268261.n31.

Lee, Y. H. (2012). *Antecedents and Consequences of Emotional Labor in Head Coaches of NCAA Division I Program* [Doctoral dissertation thesis, Ohio State University]. Reterived on March 24, 2023 from https://etd.ohiolink.edu/apexprod/rws_etd/send_file/send?accession=osu1338400126

Lock, J., Lakhal, S., Cleveland-Innes, M., Arancibia, P., Dell, D., & De Silva, N. (2021). Creating technology-enabled lifelong learning: A heutagogical approach. *British Journal of Educational Technology, 52*(4), 1646–1662. https://doi.org/10.1111/bjet.13122

Luo, Y., Xie, M., & Lian, Z. (2019). Emotional engagement and student satisfaction: A study of Chinese college students based on a nationally representative sample. *Asia-Pacific Education Research, 28*, 283–292. https://doi.org/10.1007/s40299-019-00437-5

McGaughey, F., Watermeyer, R., Shankar, K., Suri, V. R., Knight, C., Crick, T., ... & Chung, R. (2022). 'This can't be the new norm': academics' perspectives on the COVID-19 crisis for the Australian university sector. *Higher Education Research & Development*, *41*(7), 2231–2246. https://doi.org/10.1080/07294360.2021.1973384

Meyer, K. A. (2014). Student engagement in online learning: What works and why. *Higher Education Report, 40*(6), 1–114. https://doi.org/10.1002/aehe.20018

Moore, M. G. (1989). Three types of interaction. *American Journal of Distance Education, 3*(2), 1–6. https://doi.org/10.1080/08923648909526659

Moore, M. G. (1993). Theory of transactional distance. In D. Keegan (Ed.), *Theoretical principles of distance education* (pp. 22–38). Routledge.

Ng, W. (2012). Can we teach digital natives digital literacy? *Computers & Education, 59*(3), 1065–1078. https://doi.org/10.1016/j.compedu.2012.04.016

Nkomo, L. M., Daniel, B. K., & Butson, R. J. (2021). Synthesis of student engagement with digital technologies: A systematic review of the literature. *International Journal of Educational Technology in Higher Education, 18*, 1–26. https://doi.org/10.1186/s41239-021-00270-1

Paetsch, J., & Drechsel, B. (2021). Factors influencing pre-service teachers' intention to use digital learning materials: A study conducted during the COVID-19 pandemic in Germany. *Frontiers in Psychology, 12*, 733830. https://doi.org/10.3389/fpsyg.2021.733830

Palvia, S., Aeron, P., Gupta, P., Mahapatra, D., Parida, R., Rosner, R., & Sindhi, S. (2018). Online education: Worldwide status, challenges, trends, and implications. *Journal of Global Information Technology Management, 21*(4), 233–241. https://doi.org/10.1080/1097198X.2018.1542262

Pfitzner-Eden, F. (2016). Why do I feel more confident? Bandura's sources predict pre-service teachers' latent changes in teacher self-efficacy. *Frontiers in Psychology, 7*, 1486. https://doi.org/10.3389/fpsyg.2016.01486

Ping, R. A. (2009). Is there any way to improve Average Variance Extracted (AVE) in a Latent Variable (LV) X (Revised). Retrieved from http://home.att.net/~rpingjr/ImprovAVE1.doc

Prior, D. D., Mazanov, J., Meacheam, D., Heaslip, G., & Hanson, J. (2016). Attitude, digital literacy and self efficacy: Flow-on effects for online learning behavior. *The Internet and Higher Education, 29*, 91–97. https://doi.org/10.1016/j.iheduc.2016.01.001

Redmond, P., Abawi, L., Brown, A., Henderson, R., & Heffernan, A. (2018). An online engagement framework for higher education. *Online Learning Journal, 22*(1), 183–204. https://doi.org/10.24059/olj.v22i1.1175

Rotar, O. (2022). Online student support: A framework for embedding support interventions into the online learning cycle. *Research and Practice in Technology Enhanced Learning, 17*(1), 1–23. https://doi.org/10.1186/s41039-021-00178-4

Rovai, A. P. (2003). In search of higher persistence rates in distance education online programs. *The Internet and Higher Education, 6*(1), 1–16. https://doi.org/10.1016/S1096-7516(02)00158-6

Shea, P., & Bidjerano, T. (2009). Community of inquiry as a theoretical framework to foster "epistemic engagement" and "cognitive presence" in online education. *Computers & Education, 52*(3), 543–553. https://doi.org/10.1016/j.compedu.2008.10.007

Shen, D., Cho, M.-H., Tsai, C.-L., & Marra, R. (2013). Unpacking online learning experiences: Online learning self-efficacy and learning satisfaction. *The Internet and Higher Education, 19*, 10–17. https://doi.org/10.1016/j.iheduc.2013.04.001

Singh, A., Gulati, M., Kumar, M., Khadse, K., & Kishore, R. (2022). The impact of self-efficacy on student engagement in online learning: Mediating the role of motivation. *Journal of Positive School Psychology, 6*(6), 8528–8536.

Spante, M., Hashemi, S. S., Lundin, M., & Algers, A. (2018). Digital competence and digital literacy in higher education research: Systematic review of concept use. *Cogent Education, 5*(1), 1519143. https://doi.org/10.1080/2331186X.2018.1519143

Stone, C. (2019). Online learning in Australian higher education: Opportunities, challenges and transformations. *Student Success, 10*(2), 1–11. https://doi.org/10.5204/ssj.v10i2.1299
Stone, C., & O'Shea, S. (2019). Older, online and first: Recommendations for retention and success. *Australasian Journal of Educational Technology, 35*(1), 57–69. https://doi.org/10.14742/ajet.3913
Sun, J. C. Y., & Rueda, R. (2012). Situational interest, computer self-efficacy and self-regulation: Their impact on student engagement in distance education. *British Journal of Educational Technology, 43*(2), 191–204. https://doi.org/10.1111/j.1467-8535.2010.01157.x
Sung, E., & Mayer, R. E. (2012). Five facets of social presence in online distance education. *Computers in Human Behavior, 28*(5), 1738–1747. https://doi.org/10.1016/j.chb.2012.04.014
Vongkulluksn, V. W., Lu, L., Nelson, M. J., et al. (2020). Cognitive engagement with technology scale: A validation study. *Educational Technology Research and Development, 70*, 419–445. https://doi.org/10.1007/s11423-022-10098-9
Wang, M. T., Binning, K. R., Del Toro, J., Qin, X., & Zepeda, C. D. (2021). Skill, thrill, and will: The role of metacognition, interest, and self-control in predicting student engagement in mathematics learning over time. *Child Development, 92*(4), 1369–1387. https://doi.org/10.1111/cdev.13531
Wilhelm-Chapin, M. K., & Koszalka, T. A. (2020). Graduate students' use and perceived value of learning resources in learning the content in an online course. *TechTrends, 64*(3), 361–372. https://doi.org/10.1007/s11528-019-00464-5
Xie, X., Siau, K., & Nah, F.F.-H. (2020). COVID-19 pandemic—Online education in the new normal and the next normal. *Journal of Information Technology Case and Application Research, 22*(3), 175–187. https://doi.org/10.1080/15228053.2020.1824884
Yu, Z. (2022). A meta-analysis and bibliographic review of the effect of nine factors on online learning outcomes across the world. *Education and Information Technologies, 27*(2), 2457–2482. https://doi.org/10.1007/s10639-021-10720-y
Zeng, L.-H., Hao, Y., & Tai, K.-H. (2022). Online learning self-efficacy as a mediator between the instructional interactions and achievement emotions of rural students in elite universities. *Sustainability, 14*(12), 7231. https://doi.org/10.3390/su14127231

Publisher's Note

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