2023

EJEL Volume 21, Issue 3

Editors

Heinrich Söbke and Marija Cubric

Published by Academic Publishing International Limited
Curtis Farm, Kidmore End, Nr Reading, RG4 9AY, United Kingdom
karen.harris@academic-publishing.org

eISSN: 1479-4403

EJEL Volume 21, Issue 3

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Collaborative Approaches in Online Nurse Education: A Systematic Literature Review

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Abstract: According to the socio-constructivist theories of learning, collaborative learning allows negotiation of shared meanings and co-construction of new knowledge among peers. This approach fits particularly well with healthcare professional education needs, as these professionals often face challenging issues that require the ability to fully understand the complexity of the patients' health conditions through working with others. However, while collaborative learning approaches are widely used in face-to-face nurse education contexts, their online equivalent still seem to be understudied, in spite of their great potential for the field. This systematic literature review investigates: (1) to what extent are online collaborative learning activities being adopted and investigated in formal nurse education, (2) What kind of online collaborative learning activities/techniques are proposed and what team structures are employed, (3) what technologies are used to run these learning activities, and (4) what methods are used to evaluate the impact of these activities. Studies were included if they presented online collaborative learning activities proposed by Universities or VET (Vocational Education and Training) providers. Articles published in 2015 or later were collected in November 2022 from Scopus, Web of Science and Medline. A total of 1059 records were retrieved, selected and analysed by four coders, resulting in a final dataset of 75 papers that were coded for type of collaborative approach, study characteristics, research methodology used, strength of evidence, and relevance to the research questions. Most of them described the use of activities like Discussions, Case Studies and Peer Reviews, sometimes in association with Role Play. In terms of technologies, Learning Managements Systems, forums and social media were already common pre-pandemic, but during the lockdown synchronous communication tools – often used to support simulations – took over. Data collection was carried out quantitatively, qualitatively or using mixed methods, but in many cases data reporting is weak or absent at all. The majority of the retrieved papers illustrate activities where collaboration was not structured in any way and there was no joint assignment or common objective/artefact that learners needed to reach/produce. In case of blended interventions, often collaboration is limited to the face-to-face sessions, while the digital setting is used for individual work. In terms of social structure, most of the time small groups or plenaries are used. In summary, the review reveals that studies on online collaborative learning for nurses are limited, especially in Europe, and the design of online collaborative activities often clashes with the principles put forward by the Computer Supported Collaborative Learning (CSCL) research community. Based on the results of the review we put forth some key recommendations, such as ensuring that online collaboration involves the creation of a shared artefact and striving to make virtual simulations actually collaborative, rather than limited to envisage student interactions in the debriefing phase. The paper also proposes a number of research areas seldom investigated and that would deserve further attention in the future.

Keywords: Computer supported collaborative learning, Nurse training, Nurse education, Systematic literature review

1. Introduction

In recent years, a number of transformations have taken place in healthcare systems in Europe and beyond. In particular, efforts have been made to follow the World Health Organization's recommendations to provide more first-contact, continued and coordinated care to patients, forming a gateway between the community and health systems (World Health Organization, 1978; 1988; 2005; 2006; Jurgens, 2004). As a consequence, health care personnel are being called on to follow new ways of working (Kekki, 2004; World Health Organization, 2006). Specifically, in order to be able to deliver patient-centred care, they need to become members of interdisciplinary teams, be able to work in groups, have ongoing access to up-to-date evidence-based medical knowledge, understand patients' health conditions and needs, as well as make decisions and solve complex problems. With the emergence of these new and pressing demands, roles in the health professions have been subject to substantial changes, including the introduction of new categories of health professionals (Goldfield, 2017; Sasso et al., 2018).

These changes call for healthcare professionals to develop new competences, enhancing their ability to work in close collaboration with others and to share practices with colleagues (Koles et al., 2010). As a result, the curricula adopted to train nurses have started to embrace active and collaborative learning approaches (Zhang and Cui, 2018). These approaches, unlike more transmissive and teacher-led methods, are focused on negotiation of shared meanings and co-construction of new knowledge among peers (Anderson, 2008;

Reference this paper: Pozzi, F., Manganello, F., Passarelli, M., Persico, D. and Romagnoli, M., 2023 Collaborative Approaches in Online Nurse Education: A Systematic Literature Review, *The Electronic Journal of e-Learning, 21(3)*, pp 121-140, available online at www.ejel.org

Wenger, 1998). In addition, since 2020, the COVID-19 pandemic has forced many institutions to deliver all or part of the educational programs through online environments, requiring a thorough re-design of the educational approaches adopted to face the many challenges of the new circumstances.

Nonetheless, some researchers (Breen, 2013; Breen and Jones, 2015; Zhang and Cui, 2018) claim collaborative learning is not yet a very common approach in the field of online education for nurses. This is somehow confirmed by Männistö et al. (2020), in a literature review investigating the effectiveness of digital collaborative learning as opposed to traditional teaching in nursing education. This review was carried out before the pandemic and selected only randomized controlled trials, which resulted in a dataset of 5 papers only. The results support claims concerning the scarce maturity of this research field but do not shed light on state of the art practice or on the effects of the online shift caused by the pandemic. Hence, a less selective and more up to date study is needed to identify research gaps and recommendations for the future.

The importance of adopting collaborative approaches is mostly supported by studies concerning 'inter-professional learning' (i.e. learning across professions, for example in groups of nurses and doctors) (Boyd, Baliko and Polyakova-Norwood, 2015; Breen and Jones, 2015; Reis, Faser and Davis, 2015; Smith and Jones, 2016; Wright and Leahey, 2009; Zook et al., 2018). Other studies advocate the use of online collaborative learning in the context of "Collaborative Online International Learning" (de Castro et al., 2019) and of "Globally Networked Learning" (Limoges et al., 2019), approaches aimed at fostering the creation of international communities of professionals and exchanging know-how across countries.

The Covid-19 pandemic brought to further attention the challenges of online education, as many courses had to be moved online in order to comply with social distancing measures (Cameron-Standerford et al., 2020). The experience of Emergency Remote Education highlighted that online settings – when not properly designed and managed – hinder the socialization of students, especially of those with low social intelligence and sociability (Swan, 2002; Savci, Cil Akinci and Keles, 2022). As argued by Garrison and Cleveland-Innes (2005), simply offering students possibilities for online interaction is not enough to ensure authentic learning: rather, there is a need for carefully designed activities that require proper collaboration. During the pandemic, further efforts were made to adopt online collaborative approaches in practicing clinical reasoning, decision making, leadership, interprofessional communication and other important skills of modern-day nursing.

This makes it crucial to better understand whether collaborative learning in nursing education is properly designed for online settings and in line with learning theories, as done by Dolan, Amidon and Gephart (2021) limited to the case of virtual simulations.

In an effort to contribute to this debate, made all the more urgent by the Covid-19 pandemic, and following other researchers' recommendations (Breen, 2013; 2015; Zhang and Cui, 2018), this study investigates the use of online collaborative learning in the context of nurse education or advanced training through a systematic literature review. The review's aims are to shed light on whether, to what extent, and with what modalities online collaborative learning is currently proposed in nursing professional development. Specifically, we focus on the following research questions:

1. To what extent are online collaborative learning activities being adopted and investigated in formal nurse education?
2. What kind of online collaborative learning activities/techniques are proposed? What team structures are employed?
3. What technologies are being used to run these learning activities?
4. What methods are being used to evaluate the impact of these activities?

The above questions should allow us to identify possible room for improvement of current practice and further investigation areas to ultimately take full advantage of online collaborative learning approaches in nurse education.

2. Theoretical Background

When we speak of online collaborative learning, we refer to the research field known as "Computer Supported Collaborative Learning" (CSCL). CSCL research is rooted in socio-constructivist theories of learning, according to which knowledge can be constructed through social negotiation (Garrison, Anderson and Archer, 1999; Stahl, Koschmann and Suthers, 2021). In this approach, discussion with other individuals is treated as a primary way to learn, because it encourages critical thinking, understanding, and group meaning-making (Scardamalia and

Bereiter, 1994; Kanuka and Anderson, 1999; Palloff and Pratt, 2001; Dillenbourg, 2002; Cognition and Technology Group at Vanderbilt, 2013).

However, "truly collaborative" learning processes are not easy to achieve and it is widely acknowledged by the CSCL research community that learners might fail to spontaneously engage in collaborative learning activities (Bell, 2013; Persico & Pozzi, 2011; Weinberger, Reiserer, Ertl, Fischer, & Mandl, 2005). The debate about ways of fostering collaboration has been intense and touched upon several aspects: how to scaffold collaboration, what technologies are most useful, what criteria should be adopted to make pedagogically sound design decisions, and how to collect and interpret evidence of CSCL's impact. In the following, we briefly summarise the state of the art in these areas.

2.1 Ways to Scaffold Collaboration

One of the most hotly debated aspects is the extent to which online collaborative learning activities need to be structured and interactions guided. Back in 2002, Dillenbourg pointed out that unguided collaboration does not necessarily result in collaborative learning (Dillenbourg, 2002). Similarly, other researchers have reported that an excess of freedom in a collaborative task may lead to low engagement on the part of team members (Hewitt, 2005; Liu and Tsai, 2008; Demetriadis et al., 2009; Bell, 2013; Heimbuch, Ollesch and Bodemer, 2018; Radkowitsch, Vogel and Fischer, 2020). On this issue, two recent meta-analyses have provided evidence for the effectiveness of "scripts" – that is, highly structured activities – in collaborative learning processes (Vogel et al., 2017; Radkowitsch, Vogel and Fischer, 2020).

Along with scripts, which are fine-grained scaffolds, research in learning design and collaborative learning has come up with the term collaborative "techniques" (Aronson, 2021), i.e. structured methods aimed at scaffolding group interactions at a higher level than scripts. These techniques have their origins in face-to-face education and are now also applied in virtual learning contexts. Kagan (1990), for example, proposed "(competitive or cooperative) structures" as "ways of organizing social interaction in the classroom". These techniques are also referred to as "instructional methods" (Kanuka and Anderson, 1999), whereas Hernández-Leo et al. (2005) use "Collaborative Learning Flow Patterns as a way of capturing good practices in the "organization of collaboration and activity structure".

Some of the most commonly adopted techniques are Peer Review, Case Study, Jigsaw, Role Play, Pyramid and Discussion (Persico & Pozzi, 2011). These are chosen and implemented on the basis of course objectives and content, the characteristics of the target population and contextual constraints. According to Pozzi, Ceregini, & Persico (2016), these techniques can be classified according to four main aspects: the task that learners are to accomplish (which usually envisages the production of a final output, often called 'artefact' in the CSCL field); the teams that learners are divided into; the timing of the activities; and the technologies employed for communication and artefact production.

Building on this research thread, to answer our second research question, we analyse the online collaborative activities used in online nurse education and investigate the way collaboration is structured by looking at these main features.

2.2 The Role of Technology in CSCL

Researchers in CSCL have pointed out that the type of computer support provided in collaborative learning may vary depending on whether learners collaborate face-to-face or, alternatively, synchronously online or asynchronously online (Jeong, Hmelo-Silver and Jo, 2019). In 2010, a meta-analysis by Jeong and Hmelo-Silver (2010) revealed the diversity of technological applications in CSCL and pointed out that the most commonly adopted tools are communication tools, in particular discussion forums and chats.

Wiki environments are also mentioned in the literature; however, their usefulness for supporting collaborative learning is under question (Biasutti, 2017; Heimbuch, Ollesch and Bodemer, 2018). Additionally, social media sites such as Twitter or Facebook have started to attract researchers' attention, with the lingering criticism that, not being intrinsically education-oriented applications, the use of these tools for learning is problematic (Stahl, Koschmann and Suthers, 2021).

Simulation environments are another interesting technology that can be used in online collaborative learning contexts: some researchers state "[the] simulation system enhances collaboration and performance of the students" (Zulfiqar et al., 2018). More specifically, "CSCLs and virtual reality (VR) afford a number of possibilities for collaborative learning: record keeping which enables asynchronous collaboration, opportunities to access the same data/information for joint analysis, and collective interactions and dynamic

reconfigurations" (Chavez and Romero, 2012; Adefila et al., 2020). As for nursing education programs, given that the US National guidelines, before the pandemic, recommended for simulations to substitute up to 50% of in-person clinical time (Dolan, Amidon, & Gephart, 2021), there was considerable interest in US institution for virtual simulations, interest that significantly increased with the pandemic.

In the light of these standpoints, to answer the third research question, this review will investigate which technologies are used in the context of nurse education.

2.3 Methods to Evaluate the Impact of CSCL

Measuring the impact/effectiveness of CSCL is another prominent topic in the research literature. The focus of evaluation can vary from study to study: in some cases, the focus is the impact of one specific technology on the learning process; other studies are more interested in evaluating the pedagogical models underpinning online collaboration. Additionally, some studies are oriented to measuring students' learning outcomes; yet others aim to demonstrate how CSCL affects students' motivation or develops transversal skills (Jeong, Hmelo-Silver and Jo, 2019).

Over time, several methods and proposals have been put forward to observe, capture, analyse and ultimately evaluate the interactions occurring in a group, including both quantitative and qualitative approaches. Mixed methods are quite common in this field and – more recently- Learning Analytics have been studied as a way to evaluate the design of CSCL pedagogies and technologies (De Wever, Schellens, Valcke, & Van Keer, 2006; Martínez et al., 2006; Persico, Pozzi, & Sarti, 2010; Rodríguez-Triana, Martínez-Monés, Asensio-Pérez, & Dimitriadis, 2015; Saqr, Viberg, & Vartiainen, 2020; Stahl et al., 2021; Wise et al., 2015).

In order to answer our fourth research question, we will also focus on the way the impact of online collaborative activities is evaluated.

3. Materials and Methods

The review is reported according to the PRISMA guidelines, where applicable. However, since our focus is on the characteristics of the studies and educational interventions themselves rather than the outcomes being measured, bias and confidence assessment were not applicable to the review. The review was not registered, as it does not have a direct impact on human health. Data are accessible at https://docs.google.com/spreadsheets/d/1ay4fR1E5icq8f47fInPsM8CHcw5I7GQs/edit?usp=sharing&ouid=107045214489711020674&rtpof=true&sd=true.

Articles were collected in November 2022 from the following databases: Web of Science, Scopus and Medline. The following search keywords were applied in the title, abstract, and keywords fields:

- "Nurs*";
- At least one out of "education", "training", "professional development", "universit*" or learning;
- At least one out of "collaborative learning", "cooperative learning", "Computer Supported Collaborative Learning", "cscl", "problem-based learning", "pbl", "critical incident", "case stud*" or "role play", "jigsaw", "pyramid", "peer review", "debate", "gamification", "game based learning", "GBL", or "simulation";
- At least one out of "blended learning", "blended training", "blended teaching", "online learning", "online training", "online teaching", "distance" (only if near "teaching", "learning", or "training"), "e-learning", "virtual" (only if near "learning" or "education"), or "web-based learning"

The search was limited to papers in English published in 2015-2022, specifically peer reviewed studies of primary or secondary research (systematic reviews, meta-analyses). Commentaries, editorials, conference papers, grey literature and letters were excluded.

Figure 1 illustrates the selection steps, as well as the inclusion criteria adopted.

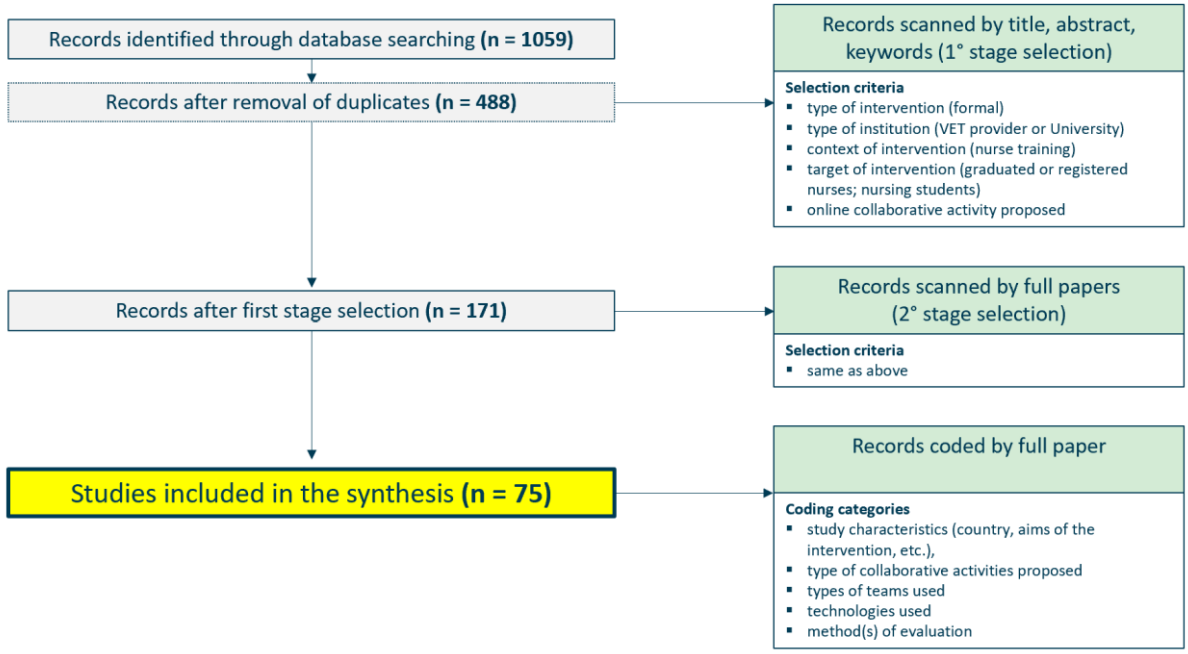

Figure 1: Selection and Coding Process and Criteria

A total of 1059 records (488 after duplicate removal) were retrieved. Titles, abstracts and keywords were read and filtered by four coders against the following inclusion criteria (first selection stage): studies must describe formal interventions run by accredited institutions (universities or Vocational Education and Training / VET providers); studies must focus on nursing education in which online or blended collaborative learning approaches were adopted; studies must describe interventions targeting student nurses, or graduate/registered nurses.

The resulting dataset contained 171 items, whose full texts were read and filtered against the same criteria as above, yielding a final corpus of 75 studies. These were coded for study characteristics (country of origin, aims of the intervention, etc.), type of collaborative activities proposed, team structure used, technologies used, and method of evaluation. No assumptions were made where information was missing, and all articles that met the inclusion criteria were included in the analysis.

Initially, each coder separately coded a common sample subset of about 10% of the abstracts/papers, and then discussed all instances of coding divergence until they reached agreement on criteria interpretation/application. Once the four coders felt confident they had achieved an acceptable level of intercoder reliability, the remaining abstracts/papers were coded independently.

A deductive method was adopted for full paper analysis, using the coding categories reported in Fig.1. Codes were inserted in a shared spreadsheet by the four reviewers. Each article was coded by one reviewer, but periodical meetings were held to discuss cases of ambiguities of critical aspects.

4. Results

4.1 RQ1 - To What Extent are Online Collaborative Learning Activities Being Adopted and Investigated in Formal Nursing?

Firstly, we must acknowledge a certain paucity of papers addressing the application of collaborative learning in online (or blended) educational contexts for nurses, at least as far as the pre-pandemic period is concerned. This is in line with Smith and Jones (2016), who reported that teaching strategies receive limited coverage in the available nursing education literature, and with several others (Breen, 2013; 2015; Smith and Jones, 2016; Vogt and Schaffner, 2016; Zhang and Cui, 2018), who highlighted the need to conduct further research in the field.

Not surprisingly, we noted a flat trend in the number of relevant papers published in this area (see Figure 2) and then a spike in 2021 (the number of papers for 2022 is likely underestimated, due to the search being last

carried out at the beginning of November 2022). In any case, it will be interesting to see if the surge of interest will last past the pandemic.

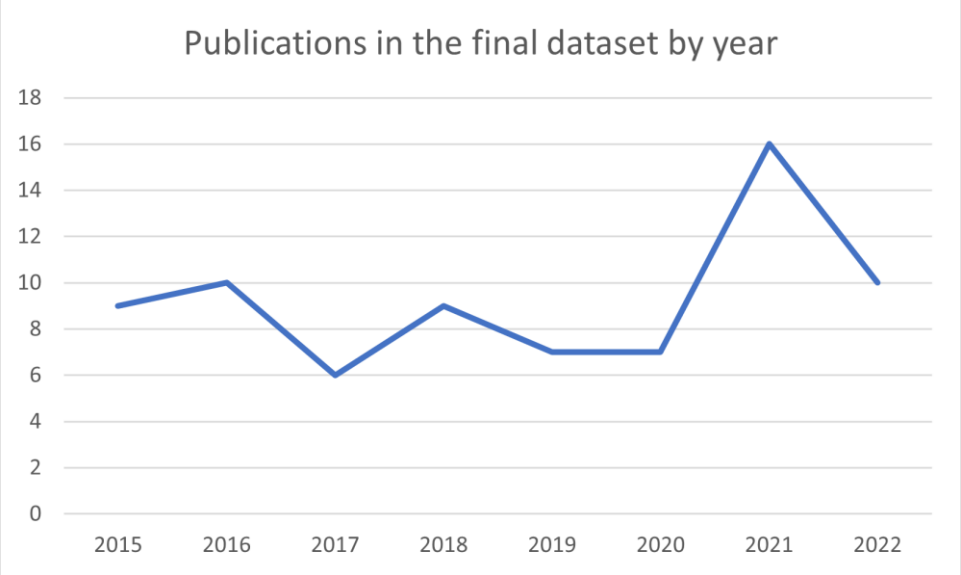

Figure 2: Papers per Year

Most of the studies were carried out in the USA (Table 1). It is also evident that Europe is hardly represented; this is true even if we consider the countries represented in studies involving 'multiple countries'.

Table 1: Distribution of Papers per Country

Country	Number of papers
USA	37
Australia	5
Canada	4
Taiwan	3
China	2
Brazil	2
UK	2
Singapore	2
Korea	2
Slovenia	1
Norway	1
Spain	1
Indonesia	1
Hong Kong	1
Multiple Countries	8
Missing	3
Total	75

In terms of setting, 85% of the studies described educational initiatives carried out in universities, while the rest were run by other VET providers. In terms of target populations addressed, Table 2 shows the distribution of the types of learners involved.

Table 2: Distribution of Papers per Target Population

Target	Number of papers
Nursing students	51
Family Community Nurses	1
Medical/ Healthcare students	1
Multiple target groups	19
Missing	3
Total	75

4.2 RQ2 - What Kind of Online Collaborative Learning Activities/Techniques are Proposed? What Team Structures are Used?

Table 3 shows the collaborative technique, the technology and the evaluation method as reported in each paper selected for this study.

Table 3: List of Full Papers Selected, With Collaborative Techniques, Technologies and Evaluation Methods Used

Paper	Collaborative technique	Technology	Evaluation methods
Avelino, Costa, Buchhorn, Nogueira, & Goyatá (2017)	Case Study	Learning Management System	Mixed
Baron, Rocha, & Anderson (2019)	Discussion	Forum	Qualitative
Boyd, Baliko, & Polyakova-Norwood (2015)	Discussion	Learning Management System	Qualitative
Breen & Jones (2015)	Discussion & Role Play	Forum	Qualitative
Breen (2015)	Case Study (unfolding) & Role Play	Forum	Qualitative
Chan, Chair, Sit, Wong, Lee, & Fung (2016)	Case Study	Learning Management System	Mixed
Chang, Chung, & Yang (2022)	Discussion	Simulation environment + Sync communication environment	Quantitative
Chua, Ooi, Chan, Lau, & Liaw (2022)	Case Study	Simulation environment + Sync communication environment	Mixed
Cowperthwait, Graber, Carlsen, Cowperthwait, & Mekulski (2021)	Case Study & Role Play	Sync communication environment	Qualitative
De Castro, Dyba, Cortez, & Pe Benito (2019)	Discussion	Learning Management System	Mixed
Dreifuerst, Bradley, & Johnson (2021)	Case Study	Simulation environment + Sync communication environment	No data
Duck & Stewart (2021)	Peer Review	Learning Management System	No data
Dugan (2016)	Discussion	Forum	Qualitative

Paper	Collaborative technique	Technology	Evaluation methods
Palancia Esposito & Sullivan (2020)	Case Study	Sync communication environment	Qualitative
Ferguson, DiGiacomo, Gholizadeh, Ferguson, & Hickman (2017)	Social networking	Social Network/Social Media	Qualitative
Flo, Byermoen, Egilsdottir, Eide, & Heyn (2021)	Case study	Simulation environment + Sync communication environment	Mixed
Fowler, Phillips, Patel, Ruggiero, Ragucci, Kern, & Stuart (2018)	Case Study	Simulation environment + Sync communication environment	Mixed
Fox (2017)	Case Study & Peer Review	Interactive lectures + Forum	Mixed
Fung, Zhang, Yeung, Pang, Lam, Chan, & Wong (2021)	Case Study	Simulation environment + Sync communication environment	Quantitative
Geng, Huang, & Huang (2021)	Peer Review	Video annotation software	Quantitative
George & DeCristofaro (2018)	Peer Review	Learning Management System	No data
Gordon (2017)	Discussion	Simulation environment + Sync communication environment	No data
Hardy, Mushore, & Goddard (2016)	Discussion	Sync communication environment	Qualitative
Hargreaves, Zickgraf, Paniagua, Evans, & Radesi (2021)	Case Study	Not specified	No data
Horowitz, Stone, Sibrian, DuPee, & Dang (2022)	Case study (unfolding), Role play	Learning Management System + Sync communication environment	No data
House, Nielsen, & Dowell (2022)	Discussion	Sync communication environment	Quantitative
Huber, Joseph, Halbmaier, Carlson, Crill, Krieger, Matthys, & Mundisev (2016)	Case study + Peer Review	Forum	Qualitative
Hudson, Clavel, Kilpatrick, & Lavoie-Tremblay (2021)	Case Study, Peer Review	Forum, Social Network/Social Media, and others	Review
Imamyartha, Wahjuningsih Puspa, Bilqis, & Hudori (2021)	Not specified	Social Network/ Social Media	Quantitative
Jones, Kelsey, Nelmes, Chinn, Chinn, & Proctor-Childs (2016)	Social networking	Social Network/Social Media	Mixed
Jung, de Gagne, Choi, & Lee (2022)	Discussion	Not specified	Quantitative
Kang, & Kim (2021)	Case Study	Not specified	Quantitative
Kubin, Fogg, & Trinka (2021)	Case Study (unfolding)	Simulation environment + Learning Management System	Mixed

Paper	Collaborative technique	Technology	Evaluation methods
Kuszajewski, Vaughn, Bowers, Smallheer, Hueckel, & Molloy (2021)	Case Study	Simulation environment + Sync communication environment	Quantitative
Leung, Wong, Kiteley, Ellis, & Esplen (2019)	Case Study & Discussion	Forum	Quantitative
Liang, Chen, Zhou, Wang, Liao, Lu, & Lin (2020)	Case study	Not specified	Quantitative
Liaw, Ooi, Rusli, Lau, Tam, & Chua (2020)	Case Study	Simulation environment	Quantitative
Limoges, Nielsen, MacMaster, & Kontni (2019)	Discussion	Not specified	Qualitative
Lin, Hwang, Chang, & Hsu (2021)	Peer Review	Peer review system	Mixed
Mackavey & Cron (2019)	Case Study	Learning Management System	Quantitative
McDaniel & Tornwall (2016)	Case Study	Social Network/Social media	Qualitative
McGarry, Theobald, Lewis, & Coyer (2015)	Social networking	Social Network/Social Media	Review
Morales (2017)	Social networking	Social Network/Social Media,	No data
New, Edwards, & Norris (2022)	Case study (evolving)	Learning Management System	Quantitative
O'Connor, Jolliffe, Stanmore, Renwick, & Booth (2018)	Social networking	Social Network/Social Media	Review
Packard, Iverson, Ryan-Haddad, Teply, Wize, & Qi (2019)	Simulation (f2f)	Synchronous communication environment	Mixed
Panepucci, Roe, Galbraith, & Thornton (2022)	Case Study	Learning Management System	No data
Pascon, Vaz, Peres, & Leonello (2022)	Discussion	Learning Management System + Sync communication environment	No data
Peddle, & Bearman, McKenna, & Nestel (2019)	Case Study	Simulation environment	Qualitative
Price, Devis, LeMoine, Crouch, South, & Hossain (2018)	Discussion	Social Network/Social Media	Mixed
Pullis & Hekel (2021)	Peer review, Discussion	Learning Management System + Sync communication environment	Quantitative
Reis, Faser, & Davis (2015)	Case Study	Simulation environment + Forum	Quantitative
Robb, & Spadaro (2022)	Not specified	Forum	Qualitative
Ropero-Padilla, Rodriguez-Arrastia, Martinez-Ortigosa, Salas-Medina, Folch Ayora, & Roman (2021)	Discussion	Sync communication environment + Forum	Qualitative

Paper	Collaborative technique	Technology	Evaluation methods
Rose, Jenkins, Astroth, Woith, & Jarvill (2020)	Case Study	Simulation environment + Sync communication environment	Mixed
Ross & Myers (2017)	Social networking	Social Network/Social Media	Review
Shaw, Sperber, & Cunningham (2016)	Discussion	Learning Management System + Social Network/Social Media	Quantitative
Smadi, Chamberlain, Shifaza, & Hamiduzzaman (2021)	Case study	Forum + Social Network/Social Media + Wiki	Qualitative
Smith & Jones (2016)	Discussion	Forum	Mixed
Stanley, Serratos, Matthew, Fernandez, & Dang (2018)	Case Study	Learning Management System + Interactive lectures	Qualitative
Stevenson, & Svoboda (2021)	Case study (unfolding) + Role play	Sync communication environment	Qualitative
Gawlik, Jeu, & Reisinger (2018)	Peer Review	Not specified	Qualitative
Thrane (2020)	Discussion, Role Play	Not specified	No data
Tracy, & McPherson (2020)	Case Study (unfolding)	Sync communication environment	No data
Trobec & Starcic (2015)	Role Slay	Learning Management System	Mixed
Van Hoover (2015)	Discussion	Learning Management System	Qualitative
Vogt & Schaffner (2016)	Case Study	Learning Management System	Mixed
Watson, Cooke, & Walker (2016)	Social networking	Social Network/Social Media	Qualitative
Wihlborg, Friberg, Rose, & Eastham (2018)	Discussion	Learning Management System	No data
Wikander & Bouchoucha (2018)	Peer Review	Not specified	Qualitative
Williams, Stephen, & Causton (2020)	Case Study	Simulation environment	Qualitative
Zehler, Cole, & Arter (2021)	Case Study	F2f simulation + Sync communication environment	Mixed
Zitzelsberger, Campbell, Service, & Sanchez (2015)	Case Study	Social Network/Social media	No data
Zook, Hulton, Dudding, Stewart, & Graham (2018)	Case Study (unfolding)	Simulation environment + Forum	Quantitative

About 25% of the retrieved papers described the adoption of simple Discussions, usually carried out in forums or via synchronous communication systems. Most of the time, though, these Discussions are not structured in any way and - apparently - there is no common artefact that learners need to produce. Only in a few cases (Breen and Jones, 2015; Limoges et al., 2019; Ropero-Padilla et al., 2021; Pascon et al., 2022) is the Discussion scaffolded by assigning learners a clear collaborative task and a common artefact to jointly develop. Sometimes the Discussion is associated with Role Play, where learners are asked to act according to assigned

roles (Breen, 2015; Breen and Jones, 2015; Schaffer and Munyer, 2015; Trobec and Starcic, 2015; Thrane, 2020).

In other studies, collaborative learning is associated with problem-based learning approaches, which are quite common in healthcare learning contexts. Online Case Studies seem to be especially popular (about 50% of the studies). Sometimes Case Studies are "evolving" or "unfolding" (Breen, 2015; Fogg and Trinka, 2021; Horowitz et al., 2022; Kubin, Stevenson and Svoboda, 2021; New, Edwards and Norris, 2022; Tracy and McPherson, 2020; Vogt and Schaffner, 2016; Zook et al., 2018), i.e. information about the case is not given to learners "all at once" from the very beginning, but is collected gradually, at different stages of the activity. Some Case Studies are oriented to "route case analysis" (Fox, 2017; Fowler et al., 2018), a method for problem solving used for identifying the root causes of faults, problems, or diseases. In one case (McDaniel and Tornwall, 2016) the Case Study was not provided by the lecturer, but was developed by learners themselves, therefore representing the final artefact to be produced.

In most of the studies, the Case Study is the collaborative technique adopted within online simulation activities and these activities are often referred to by their authors as 'virtual simulations'. Simulations in the nurse education field are usually proposed to allow students practicing clinical competences and developing clinical reasoning skills. Some pre-pandemic studies already focused on online simulations as alternatives to traditional clinical experiences and manikin-based simulations (Fowler et al., 2018; Gordon, 2017; Liaw et al., 2020; Reis, Faser and Davis, 2015; Zook et al., 2018), but during the lockdown this became a necessity and in that period the number of reported digital simulations increased (Chua et al., 2022; Dreifuerst, Bradley and Johnson, 2021; Flo et al., 2021; Kubin, Fogg and Trinka, 2021; Kuszajewski et al., 2021; New, Edwards and Norris, 2022; Palancia Esposito and Sullivan, 2020; Panepucci et al., 2022; Rose et al., 2020; Williams, Stephen and Causton, 2020).

Sometimes simulation activities start from video clips presenting cases, that are then jointly commented and discussed through asynchronous or – more frequently. ®synchronous communication environments (New, Edwards and Norris, 2022; Palancia Esposito and Sullivan, 2020; Panepucci et al., 2022). Other simulations are based on the analysis and joint discussion of virtual patient cases proposed by simulation software (Flo et al., 2021; Kuszajewski et al., 2021; Rose et al., 2020; Williams, Stephen and Causton, 2020). Interestingly, often the pre- and de-briefing sessions preceding and following the 'actual' simulation, are conducted in plenary through open-ended discussions, while the simulation itself is conducted individually (Fung et al., 2021; Rose et al., 2020). As a matter of fact, in many of the studies presenting 'virtual simulations', a lot of emphasis is given to these phases of pre- and –de-briefing (Chua et al., 2022; Dreifuerst, Bradley and Johnson, 2021; Fung et al., 2021; Kang and Kim, 2021; Rose et al., 2020), as these are recommended steps in nursing simulation protocols (see for example INACSL; Gordon, 2017; Kuszajewski et al., 2021; Panepucci et al., 2022). However, these simulation phases seem to be oriented to sharing or decision making, rather than collaborating, as there is no common artefact that students need to produce.

Exceptions are those Case Studies where learners are explicitly asked to collaboratively write a report (New, Edwards and Norris, 2022) or formulate questions for patients (Hargreaves et al., 2021).

Interestingly, sometimes the Case Study technique is used in association with the Role Play (Cowperthwait et al., 2021; Horowitz et al., 2022; Stevenson and Svoboda, 2021): in these studies, students assume roles thus analysing cases from different perspectives (Horowitz et al., 2022) or putting themselves in the patient's (or patients') relatives' shoes (Cowperthwait et al., 2021).

Peer Review and/or peer assessment are sometimes adopted to foster online collaboration (15% of the studies). Examples are: Gawlik, Jeu and Reisinger (2018) and Pullis and Hekel (2021). In two studies (Wikander and Bouchoucha, 2018; Geng, Huang and Huang, 2021), the Objective Structured Clinical Assessment (OSCA) is mentioned. OSCA is quite a popular approach to students' assessment in medical education, where learners are asked to practise and demonstrate their clinical skills in a standardized medical scenario. In Wikander and Bouchoucha (2018) the method is adapted for peer assessment and implemented in an online setting, while in Geng, Huang and Huang study (2021), students are asked to comment on videos produced by their peers through a video annotation software. Finally, in Lin et al. (2021) the interaction between assessors and assessees is enriched by a final phase whereby the latter reply to the former, commenting on the feedback received in such a way that the prevalent one-way communication through which feedback is provided in peer review becomes two-way communication.

In terms of team structure, sometimes the task starts as an individual assignment (de Castro et al., 2019; Dugan, 2016; Fowler et al., 2018; Gordon, 2017; Huber et al., 2016; Mackavey and Cron, 2019; Reis, Faser and Davis, 2015; Van Hoover, 2015) and the results of individual work are then shared and discussed online with peers. This phase often takes place in small groups and the social structure tends to remain stable for the whole activity. Alternatively, especially in simulations, the task starts and ends in plenary (for the pre- and the post-simulation briefing) and the rest of the activity is conducted at individual level.

Importantly, in five studies (House, Nielsen and Dowell, 2022; Jung et al., 2022; Limoges et al., 2019; Morales, 2017; Wihlborg et al., 2018) online collaborative learning is used to support collaboration among learners living in different countries. Especially during the pandemic, allowing interaction and sharing with professionals of other countries served to replace mobility.

In seven studies (Chua et al., 2022; de Castro et al., 2019; Fowler et al., 2018; Packard et al., 2019; Reis, Faser and Davis, 2015; Williams, Stephen and Causton, 2020; Zook et al., 2018) online collaboration is used to foster inter-professional education.

In one case (Zeler, Cole & Arter, 2021), teams of two to three students took part in simulations with one quarantined team member connected remotely via Zoom and the other(s) interacting with a high fidelity mannequin in a simulation centre. This way, quarantined students were able to achieve the same learning objectives as their peers in terms of perceived critical thinking and clinical judgment, while for clinical skills and communication the results were significantly lower. The peculiarity of this study lies in the asymmetry between the capabilities of team members due to mandated quarantine.

4.3 RQ3 - What Technologies are Used to Run Online Collaborative Learning Activities?

In terms of technologies used (see Table 3), several papers mention Learning Management Systems (18 studies) and boards/forums (12 studies). Not surprisingly, synchronous communication environments that were limited to 3 studies in the pre-pandemic, are mentioned in almost all the studies based on quasi-experiments carried out during the lockdown, as synchronous communication was the immediate replacement for f2f communication.

Simulations – that were limited to 5 studies up to 2020 – increase to 10 during Emergency Remote Education. Simulations may be based on 3D learning environments where an immersive experience is allowed (like in Second Life – see for example Zook et al., 2018) or based on highly sophisticated programmed mannequins (Zeler, Cole & Arter, 2021). Alternatively, 2D learning environments may be used (see for example Williams, Stephen and Causton, 2020), or even mere discussion forums devoted to the analysis and discussion of specific cases, such as standardized patients (this type of simulation seems to have become increasingly popular with the pandemic).

In addition to the above, 14 studies mention the use of social media. This result is undoubtably skewed by the fact that 3 out of the 4 literature reviews retrieved for this study all focus on the use of social media in nursing education. Twitter is used in Ferguson et al. (2017) and Price et al. (2018) to develop an online journal club and promote discussion on the topic “What is nursing?”, while blogs and wikis are used, respectively, in McDaniel and Tornwall (2016) and in Zitzelsberger et al. (2015) to propose case studies. However, in some cases (Watson, Cooke and Walker, 2016; Morales, 2017) the aim of social media use is to implement participatory approaches to learning, rather than to support fully fledged collaborative learning. In other cases (Jones et al., 2016; Shaw, Sperber and Cunningham, 2016), the development of pages on social media is used as a collaborative task, so we would claim in these cases social media are not used as a learning environment, but rather as the platform hosting the final artefact to be produced.

Interestingly, a couple of studies (Fox, 2017; Stanley et al., 2018) mention the use of VoiceThread as a technology to actively engage learners with contents and peers, by allowing them to comment on any digital media produced by others. In a similar vein, Geng, Huang and Huang (2021) use a video annotation software to allow what they call “Crowdsourcing Collaborative Learning Strategy”.

Finally, in a couple of cases (Vogt and Schaffner, 2016; Limoges et al., 2019) technologies were not suggested by the lecturers; rather, learners (or groups) were free to choose the preferred technology to communicate.

4.4 RQ4 - What Methods are Used to Evaluate the Impact of Online Collaborative Learning Activities in Nurses' Professional Development?

Our data (see Table 3) show that, in order to assess the impact of the initiatives described, several studies (about 30% of the papers) applied qualitative approaches, using interviews, focus groups, or textual analysis of transcripts from activities based on asynchronous online communication.

In addition, about 23% of the studies applied mixed methods and another 23% of the studies adopted quantitative approaches. Four studies are literature reviews and the rest of the studies report no data at all, thus adding little new evidence in terms of research results.

Among the papers that report quantitative or mixed method data, most focus on the impact of different types of technology. For example, in Fox (2017) the authors evaluate the impact of VoiceThread by analysing student opinions. Similarly, in Fowler et al. (2018) the authors report data from a focus group, a pre-post-test questionnaire and a survey, and their object of investigation is the effectiveness of a newly developed platform. Jones et al. (2016) report interesting data about the use of Twitter, Liaw et al. (2020) and Zook et al. (2018) are based on data concerning Case Studies in simulation environments. Chan et al. (2016) compare case-based web learning in the context of F2F and web interactions. Lastly, Vogt and Schaffner (2016) compare the impact of different technologies used for an online Case Study. Needless to say, many of the recent studies were carried out in response to the pandemic and investigated the impact of some form of distance learning on nurse education.

Besides the above studies concerning impact of different technologies, a number of studies investigate evaluation of other aspects: for example, Shaw et al. (2016) evaluate teamwork, Avelino et al. (2017) measure the impact of a Case Study in terms of students' opinions, and Trobec and Starcic (2015) use a pre and post-test research design to measure students' performance in a collaborative activity. Lastly, Smith and Jones (2016) measure the impact of a family assessment activity based on movies.

Unfortunately, many of the studies provide insufficient information to determine the relevance of the contribution: for example, de Castro et al. (2019) do not mention the sample size, while in Packard et al. (2019), only 1 student out of 9 was online, thus limiting the possibility to derive evidence on the impact of online collaborative learning.

5. Discussion

The results of this systematic literature review confirm the limited number of studies at the intersection between CSCL and nurse education, especially as far as European countries are concerned, and show that existing studies tend to concentrate on consolidated approaches (e.g. peer reviews, open ended discussion, case study) while taking little advantage of the potential of collaboration for learning. This is in line with Smith and Jones (2016), who claim the available nursing education literature regarding online collaborative strategies is limited and with those authors (Breen, 2013; 2015; Smith and Jones, 2016; Vogt and Schaffner, 2016; Zhang and Cui, 2018) who highlight the need to conduct further research in the field. We believe further investigation in this area and more extensive adoption of a variety of approaches (starting from those that are consolidated in other areas) would benefit the nurse education field and – as a consequence – would help the current transition towards the new European healthcare systems that is taking place in many countries.

However, since 2021 there has been a surge of interest in this topic, which is likely due to the Covid-19 pandemic and the consequent necessity to move several nursing courses online. Such interest has triggered more creative approaches and it will be interesting to monitor long-term effects on the field.

Generally speaking, it seems the potential of online learning is underutilized for collaborative learning: even in blended interventions (before the pandemic), the collaborative component was often carried out during f2f sessions. Online environments were instead used mainly as repositories, tools for delivering transmissive lectures (e.g., webinars), or for running individual activities, simulations included (Hickman et al., 2018; Hogan et al., 2018; Pierce and Reuille, 2018; Shorey et al., 2018; Trollor et al., 2018). Then, during the pandemic, synchronous communication tools mainly replaced f2f communication, thus becoming pervasive, but in most cases, the activities proposed took the form of open-ended debates, rather than true collaborative activities. The very fact that synchronous tools were largely preferred to asynchronous ones, reveal a lack of trust in the latter, in spite of the evidence in favour.

Additionally, the proposed online collaborative activities appear relatively unstructured, with little scaffolding. In most cases, simple debates are proposed, with no clear objective or common artefact to be produced, as for

example during the pre- and de-briefing sessions in simulations. This is in contrast with most of the literature related to online collaborative learning (Hewitt and Scardamalia, 1998; Stahl, 2002; Stahl et al., 2014), which suggests that having a common goal or artefact to produce serves as a catalyst for negotiation and meaning-making.

Some of the studies adopt problem-based learning and peer-review approaches. Both the approaches fit particularly well with the needs of the educational context, but the design of these activities could be improved by: a) enriching the Case Studies with the collaborative production of common artefacts, for example in preparation or as a follow up of virtual simulations; b) empowering the Peer Reviews by allowing direct interactions between assessors and assesses and envisaging a revision of the original artefact by the assesses, so as to take the most from the exchanges.

In terms of team structure, in the retrieved studies interactions seem poorly scaffolded: individual work is usually proposed as the starting point for small-group work, with groups tending to remain stable throughout the online activities proposed. Alternatively, individual work is preceded or followed by plenaries. This suggests a poor use of the features offered by online platforms, which could support more dynamic team structures and interactions. As a matter of fact, only one of the retrieved papers (Breen and Jones, 2015) explicitly describes the rationale behind adopting small groups (instead of other social structures) and informing the choice of role-playing as a way to support interactions.

In terms of technologies, forums and synchronous communication environments are the most frequently used, in line with general CSCL literature (Jeong and Hmelo-Silver, 2010).

Surprisingly, the potentialities offered by online simulation environments seem to be underutilized; in most cases, virtual simulations are proposed as opportunities for individual tasks and with only the results (possibly) discussed in groups. Our suggestion would be to try to fully harness the potential of collaborative virtual simulations, rather than limiting interaction to the pre- and de-briefing phase.

As far as evaluation is concerned, most of the retrieved studies are weak in terms of data analysis: some provide no data at all, while others provide insufficient information to measure the impact of the proposed interventions. This is in line with Hudson et al. (2021), who claim the reporting of many healthcare educational interventions is suboptimal and point out that the Criteria for Describing and Evaluating Training Interventions in Healthcare Professions (CRe-DEPTH) tool (Van Hecke, Duprez, Pype, Beeckman, & Verhaeghe, 2020) should be used more extensively for planning and reporting nurse education interventions.

Considering this review's findings regarding the design of online collaborative learning activities in the specific field of reference, our suggestion is that there should be greater alignment with the main design principles suggested by the CSCL research community and wider use of the collaborative techniques they elaborated. This would call for stronger links between the CSCL research community and the community working in nursing education. In other terms, we suggest that, when designing online collaborative activities, nurses' teachers should draw on established techniques, such as Jigsaw (Aronson, 2021), pyramid and structured discussion (Persico & Pozzi, 2011) and make sure that the development of a joint artefact triggers actual negotiation and collaboration. Alternatively, interdisciplinary projects might lead to greater cross-pollination between the two fields and more robust educational designs.

From the point of view of evaluation, we recommend that, in the design of CSCL activities, sound and transparent evaluation methods (be they qualitative, quantitative or mixed) should be adopted so as to assess relevance and guarantee replicability of the studies.

6. Conclusions

In this paper we presented the results of a systematic literature review conducted to investigate the use of online collaborative learning approaches in nursing education.

One limitation of this study is that it concentrated exclusively on nurses, while it would be interesting to expand the scope to include other healthcare professionals as well. Additionally, the review did not account for publication bias. On the one hand, we could expect that many nurse trainers propose collaborative activities to their students but do not care for publishing them, as pedagogical research is not their core interest. On the other hand, for the interventions that do get published, we could expect that the quality of data collection and evaluation is higher than average.

Moreover, it would be interesting to see if, after the relaxation of social distancing measures taken due to the COVID-19 pandemic, the level of interest in online collaborative learning will return to pre-pandemic levels.

Lastly, since this review focused on the characteristics of the studies on online collaborative nurse education, it required a qualitative approach. Further research could assess the effectiveness of online collaboration for nurse training by carrying out a meta-analysis.

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Improving Self-Efficacy With Automatically Generated Interactive Concept Maps: DIME Maps

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Abstract: The Dynamic and Interactive Mathematical Expressions (DIME) Map system automatically generates DIME maps, which are personalizable and manipulable concept maps that allow students to interact with the mathematical concepts contained in any portable document format (PDF) textbook or document. A teacher can automatically upload a PDF textbook chapter and retrieve a DIME map of the contained mathematically based concepts. The DIME map is interactive and manipulable and can be used to interactively navigate the PDF textbook chapter. Our goal was to investigate the relationship between use of DIME maps and student learning outcomes, including self-efficacy and ability to understand and recall connections between physics concepts. We implemented a pretest/posttest to determine if student self-efficacy and connections in knowledge increased after participation in a summer camp physics class. We additionally conducted student interviews to better understand how changes in these two factors may have occurred. We then used multivariate analysis of variance and thematic analysis, finding and investigating positive effects of students using DIME maps, namely growth in self-efficacy and connections in knowledge. Based on our findings, we conclude that DIME maps can be valuable learning tools for students that have positive effects on both cognitive and affective learning outcomes.

Keywords: Technology integration, Concept mapping, Mixed methods, Physics, STEM

1. Introduction

Graphic displays of information have long been critically examined for their ability to improve students' learning and retention of new information. Traditionally, graphic displays of information include concept maps, flow charts, semantic maps, tree diagrams, and other organizers dealing with the display of information graphically in a meaningful way (Horton, Lovitt and Bergerud, 1990; Guo, et al., 2020). In education settings, graphic displays of information can be provided as advance organizers prior to students' learning to present a road map for potentially challenging material (Ausubel, 1968; Githua and Nyabwa, 2008; Chuang and Liu, 2014). Doing so potentially has positive learning outcomes, as there is evidence that when introduced to the material beforehand students learn more from lectures covering difficult concepts (Schwartz and Bransford, 1998; Stelzer, et al., 2009). Concept maps have also been shown to reduce cognitive load by providing students an alternative visual representation of the connections between ideas or concepts (Novak, 1998; Hill, 2005; Stull and Mayer, 2007; Özmen, DemirciOğlu and Coll, 2009). The cognitive theory that underpins most research on the use of graphic organizers is that advance organizers allow students to link previous knowledge to new knowledge, creating knowledge schemas (Ausubel, 1968). The intervention used in this study can be considered an automatically computer-generated concept map or graphic organizer of mathematical knowledge. Underlying this study is the idea that students are better able to meaningfully learn when they can interactively engage with material and connect new learning to prior knowledge and future goals.

2. Background and Framework

Having the ability to access, apply, and connect various mathematical equations is useful in helping individuals understand the topics that these equations describe. This is because equations are a way of writing and making sense of formal mathematical concepts (Wang and Liu, 2017). Graphic organizers have been used to assist students in making sense of new, formal concepts across many subjects, mathematics included. Graphic organizers have the potential to improve learning and retention by making new, abstract material more concrete and by making connections between prior knowledge and new information (Ausubel, 1968; Mayer, 1979; Dexter, Park and Hughes, 2011). By building on a strong foundation of educational theories and practices, we explore the use of Dynamic and Interactive Mathematics Expressions (DIME) maps to enable students to meaningfully learn and engage with their educational materials.

Reference this paper: Rugh, M.S., Capraro, M.M. and Capraro, R.M., 2023 Improving Self-Efficacy With Automatically Generated Interactive Concept Maps: DIME Maps, *The Electronic Journal of e-Learning, 21(3)*, pp 141-157, available online at www.ejel.org

2.1 Theoretical Framework

This study was built on the theoretical foundation of assimilation theory, which states that meaningful learning occurs when students assimilate, or anchor, new concepts into their existing prior knowledge structure (Ausubel, 1968; Ausubel and Robinson, 1969; Ausubel, Novak and Hanesian, 1978; Gardee and Brodie, 2021). This theory frames the world around us as a web of interconnected thoughts and ideas. Through this lens, rote memorization is found to be a poor substitute for meaningful learning, as it requires the learner to memorize a fact or formula without connecting it in any meaningful way to their past experiences or knowledge. Knowledge acquired during rote learning has a weak association with one's pre-existing knowledge structure and is, therefore, not stable enough to remain in long-term memory. With this theoretical framework in mind, we propose that the intervention used in this study supports making connections between prior knowledge and new concepts, thus leading to more meaningful learning and improved self-efficacy.

2.2 Technology and Concept Maps

Developed in accordance with the assimilation theory of learning, concept maps provide opportunities for students to visualize the interconnections between the concepts they are presented (Novak, 1990; 2004). With concept maps, concepts are represented as nodes and relationships between ideas are represented as links. The resulting map shows the interconnections between these ideas (Shahbari and Abu-Alhija, 2018). Several researchers have shown that concept mapping has been connected with improved academic self-efficacy (Chularut and DeBacker, 2004; Adiyiah, Mutangana and Ameyaw, 2020; Roshanger, et al., 2020). On this foundation, we sought to see how technology could be harnessed to maximize the potential for concept mapping.

Designers of electronic concept maps have benefited greatly from recent technological developments. For instance, Cañas, et al. (2004) created CmapTools to aid in the construction, publishing, and sharing of electronic concept maps. To further aid in sharing concept maps, Cañas, Carff and Lott (2018) later created eCmap, which is a concept map editor that can be embedded easily into HTML for use on websites. In addition to showing connections between abstract text-based knowledge, technology-enhanced concept maps have the capability to display multimedia information (Kornilakis, et al., 2004; Tergan, Keller and Burkhard, 2006; Hsieh, Chu and Yang, 2018). Developments in technology have allowed concept maps to become interactive, further increasing the potential for student engagement in learning (Dowell, 2016; Wang, 2016), and both traditional concept maps and interactive concept maps have been associated with positive gains in cognitive and affective measures (Schroeder, et al., 2018).

There are several types of interactivity in multimodal learning environments that can improve learning (Moreno and Mayer, 2007). Some interactive concept maps display additional information when users click on individual nodes (McClellan, et al., 2004; Dowell, 2016; Wang, 2016), and others allow users to easily add nodes and links with a few clicks (McClellan, et al., 2004; Wang, 2016). Another type of interactivity used by some interactive concept maps is allowing users to mark, note, or highlight individual concepts (McClellan, et al., 2004; Dowell, 2016). In each of these examples, interactive elements were added to electronic concept maps to improve creation and consumption of concept maps.

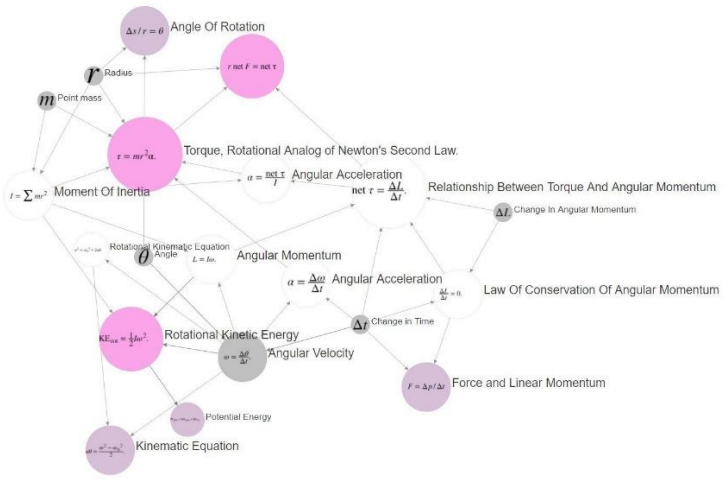
Although interactive concept maps have much to offer, they are still tedious to create, posing a significant obstacle to regular use in classroom settings by heavily burdened teachers. McClellan, et al. (2004, p. 2) suggested, "It would be extremely difficult and tedious to process the whole book (by hand) to add relevant resources to each and every concept; and the resulting linkage of resources to concepts would be static". Their solution at the time was to create a concept map software, CNT, that allows a person to define a list of concepts. The system would then search a textbook for occurrences of those concepts and link them to a student-generated concept map so that users could quickly navigate relevant content in their course materials. The strength of this concept map software is that it significantly reduced the load of both teachers and students in creating an interactive concept map, but users still needed to develop an initial concept map for the software to connect content to. In more recent years, various researchers have examined the efficacy of using algorithms to generate concept maps, thereby removing the need for an expert to create a concept map (see Atapattu, Falkner and Falkner, 2017; Shao, et al., 2020). The algorithm developed by Atapattu, Falkner and Falkner (2017) required the use of pre-existing lecture slides, however, which still require an expert to create, and that of Shao, et al. (2020) utilized only natural language processing that requires the setting of parameters before implementing text analysis. The concept maps produced by both of these systems are effective for improving student learning, but their implementation is still limited by the necessary intervention of an expert in setting the boundaries of their creation.

Clearly, previous interactive concept maps and concept map-developing algorithms have provided many tools for both concept map creators and consumers. However, to our knowledge, no existing concept mapping system provides the means for the truly automatic generation of concept maps, producing concept maps without the need for experts or instructors to set parameters or even input data. The DIME Map system we developed provides a significant reduction in effort and time required to create concept maps because an uploaded portable document format (PDF) text is automatically parsed by the DIME Map system to create a meaningful interactive concept map. Importantly, this can be done by any individual with access to a PDF text file, including students. We propose that DIME maps provide many of the same benefits of previous interactive and technology-enhanced concept mapping systems with the added benefit of automatically generating concept maps using an artificial intelligence (AI) system.

2.3 DIME Maps

With the intent to help students learn mathematical ideas, a team of computer science engineering researchers developed the DIME Map system (Wang, et al., 2018; Beyette, et al., 2019; Rugh, et al., 2019; Rugh, et al., 2021;). The DIME Map system automatically provides a concept map of interconnected topics and equations. This outcome is achieved by the AI system which algorithmically carries out three major steps: 1) identifying mathematical objects, including variables (e.g., *x*), expressions (e.g., mc^2), and equations (e.g., F = ma); 2) identifying the names or definitions of those mathematical objects using natural language processing; and 3) finally representing those mathematical objects as an interactive concept map with meaningful links. The links, or arrows, between concepts all have the same meaning and indicate how certain concepts "build into" others; for example, an arrow from *mass* to *force* indicates that mass "build(s) into" force. Theoretically, DIME maps, like concept maps before them, should reduce the cognitive load inherent in learning new material, enabling students to acquire new knowledge at faster rates and establish enduring understandings of the interrelationships between their knowledge.

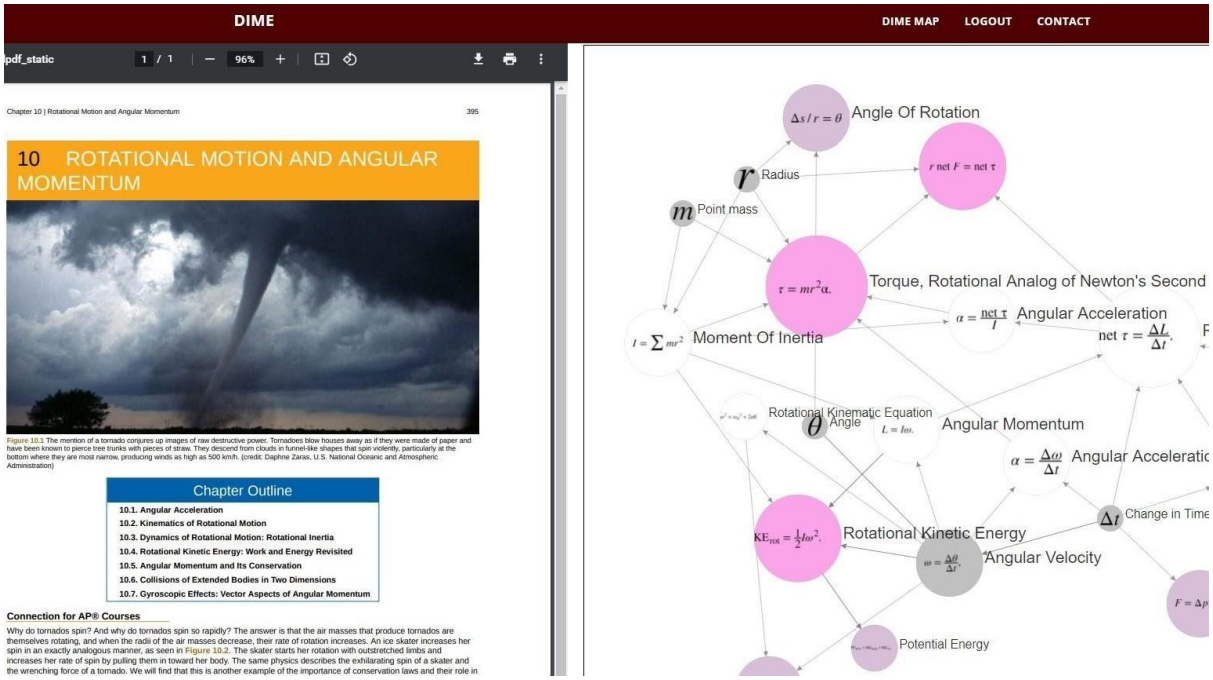
This "road map" of interconnected topics manifests itself through the DIME map, which uses links, arrows, and spatial arrangement to highlight both key concepts and structural relationships (see Figure 1). The DIME Map system removes redundant elaborations found in texts and covers only the key fundamental concepts expressed in equations bounded with words. In other words, the DIME Map system finds mathematical objects (e.g., variables, expressions, and equations) and identifies them using the surrounding text, even when there are many other unrelated words in the surrounding sentences. It then automatically creates a map that displays the interconnection of mathematical equations and expressions from this information, specifically identifying the in/out relationship of concepts through the use of arrows. It also uses the semantics established throughout the document to accurately identify and connect elements of the expressions and equations, creating a smooth continuity of meaning across presentations. Previous researchers examined the automatic generation of concept maps using natural language processing (Atapattu, Falkner and Falkner, 2017; Shao, et al., 2020), but the DIME Map system is focused on mathematically based concepts. Additionally, the relationships in a DIME map are well defined in that one concept builds into or is a component of the concept it is connected to.



Note. A typical DIME map shows concepts as circular nodes and relationships between concepts with linking arrows.

Figure 1: An Example DIME Map

In addition to being automatically generated, DIME maps differ from manually constructed and visually static concept maps in the way that users engage with them. Users can customize their maps interactively to meet their own conceptual needs. This is possible because the DIME map is housed inside an elastic container that allows users to see the DIME map displayed side-by-side with the original PDF text document (see Figure 2). This format for displaying the textbook on the left and the concept map on the right is similar to previous interactive concept maps designed by Wang (2016). The elasticity of the map further allows it to hold large amounts of content while also providing a convenient way for users to move the map's display through panning and zooming in towards or out from operations. The density of the nodes can be adjusted to make best usage of the space and avoid overlapping. A user can also customize the spatial arrangement of partial nodes to meet their own conceptual understanding. The nodes are linked back to the text as well, and clicking on a given node will navigate the PDF display to the first occurrence of the associated mathematical concept. Students and teachers can additionally "hide" a node from the map that they regard as less important for the current educational encounter.



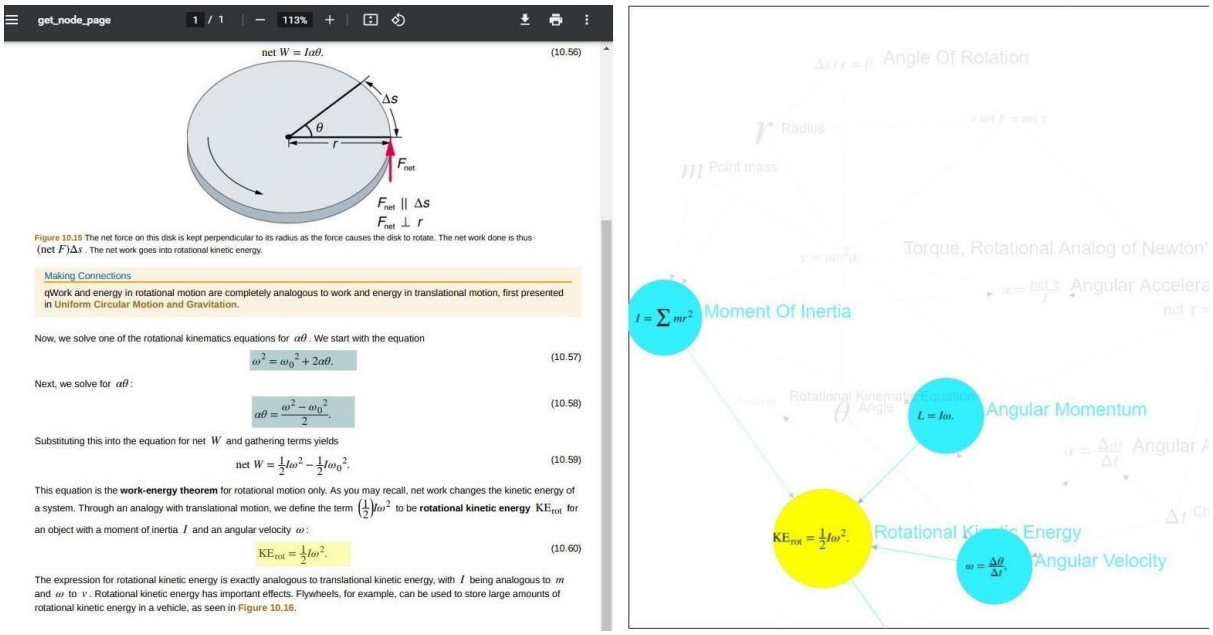
Note. This figure provides a visual example of how a DIME map is displayed next to original text. Not intended to be readable.

Figure 2: A DIME Map (Right) and PDF Textbook (Left)

Those using the DIME Map system can interact with their maps through multiple additional features. Users can search for words and mathematical expressions directly to locate certain pieces of information, and matched information found through the search function will be highlighted in both the DIME map and PDF text document. This is because each DIME map is synchronized with the original material through side-by-side displays and color coding. Because of this, users can also navigate to the original materials in the PDF text document by clicking on the mathematical object in the DIME map. Additionally, when studying the building components and usage of certain concepts, students can simply click on a node to focus the map and text on that concept. After the click, the textbook page where that concept is introduced is displayed, mathematical objects directly related to that concept will be highlighted in the DIME map, and unrelated concepts will fade out by using transparency (see Figure 3). Finally, a snapshot of the user-made arrangement can be taken for personal records or for sharing with others. If space is limited, as with a tablet or phone, the PDF text document or the DIME map can be hidden. Redundancy input options, such as buttons, are provided for users using touch screens or touch pads.

DIME maps are dynamic and interactive and, therefore, potentially more engaging and useful than traditional concept maps. Other concept mapping systems that utilize interactive elements have proven effective at improving the cognitive (content knowledge) and affective (emotion towards content) outcomes for learners (Schroeder, et al., 2018). There has yet to be a study examining whether a fully AI-generated interactive concept

map yields similar learning outcomes. The purpose of this small-scale pilot study was to test whether DIME maps are indeed an appropriate alternative to traditional instruction.



Note. This figure provides a visual example of the navigation feature of DIME maps—clicking on a concept in the map highlights related concepts and navigates the user to the introduction of that concept in the text. Not intended to be readable.

Figure 3: A DIME Map and PDF Textbook Focused on One Concept

2.4 Research Questions

As computer-generated concept maps, DIME maps already possess the potential to reduce a teacher's workload. The additional dynamic and interactive features, however, suggest potential to improve student learning as well (Rugh, et al., 2021). Therefore, we focused on the following research questions:

- Is there a multivariate relationship or pattern between using DIME maps and two learning outcomes for students:
    - *self-efficacy towards learning physics,*
    - *and understanding connections between content knowledge?*
- How do students feel about using DIME maps—what aspects of DIME maps do students consider helpful or harmful to their learning process?

3. Materials and Methods

We employed a mixed methods design that included a small-scale pretest/posttest control group design for the quantitative phase, as well as observational and interview data for the sequential qualitative phase. The subsequent qualitative phase was used to support the quantitative exploration in order to learn more about this novel educational technology and examine the quantitative results; such a design can be expressed symbolically by QUAN → qual to describe the precedence of the quantitative phase, both temporally and in terms of contribution to the outcome (Morse, 1991; Leech and Onwuegbuzie, 2009). This study design was deemed appropriate for the current study because although measuring learning outcomes provides data on the success of DIME maps as a learning tool, data on student user experience is necessary to understand if DIME maps help students connect new information to previous knowledge in similar ways to other concept maps and where they may potentially fall short. In the current study, we collected pretest and posttest scores of students' cognitive and affective learning in a physics class and then conducted interviews to understand how and why these scores may have changed. The resulting data allowed us to determine if computer-generated concept maps have the same efficacy as other interactive digital concept maps in improving student learning outcomes.

3.1 Participants and Setting

Participants included 31 high school students who attended a science, technology, engineering, and mathematics (STEM)-oriented summer camp in 2018. Summer camp attendees selected four of eight possible classes to enroll in while attending the camp, which included physics, robotics, coding, and other topics. Students were then immersed in 1.5-hour daily sessions for each selected class for four to five days total. The participants in the current study (*N* = 31) included those students who enrolled in the physics class, which engaged students in project-based learning (PBL) while exploring mathematical and physics concepts. These students were randomly assigned to one of two groups before the first day of camp: 15 were assigned to the control group (five female students and ten male students), and 16 were assigned to the treatment group (five female students and eleven male students). A control group design was implemented to account for other potentially impactful moderators, such as PBL, which has been shown to have a significant positive effect on student learning (Bicer, et al., 2015; Chen and Yang, 2019). Both the treatment and the control group made use of PDF textbooks during the class, but the treatment group were also able to use the DIME Map system alongside the textbook. Importantly, none of the students had taken a physics class in school, so the participants all began the study with similar levels of formal physics instruction and knowledge. Detailed demographics for the participants in this study were as follows: 10 (32%) female and 21 (68%) male; nine (29%) Hispanic or Latino and 22 (71%) White (non-Hispanic); 10 (32%) in 9th grade, seven (23%) in 10th grade, 11 (35%) in 11th grade, and three (10%) in 12th grade.

For the purposes of this study, an overall sample size of 31 was sufficient, as analysis was to be done using a simple multivariate analysis of variance (MANOVA; Jafar, et al., 2016). Still the sample size was small, so there was concern whether we could examine interaction effects without significant likelihood of a Type II error. The a priori power analysis—with an estimated effect size of $f^2(\lambda) = 0.25$, $\alpha = .05$, and power of 80%—indicated a sample size of five participants per group was sufficient. As such, the sample size was more than adequate for the current study.

The physics behind fixed-axis rotation comprised the content covered in the class. Both sections of the physics class were taught by a single instructor who was observed by at least two, but on some days three, researchers whose primary focus was to ensure that lessons were presented to the two groups in exactly the same fashion, with the same pacing, and using the same pedagogical strategies, ensuring continuity of the lessons. The only deviation that occurred was that the treatment group was also instructed on how to use the DIME Map system. The purpose of using the same instructor was to avoid scripting, to reduce the cognitive load on the instructor, and to afford a more uniform implementation of course curriculum. The instructor was trained to use DIME maps by the development team, and the instruction for teaching students about the DIME maps was co-developed by the instructor and the research team.

3.2 Data Sources

One pre/posttest for both *Self-efficacy* and Connections in Knowledge (*Connections*) was administered to determine the effects of student participation in the physics class on these affective measures. The instrument was written by the physics teacher for the STEM summer camp and first vetted by research faculty in the Colleges of Science and Education at an R1 University, who evaluated validity and alignment to the lesson content and objectives. There were four questions related to Self-efficacy, posed as 5-point Likert-type questions (see Appendix A). There were also five questions testing for Connections in Knowledge (see Appendix B). To test for internal consistency, we calculated that the Cronbach's alpha was sufficient across Self-efficacy ($\alpha = .8348$) and across Connections ($\alpha = .4286$), indicating that the questions intending to measure self-efficacy were closely related to each other, and the questions intending to measure connections in knowledge were also closely related to each other (although less so). Self-efficacy specifically was robust, yielding a strong positive internal consistency estimate.

Finally, at the end of the week-long intervention, we conducted semi-structured interviews with students who had used the DIME maps. By following an interview protocol (Knox and Burkard, 2009), we were able to pre-emptively consider what questions we wanted to ask and uniformly ask the same questions to multiple participants. Some of the interview questions were included to inform the research team as to ways DIME maps could be improved in the future. See Appendix C for the full interview protocol. We conducted the interviews face to face. Three students were selected based on their high levels of interactions with the DIME maps throughout the week, as we determined that students with greater familiarity with the DIME maps would provide richer data and insights than students who utilized the DIME maps less. After conducting interviews with the three selected students, our data reached saturation and we stopped hearing new ideas or themes in the

students' responses, so further interviews were determined to be unnecessary. For the purpose of confidentiality, the three students interviewed will be referred to under the pseudonyms Alice, Bailey, and Chris. We recorded audio from the interviews to later transcribe and analyze.

3.3 Data Analysis

The quantitative data were analyzed using MANOVA in SPSS 24, and the qualitative data helped to explain the results. The use of MANOVA to analyze the relationship between the treatment and both Self-efficacy and Connections is justified because these two dependent variables are closely correlated (Freedman, 1997; Warne, 2014). We also reported effect sizes because they are often referred to as the single best reporting strategy for quantitative methods and need not be reserved for when reporting a statistically significant result (Capraro, 2004; Fritz, Morris and Richler, 2012). To account for the relatively small sample size and encourage future meta-analyses of these results, we calculated Hedges' (1981) bias corrected effect size (g) using the following equations:

$$s_p = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{(n_1 - 1) + (n_2 - 1)}}$$

$$g = \frac{M_1 - M_2}{s_p} \times \left(\frac{N - 3}{N - 2.25}\right) \times \sqrt{\frac{N - 2}{N}}$$

For these equations, we used the sample size (n_1), mean (M_1), and standard deviation (s_1) of the first group; sample size (n_2), mean (M_2), and standard deviation (s_2) of the second group; and total sample size ($N = n_1 + n_2$) to calculate pooled standard deviation (s_p) and Hedges' bias corrected effect size (g). A standard statistical significance level, $p = 0.05$, was set for all analyses in accordance with traditional practice in education research.

For the qualitative phase, we used deductive thematic analysis to analyze the interview data to further investigate the findings from the quantitative analysis. Thematic analysis can be used "both to reflect reality and to unpick or unravel the surface of 'reality'" (Braun and Clarke, 2006, p. 81). We considered our initial interpretations of the quantitative analysis results to inform our assumptions about the nature of the qualitative data. We used a theoretical thematic analysis approach in that our coding of the qualitative data analysis was guided by our second research question. Themes were identified using a semantic approach by looking at specifically what the participants said (Braun and Clarke, 2006). To begin, three researchers transcribed the interviews and carefully read each response to identify meaningful units of text—words, phrases, or sentences that stood out to the coders as related to our second research question in some way. Next, we grouped the units together into tentative categories, discussed the categories, and decided on a final set consisting of five major themes. We then interpreted the themes to theorize their importance in relation to the quantitative findings and prior literature.

4. Results

The primary interest of this exploratory study was to determine if using DIME maps in some way mediated learning for the treatment group as compared to the control group. After the data were collected and analyzed preliminarily, it also became interesting to examine the effects of the DIME maps by gender. After the quantitative analysis, the interviews were examined using thematic analysis. The three coders identified five major themes that were related to the second research question.

4.1 Quantitative Results

By using two-sample t tests, we determined that there were no statistically significant differences in pretest scores across Self-efficacy and Connections in Knowledge between the treatment and control groups nor between the female students of each group. Therefore, the pretest and posttest data were combined to form new variables, *Self-efficacy growth* and *Connections growth* (see Table 1), by subtracting the total for the pretest from the total for the posttest for each category. Additionally, boxplots indicated no univariate outliers, and tests for Mahalanobis distance indicated no multivariate outliers. Therefore, a MANOVA was a suitable choice for the analysis of these two new data groups. The adjusted R^2 effect sizes were small and relatively unimportant. Therefore, the random assignment of the participants and the pretest results allowed us to conclude with reasonable certainty that any obtained effects were due to the intervention and use of the DIME Map system.

Table 1: Descriptive Statistics for Subgroups' Growth

	Self-efficacy Growth						Connections Growth			
	Control			Treatment			Control		Treatment	
	n	Mean	SD	n	Mean	SD	Mean	SD	Mean	SD
F	5	-0.200	2.049	5	2.800	1.789	0.200	.447	1.600	1.140
M	10	2.100	3.143	11	1.273	1.849	0.700	0.823	1.455	0.934
All	15	1.333	2.968	16	1.750	1.915	0.533	0.743	1.500	0.966

Note. F = Female, M = Male, All = Males and Females Combined

Results from the MANOVA showed that statistically significant differences existed between groups (see Table 2). The overall model was statistically significant ($p < .05$), indicating a statistically significant difference in Self-efficacy growth and Connections growth based on the predictor variables: group (control vs treatment) and gender (female vs male) ($F(6,52) = 2.38$, $p < .05$; Wilk's $\Lambda = 0.616$). There was not a statistically significant interaction effect between group and gender on Self-efficacy and Connections ($F(2,26) = 2.60$, $p = .094$; Wilk's $\Lambda = 0.834$). The lack of a statistically significant interaction effect indicated that the treatment may not have had different effects based on gender.

Table 2: Results of the MANOVA on Self-efficacy Growth and Connections Growth

Source	Wilk's Λ	df	F	p
Model	0.616	3	2.38	0.042
Residual		27		
Group	0.696	1	5.67	0.009
Gender	0.983	1	0.22	0.801
Group by Gender	0.834	1	2.60	0.094
Residual		27		

The standardized effects were computed using Hedges' g for all variables, including those that were not of primary interest, to provide study information for future meta-analyses (see Table 3). Because no statistically significant differences were found between groups and subgroups on the pretest, effect sizes for multiple comparisons were calculated. DIME maps had positive effects on Self-efficacy growth ($g = 0.158$) and Connections growth (g = 1.052). In particular, female students who used DIME maps showed greater growth in Self-efficacy ($g = 1.260$) and in Connections ($g = 0.466$) than female students in the control group. Finally, it is important to note that although a significant interaction effect between group and gender was not detected in the MANOVA, different outcomes were observed in the two groups when comparing female students and male students. In the control group, male students outperformed female students in Self-efficacy growth ($g = 0.707$) and Connections growth ($g = 1.082$). However, the opposite was observed in the treatment group, wherein female students outperformed male students in Self-efficacy growth ($g = 0.737$) and Connections growth ($g = 0.129$). These results suggest that using DIME maps may actually have had a larger effect on female students than on male students, and this finding warrants further investigation in future studies.

Table 3: Hedges' Bias Corrected Effect Sizes (*g*) for Growth in Self-efficacy and Connections

		Hedges' Bias Corrected Effect Sizes (*g*)		
	n	Self-efficacy growth		Connections growth
Control vs Treatment (Overall)	31	0.158		1.052
Control vs Treatment (Female students only)	10	1.260		0.466
Control vs Treatment (Male students only)	21	-0.297		0.930
Female vs Male (Control group)	15	0.707		1.082
Female vs Male (Treatment group)	16	-0.737		-0.129

Note. Positive effect sizes indicate the second named group scored higher than the first.

4.2 Qualitative Results

The three authors, including two professors and a graduate student, performed the initial coding of the interview transcripts. Once all three had initially examined the transcripts, we met together to discuss the list of codes until 100% agreement was achieved. We came up with 52 unique codes that described the interviewees' words, phrases, and sentences. From those 52 codes, we identified patterns and sorted them into five themes consisting of how DIME maps were considered a pre-assimilator of knowledge, led to improved accessibility, involved high interactivity, were a tool for empowering learners, and displayed initial complexity. We identified these themes as being particularly connected to answering our second research question. We then examined, in order of prevalence in the original interviews, the themes and their underlying codes and units, or codable portions of the transcribed interviews.

4.2.1 Pre-Assimilator of knowledge

The first major theme we noticed was that DIME maps served the students as a pre-assimilator of knowledge—a tool that helped digest or breakdown complicated concepts, making them easier to learn. During the automatic creation of DIME maps, the DIME Map system breaks down the information contained in a PDF textbook chapter or document section and presents concepts along with the relationships between those concepts. In the DIME map, students can see how introductory concepts, usually in the form of individual variables, build into more complex concepts or equations. Those complex concepts are themselves connected to each other and to further complicated concepts. While describing how the map showed the connections between individual equations, Alice explained that using the DIME map "makes it easier to understand how everything has an effect on everything". Implied connections between concepts became explicitly represented in DIME maps. In this way, DIME maps served as an advance organizer of knowledge. Advance organizers have been found to be particularly useful for novice learners (Gurlitt, et al., 2012), which can help explain why our novice students valued how DIME maps organized information for them. During the interview, Chris explained the following:

> *It allowed me to see the formulas, which was always nice. Usually, when I read books like that, I have to find the formulas to write them out. This kind of just did that for me... It would definitely make learning through textbooks a lot easier.*

Chris' description of how the DIME maps reduced effort connects directly to prior literature on advance organizers and reduction of cognitive load. Cognitive load theory assumes that learners have limited working memory (Baddeley, 1986; 1992; Kirschner, 2002). By presenting the interconnected nature of concepts, DIME maps reduce the extraneous cognitive load of finding and organizing formulas. Thus, students have access to

more available working memory to focus on understanding the application of the concepts presented and any connections that they do not yet fully understand. In this way, the interviewed students made clear how DIME maps improved their Connections in Knowledge growth.

4.2.2 Improved accessibility

The second theme we identified was that DIME maps offered improved accessibility. There are many abilities that some students may lack and which we normally discuss when it comes to accessibility (visually impaired, language impaired, etc.). However, there is another, cognitive ability, which may be lower or higher for individual students due to varying opportunities and propensities. It is here that we see the DIME map making a larger difference. When asked whether DIME maps helped her to learn differently, this was Alice's response:

> *I feel that it did [help me to learn differently] because once you see something visually, um, it kind of helps you get a better understanding. Because I'm a visual learner, or visual and kinesthetic, so it helps me when I move the mouse around, and I see like how all the terms are connected to one another.*

Alice appreciated having a visual organizer of knowledge with which she could interact. This result corresponds with decades of research that have shown graphic organizers of knowledge to be valuable for improving students' learning (Horton, Lovitt and Bergerud, 1990; Dexter, Park and Hughes, 2011). DIME maps helped students to see knowledge in different ways that they had never thought of before. For Bailey, this benefit was especially noticeable when extra information was hidden. She commented, "It made it so much simpler when you pressed on it and it only showed a few terms and you could actually look at it. It was better when it showed it like that". Complex concepts and relationships between concepts were made approachable and, therefore, more accessible. Chris confirmed this notion when describing how he thought that using DIME maps "definitely made it faster. I'm not sure it improved the learning, but it definitely made it faster, which would allow you to learn more in less time". Although he was not sure whether the depth of learning was improved, Chris noticed that he could learn faster using DIME maps. Graphic organizers in general have been shown to facilitate faster comprehension of study materials than text alone (Robinson, 1997; Ward and Marcketti, 2019). Students who used DIME maps noticed that DIME maps assisted in visualizing connections between knowledge and decreased time required to learn new material, making them feel that they could learn faster and more easily, important aspects of self-efficacy in learning physics..

4.2.3 High interactivity

All of the interviewed students described the high level of interactivity available with DIME maps and how this improved their learning experiences. Alice was particularly impressed with the features of DIME maps, describing the benefits of an interactive system over a static textbook:

> *Yeah, I feel the textbook, it doesn't have as much… you can't really touch it or interact with it as much. It was really helpful to have [the DIME map] in front of you and see it and see if you move this strand here and if you move that strand there or whatever, you got to see, like, where it had impacts. Whereas in the textbook, it would be really straightforward and you really wouldn't understand it as much. This kind of just sped up and made the learning process easier for me.*

Visual connections alone were not enough for Alice. She enjoyed being able to actively manipulate the map and watch how the strands would move. This feature helped Alice understand concepts were robustly interconnected.

Students expressed appreciation for other features of DIME maps as well. Bailey and Chris both expressed appreciation for the navigation and control features of the DIME maps. Bailey mentioned that she enjoyed "clicking and being able to see connections. Clicking and then the textbook would make it go to that spot. That was good". Chris mentioned "being able to highlight things and see where they are on the page". Both of these students could decide what they were interested in learning about and then use the DIME map to navigate the textbook and focus their learning. Another example of interactivity of the DIME maps that students enjoyed is in its search feature, which finds instances of term occurrences in both the textbook and the map. "I thought it was really good for finding one section", Bailey commented. Through these observations, we determined that by reducing cognitive load in the learning process, DIME maps improved students' Connections growth.

4.2.4 Tool for empowering learners

Students expressed that using DIME maps generally empowered them as learners. A powerful example of this was seen with Alice, who decided to use the DIME maps to help her roommates:

> *I have my roommates, and they are in the same course as me, so all three of them, they were in a separate class that didn't have the map. So I found myself a lot at home, we would like look over our notes or whatever, and I found myself kinda helping them a little bit just because I understood it and they were still a little stuck on it... I showed them it for a little bit. They thought it was very difficult. They thought the map was difficult just because it had like so many things. Like strands. But once they kind of got the gist of it, it was good and it helped them as well… Also, they didn't know that some of them were connected. So, like, once they saw the chains light up, they were like, "oh!"*

Alice was empowered by the DIME maps to feel comfortable with her own understanding and use the tool to then teach her roommates. Peer teaching has been shown to be linked to higher self-efficacy for learning (Brannagan, et al., 2013; Irvine, Williams and McKenna, 2018) and deeper learning of concepts (Evans and Cuffe, 2009; Irvine, Williams and McKenna, 2018). Personal performance accomplishments or mastery experiences have been shown to also improve self-efficacy (Bandura, 1977; 1997). That is exactly how Baily recalled her experiences using the DIME maps.

Throughout the class, students were asked to research specific concepts and share what they learned. When Bailey wanted to understand the concepts, she set out to know what the formula was and how it could be used. Bailey mentioned how "it was good to find the formulas, and then you could see what connected to what and then branch out from there". For Bailey, DIME maps made the first step of the learning process easier. Through using DIME maps, Bailey was able to successfully explore relationships between concepts and learn more deeply. Even though she expressed having some difficulties early on, Bailey described how, "At first, I was a little confused. But then after some time, I definitely liked it… I figured it out, and I understood". Her confusion was replaced with successful navigation of the complex material. This mastery experience helped Bailey feel more confident in her abilities to learn. In summary, students who used DIME maps became more empowered learners and developed self-efficacy through concept mastery and peer teaching experiences.

4.2.5 Initial complexity

Students revealed that they initially found the visual presentation of DIME maps complex and confusing. When first opened, the DIME map originally showed all of the mathematical variables, expressions, and formulas contained in the selected physics textbook chapter (see Figure 2). One of the biggest lessons we learned was that this presentation of all of the mathematical objects and relationships was overwhelming for students. Bailey's comment that, "At first, I was a little confused", was later followed by, "It was just a little confusing to me because of all the… just seeing all the equations at once and then being surprised". She noted that one possible source of her confusion was because she "had never done any physics before". Without prior encounters with these concepts, she found the display of all of the concepts at once somewhat overwhelming. Chris also drew our attention to this issue in his interview when he described his first impressions of the DIME map:

> *It was kind of messy. It looked like a really useful tool, but it looked kind of messy and all jumbled up. There was this one point, when I first opened it, that there were so many lines you couldn't see which line went to where.*

When there are so many objects and links between objects, students could not understand which concepts were connected. Thus, the benefits of DIME maps were overridden by confusion.

Alice also found the DIME maps to be complicated at first, stating, "Well, I thought it was really complicated, um, because of all the equations and symbols I didn't know. But once I started learning about it, I realized how it was kind of... all just connecting your learning". Too much information was clearly presented on the screen without a gentle introduction. Students initially experienced a heavy cognitive load. Excess visual load can lead to cognitive overload, where students' construction of internal connections between visual and verbal information is disrupted and some information is lost (Mayer, 1997). Interactive materials are especially prone to the issue of presenting students with too much cognitive load (Moreno and Mayer, 2007). For the students who engaged with DIME maps, the initial confusion was eventually replaced with understanding. Alice told us the story of this progression: "Well, I thought it was really complicated, um, because of all the equations and symbols I didn't know. But once I started learning about it, I realized how it was kind of... all just connecting your learning". This seems to bring about a sense of expertise and educational independence—Alice was able to learn independently and then turn that knowledge into something she could translate as she taught her roommates. Both concepts, expertise and independence, seemed to be fueled by the self-efficacy that grew as an amalgamation of small events situated in the nexus of real-life instruction and affordances from AI.

5. Discussion

Through this study we extend the research on concept mapping by determining that automatically generated concept maps using an AI system are an effective alternative to traditional instruction. Previous algorithms designed to help construct concept maps have proven effective at improving student content knowledge but required teacher or expert input in order to create a concept map (see McClellan, et al., 2004; Atapattu, Falkner and Falkner, 2017; Shao, et al., 2020). The current study brings the field forward by examining the effects that a fully automatic concept mapping system, the DIME Map system, has on student cognitive and affective learning outcomes. Our findings suggest that DIME maps have similar positive effects on student learning as previous concept mapping systems but with the added benefit of relieving teachers of the burden of concept map creation. The success of DIME maps derives from several factors.

Like concept maps before them, DIME maps can provide a means to reduce cognitive load, and this characteristic comes from the way the system approaches mathematical or symbolic language (see Hiebert, 1988; Goldin and Kaput, 1996; Esteve, 2008; Silver, 2017). By pre-assimilating the knowledge contained in textbooks and presenting it as an alternative visual representation, DIME maps make mathematical and symbolic language more accessible to students. As students interact with DIME maps, they observe the nuanced interplay of mathematical and symbolic language, once in the textbook and again in the DIME map. In doing so, DIME maps have the potential to facilitate the development of a stronger understanding of the semantics and syntax of mathematics (see Capraro, et al., 2010). In this way, DIME maps address the reality of the disciplinary language as a potential gatekeeper to student mathematical success.

Cognitive load on students is additionally reduced by the ability of DIME maps to visually represent the complexity of mathematics. For many students, the syntax and semantics of algebra, which often integrate aspects of other formulas (Capraro, et al., 2010; Rupley, et al., 2011), is a complex web that is difficult to understand. To approach such complexities, students using DIME maps can easily track a complex formula back through its development using a wide variety of interactive features and meet immediate personal learning needs. These features correspond to the several types of interactivity described by Moreno and Mayer (2007) for multimodal learning environments: controlling, manipulating, searching, and navigating. However, it is important to note that interactivity alone is not sufficient to promote deep learning. The behavioral activity promoted by interactive elements does not necessarily accompany cognitive activity required for deeper learning (Moreno and Mayer, 2007). Although we have seen that DIME maps offer high levels of interactivity and ease cognitive load, future research is needed to investigate what multimodal design principles are present in DIME maps and support deep cognitive processing.

An additional benefit that DIME maps have over traditional instruction concerns the broad research agenda of reading in the mathematics content area (see Moschkovich, 2007). By providing an alternative, visual representation of written text, DIME maps have the potential to improve learning for students who are not well served by traditional textual reading. The removal of barriers between lengthy expository text and student comprehension and translation into mathematical symbols means that DIME maps can be considered to be an equitable and accessible tool for underserved populations (see Moschkovich, 2013) or people with comorbid reading difficulties or dyslexia. In the control group for this study, male students outperformed female students on both growth in self-efficacy and growth in ability to make connections between tangentially and hierarchically related concepts. However, the use of DIME maps led to the exact opposite results in the treatment group, in which female students outperformed male students on both constructs. This interaction effect was not statistically significant, but due to the large differences in effect sizes, we suggest that replication studies measure the varying effects by gender of using DIME maps. Additionally, our sample was not sufficient to support conjectures about underserved students or those with comorbid reading difficulties, so future research might be directed toward these populations to determine if this affordance could make a meaningful contribution. The overall potential for this tool to address both the rate of learning and the depth of learning provides broader impacts across many different student populations, including potentially those with learning difficulties, language minorities, and underserved populations.

The DIME map system has further implications for future research, specifically on how connections between the text intended to teach mathematics and symbolic representations emerge for students (see Hiebert, 1988; Godino, Batanero and Font, 2007). Because DIME maps visually display the interrelationships between concepts, students using DIME maps can simultaneously read about a concept and its related formulas while visually seeing the connections between each node displayed across chapters as well as see how those concepts develop and build upon each other. The intellectual importance of the software lies in the ability to better understand how

students learn and think while browsing and learning from an interactive model. Future research may examine how students navigate the web of connections the DIME Map system develops from a textbook chapter and if their structure of understanding follows the pathways set forth in the textbook.

The limitations of the current study necessitate further research on student cognitive and affective benefits from DIME maps as well. The setting of a STEM summer camp physics class the students self-selected into provided participants who were already motivated and interested in learning the topic. Future studies should seek to implement the DIME Map system in formal learning settings to more deeply examine potential benefits that DIME maps may have over traditional instruction. Furthermore, the small sample size of three student interviews, while appropriate for the current study, does limit our understanding of the mechanisms that enable DIME maps to improve student connections in knowledge and self-efficacy in physics. Future research should thus analyze the effects of DIME maps on larger groups and across more variables, and this will enable education researchers and instructors to better understand how DIME maps may prove to effectively improve understanding, retention of knowledge, and self-efficacy for high school students in mathematics.

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Appendix A

		Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
1.	I feel that complex physics concepts are approachable.	1	2	3	4	5
2.	I am comfortable exploring new topics in physics.	1	2	3	4	5
3.	I understand ways in which physics concepts are related to each other.	1	2	3	4	5
4.	I am able to learn difficult physics concepts.	1	2	3	4	5

Appendix B

Please write your answers in the blanks provided. Each question **may have more than one answer**.

EXAMPLE: If A and B are correct, please write both answers.

1. Moment of inertia is used to calculate:
    a. Angular velocity
    b. Angular momentum
    c. Rotational kinetic energy
    d. Angular displacement
2. Energy in a fixed axis rotation system relies on:
    a. Moment of inertia
    b. Angular velocity
    c. Angular displacement
    d. Time
3. A 10 kg point mass travels around a circle of radius 5 m at an angular velocity of 3 radians per second. What is its angular momentum?
4. Increasing radius and keeping mass constant causes the moment of inertia to:
    a. Decrease
    b. Remain the same
    c. Increase
5. If an object's angular velocity stays constant, then its rotational kinetic energy remains constant.
    a. True
    b. False

Appendix C

- What was your first impression of this map?
- Did the map help you to approach things differently? To learn differently?
- What is one feature of the tool that you found helpful?
- Did you see the system improving your understanding of math or science material?
- Did you use the system throughout the week to browse the material?
- How useful was this system compared to traditional reading?
- Did you notice the colors on the map? Did they mean anything?
- What kind of additional controls would you add to the graph to help understand the text better?

- If it was possible for you to create your own graph, would you do that and share it with other students?
- Would you consider competing with other students to see who could make the best graph?
- Would you want to use this tool to learn mathematics or science for school next year?

Factors Mediating the Link Between Engagement and Satisfaction Among Online English-Mediated Instruction Learners During COVID-19

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Abstract: The COVID-19 pandemic forced universities worldwide to make the switch to online instruction, raising concerns about the quality of online courses and their impact on student satisfaction and engagement. This study aimed to explore Korean university students' satisfaction levels with online English-mediated instruction (EMI) courses during the pandemic and identify factors that influence class satisfaction. The purpose of this study was to provide insights into how EMI instructors could improve their online teaching practices during and after a pandemic. The hypothesis was that instructional strategies (IS), academic conscientiousness (AC), and academic integration (AI) could mediate the link between engagement and satisfaction. The study used a survey design to collect data from 219 Korean university students who took online EMI courses during the spring 2020 semester. The survey collected demographic information as well as students' perceptions of valuable IS, AC, AI, and satisfaction. Data analysis included independent samples t-test, correlation analysis, Structural Equation Modelling (SEM), and multiple regression analysis. The results showed IS use and satisfaction differed among disciplines. Specifically, there were significant differences in satisfaction levels between Arts, STEM, Business, Social Sciences, and Literature and Languages majors. Additionally, there were significant relationships between demographics, AC, AI, IS use, and satisfaction. SEM was used to provide a general view of factors mediating the link between engagement and satisfaction. The results revealed that AC, AI, and IS use mediated the link between engagement and satisfaction. Multiple regression analysis showed that students were more satisfied with instructors who demonstrated care and warmth using social networking sites to communicate. Overall, this study provides valuable insights into student satisfaction with online EMI courses during the COVID-19 pandemic and for the future of online EMI teaching-learning. The findings suggest that online EMI instructors should consider using social networking sites to communicate with students in order to increase satisfaction levels. Additionally, instructors should be aware that different disciplines may require different instructional strategies to maximize student engagement and satisfaction.

Keywords: English-mediated instruction (EMI), Engagement, Instructional strategy, Online learning, Satisfaction

1. Introduction

When students study online, they improve attention to detail, time management, and critical thinking skills, as well as develop writing skills, and improve oral communication ability (Clinefelter, Aslanian, & Magda, 2019). Moreover, online students have a willingness to continue to enroll in and recommend online learning to others (Borstorff & Lowe, 2007). However, Means and Neisler (2021, p. 23) reported a "sharply lower student satisfaction with their courses after they shifted to remote instruction in response to the COVID-19 pandemic (from 51% to 19% of students 'very satisfied')".

Online learning was termed Emergency Remote Learning (ERT) and refers to remote teaching and learning that would normally be face-to-face or blended (Hodges et al., 2020). Once an option for students, online learning suddenly became an obligation (Bozkurt & Sharma, 2020). Basilaia and Kvavadze (2020) argued that countries with the capacity could successfully transition from traditional to online education. However, students at universities in the UK and the US in 2020 demanded tuition refunds, claiming their studies had been disrupted and they were not receiving the educational experience paid for (Belkin, 2020; Weale, Hall, & Adams, 2020). Korean university students also demanded tuition refunds, even though for six years prior to 2020, the nation ranked first on the Bloomberg Innovation Index as the most innovative technological power in the world. Claiming paid tuition did not equate to the level of education received from learning from online classes, 22 national and private student councils from various Korean universities demanded tuition refunds (Lee, 2020). Students cited dissatisfaction with lecture quality, lack of communication with instructors, and the lack of practical classes (Chung, 2020). In other words, Korea, a nation known for its ICT adoption and regular use of the Internet, had 99.2% of participants in a poll of over 20,000 university and college students demanding a tuition refund citing poor quality of online lectures (Yoo, 2020).

Reference this paper: Murdoch, Y. D. and Lin, Y., 2023 Factors Mediating the Link Between Engagement and Satisfaction Among Online English-Mediated Instruction Learners During COVID-19, *The Electronic Journal of e-Learning, 21(3)*, pp 158-174, available online at www.ejel.org

In English-mediated instruction (EMI), instructors use English to teach the academic subject-matter. EMI is not the same as language classes nor first language (L1) English classes. Both the setting and the students' roles are different. The primary goal is for students to achieve their course objectives in English (Dearden & Macaro, 2016). The majority of EMI class students are non-L1(English) speaking students who are local national students, but class enrollment will also include international students. By 2011, it was estimated that approximately one-third of all university classes in Seoul, South Korea, herein Korea, were offered as EMI classes (Kim, Kweon, & Kim, 2017). However, due to COVID-19, the nation announced that all education would be online, and this included EMI classes. The abrupt 2020 COVID-19 pandemic-induced switch to online learning caused many instructors, including EMI instructors, to struggle, especially those who had never taught or never planned to teach online, and to face an arduous curve learning new or modifying existing instructional and communication strategies as well as demonstrating care and concern (Gillis & Krull, 2020; Johnson, Veletsianos, & Seaman, 2020). Moreover, a number of university EMI students may never have planned for or had had little or no experience with online learning, even though the younger generation is likely quite sophisticated in online resources usage. In other words, EMI students who could have generally been amiable towards online learning expressed dissatisfaction as they felt more tired and pessimistic, and that online learning affected social relationships and motivation beyond academics (Gonzalez-Ramirez et al., 2021).

Given the number of various issues involved in moving from traditional to ERT during 2020 that universities, instructors, and students had to face, it is probable that disappointment with the tertiary education situation, masqueraded as class dissatisfaction, not actual lecture quality or instructional strategy usage satisfaction. Better understanding of EMI tertiary student satisfaction could increase EMI instructor effectiveness, improve pedagogy, and suggest directions for productive change and support on-going development.

Satisfaction during COVID-19 pandemic transition to online learning depended on students' emotional responses to social and technical aspects, and if the student felt successful at online learning (Conrad et al., 2022). In other words, satisfaction shapes positive learning outcomes and is an important requirement for learning success (Sinclaire, 2014), but there is a research gap in the examination of factors mediating the link between engagement and satisfaction, in particular for online EMI classes. The paper hypothesized that a) academic conscientiousness, b) academic integration, and c) instructional strategy use could have a direct effect on satisfaction and mediate the relationship between online engagement and satisfaction. Understanding of the factors that influence satisfaction with online EMI courses has not yet been well explored, particularly among university students. The study seeks to identify factors that mediate the link between engagement and satisfaction, as well as the instructional strategies that students feel are most effective for their different disciplines. By addressing this knowledge gap, the study provides insights into how instructors can improve their teaching practices and increase online EMI course student satisfaction.

1.1 Research Objectives and Questions

The primary research aims of this study are to investigate variables that affect student satisfaction with online EMI courses and to identify mechanisms through which these variables operate. Intensified social distancing measures required instructors around the world to move their lectures online. Korea, like other countries, suffered at the beginning of the pandemic and had very little experience or guidance from the past or other countries. Nevertheless, classroom and online learning will continue to meld after COVID-19 is no longer a threat as the flexibility and range of online learning will be useful and familiar to both educator and students (Lockee, 2021).

To address the knowledge gap on the relationship between student engagement and satisfaction among online EMI learners and to develop efficient teaching strategies for the post-COVID era, research questions for this exploratory study on online EMI class satisfaction are:

RQ1: What instructional strategies do learners consider most useful?

RQ2: What are the relations between learners' background, demographic variables, and variables of interest?

RQ3: What is the relationship between online engagement and satisfaction as affected by a) academic conscientiousness, b) academic integration, and c) instructional strategy use?

RQ4: What factors influence specific aspects of online EMI learners' class satisfaction?

2. Literature Review

2.1 EMI Satisfaction

Studies have reported positive levels of satisfaction and attitude with EMI classes (Akçayoğlu, Ozer, & Efeoğlu, 2019; Yeh, 2014). For instance, Byun et al., (2010) found that EMI policy was viewed positively in terms of overall satisfaction level, and Yu and Chung (2009) found that EMI class students showed positive attitudes towards EMI class effectiveness on subject matter, motivation, and learning activities. More recently, a paradoxical attitude was found among EMI students in Korea: although only 22% of students in both Korean-mediated Instruction (KMI) and EMI classes stated that EMI classes improved their English skills, most students still support a school EMI policy, in spite of KMI-class students being superior both in class satisfaction and class performance (Kim & Yoon, 2018). EMI, though, is not without dissatisfaction: students favoured L1 classes over EMI classes with regards to English ability, class interaction, and satisfaction (Kim, Kim, & Kweon, 2018), and Lei & Hu (2014) reported over half of their study participants considered EMI unsatisfactory. One EMI study found that overall satisfaction correlated with instructor organisation and that overall satisfaction, instructor encouragement, and instructor organisation were positively linked to task value (Ancliff & Kang, 2017). However, EMI students who do not value EMI classes may not sense satisfaction, especially if classes are mandatory requirements.

At the time of the current study, there was a lack of online EMI satisfaction investigations. However, since then, a literature investigation found three studies on online EMI satisfaction. One investigation of online EMI students in Turkey on the rapid move to ERT found low satisfaction with learning, and there was a significant positive correlation between perceived level of interactional quality and satisfaction (Yüksel, 2022). Likewise, examination of international students' perceptions of ERT in an online EMI class in China found low levels of satisfaction and that low levels of emotional engagement predicted this low level of satisfaction (Tian & Lu, 2022). In an elective blended EMI class—asynchronous and synchronous—student satisfaction remained steady with ERT following an organised, productive structure of combined work (Lin et al., 2021).

2.2 Satisfaction and Engagement and Their Relationship

Student satisfaction, especially with teaching and learning, is valued at universities (Douglas, Douglas, & Barnes, 2006; Ginns, Prosser, & Barrie, 2007). Globally, students' lack of college persistence with online learning and its' consequence of attrition is a recognised concern (Hart, 2012). Research on L1 classes has shown satisfaction with online and traditional learning to be similar (Nichols, Shaffer, & Shockey, 2003; Driscoll et al., 2012). EMI research, on the other hand, has found both high and low rates of satisfaction from students in traditional classrooms (Fernández-Costale, 2017; Kim & Yoon, 2018). The meta-analysis by Gegenfurtner and Ebner (2019) found descriptive differences, but as the effect was negligible, reported satisfaction in interactive online learning to be as high as in traditional classroom or asynchronous online instruction. However, Guest et al., (2018) examining the impact of transitioning from traditional to online did find that online learning lowered class and instructor, to a lesser degree, satisfaction among students. Similarly, a much lower satisfaction level was also reported by Means and Neisler (2021) when traditional university classes shifted to online due to the COVID-19 pandemic.

Engaged students invest effort, time, and emotion into learning (Dixson, 2015). A literature review by Delahunty, Verenikina, and Jones (2013) that revealed that online learners need clear, frequent, and structured opportunities to engage with fellow learners online as they cannot engage physically. In a qualitative case study reporting on the experiences of students, Kahu, Picton, and Nelson (2020) reported student engagement led to satisfaction. In the study, participants' engagement in academic coursework led to positive academic outcomes of knowledge and grades, as well as satisfaction. Farrell and Brunton (2020) also argued that for university students, psychosocial factors such as peer interaction and teacher involvement affected student engagement online as well as course design.

Instructors and course designers can better understand students' needs if they understand online satisfaction with what and how students learn (Rios, Elliott, & Mandernach, 2018). Studies have indicated that engagement impacts learning outcomes; specially, engagement seems to affect quality and depth of learning as well as satisfaction (Meyer, 2014). Engagement, however, was found to be not statistically associated with overall satisfaction (Pelletier et al., 2017). Nonetheless, it was found to partially mediate the effect of instructor presence on student satisfaction (Gray & DiLoreto, 2016). Students have been found to concurrently assess how aspects of an online course and any aspect of engaged learning such as understanding materials, formulating questions, and managing their own learning affects their satisfaction level (Dziuban et al., 2015). Hence, in

addition to satisfaction, persistence is among factors connected to engagement, and interaction with instructors promotes greater effort (Kuh et al., 2006).

2.3 Academic Conscientiousness and Academic Integration and Relationship With Satisfaction

The College Persistence Questionnaire (CPQ) is a validated and reliable six-factor structure tool (Davidson, Beck, & Milligan, 2009; García-Ros et al., 2019). Two factors of interest from the CPQ: Academic Consciousness and Academic Integration could be influencing the effect of engagement on satisfaction. Academic Integration (hereinafter AI for the purposes of this study)—perceptions of learning success and instructor support—has been shown to be one factor influencing online students, especially timely, proactive, and embedded support. Student satisfaction as indicated by continuing and succeeding in their courses, and in attaining a degree, was found to be positively and strongly affected by early, personal, frequent communication, and personal contact, as well as in supportive online class design in which the instructor acted as a guide through the learning process and was readily accessible to student concerns and questions (Stone & O'Shea, 2019). AI, then, positively influences students (Liu & Liu, 2000; Park & Choi, 2009). In particular, faculty services such as instruction, individual student care, fairness and feedback, as well as availability and knowledge of the teaching field were all confirmed to have a positive impact on students' satisfaction (Kieng, Phothikitti, & Vongurai, 2021). However, Parkes, Stein, and Reading (2015) reported that online students felt unprepared to integrate online learning into their lives and did not have the necessary skills.

Academic Conscientiousness (hereinafter AC for the purposes of this study), on the other hand, refers to being organised, hard-working, and adhering to regulations. While Sweeney (2022) found higher conscientiousness associated with an increased preference for face-to-face classes, Bhagat, Wu, and Chang (2019) reported that conscientiousness had a large positive role on students' perceptions of online classes. Namely, AC was found to reliably predict student impressions about online course engagement, anxiety, or preference (Keller & Karau, 2013). Moreover, AC has been found to have a direct effect on students' major satisfaction (Sanchez-Ruiz & El Khoury, 2019). Online requires students to take on more responsibility for their learning, but Casper et al. (2022) reported that during ERT, student amotivation was problematic for self-directed learning. Then, as Radovan (2019) concluded, online learning requires more motivation and effort on the part of students compared to face-to-face education.

2.4 Instructional Strategy and Relationship With Satisfaction

Just as AC and AI could be influencing learners' willingness to study and their desire for deeper learning and in turn could be influencing satisfaction, the instructor's instructional strategy use might either encourage or demotivate a learner to engage. Instructional strategies (hereinafter IS for the purposes of this study) or the specific teaching methods and approaches of the class are essential factors affecting online learning and learning experiences, for learning goals are attained through them, and in the Yang (2017) study, different IS had different impacts with online learning, and the most effective strategies were case studies, video demonstration, instructor's notes, mini projects, and discussion forums.

Elkins and McDade (2021) reported student satisfaction with online learning was related to students' opinions about course design and structure, relationships, and understanding. Smimou and Dahl (2012) confirmed a positive link between students' satisfaction and teaching quality, suggesting that effective online IS that meet both the needs and desires of learners influence satisfaction. Rois et al. (2018) argued that good course design and methods, as well as attention to students' needs, increased student satisfaction, which is critical to the success of online classes.

3. Method

3.1 Theoretical Framework

3.1.1 Factors mediating engagement and satisfaction

In the university online EMI teaching-learning environment, this study conjectures engagement might be indirectly affecting satisfaction through IS and aspects of learning persistence: AC and AI. Küçük and Richardson (2019) have argued that engagement is an additional predictor of satisfaction and because engagement predicts satisfaction in online learners, the *Community of Inquiry* (CoI) framework can help determine useful strategies to promote student engagement and satisfaction. They found teaching presence emotional, behavioural, and cognitive engagement had significant effects on satisfaction in the online environment. Lim, Murdoch, and Cho

(2021) also examined perceptions of teaching and learning as predictors of engagement during ERT and found instructor warmth and openness significantly predicted engagement.

3.1.2 Engagement

Tertiary education has long been interested in student engagement as an important aspect of instruction assessment and effectiveness. Increased student learning through increased effort, time, and commitment to active learning increases learning persistence and success (Jennings & Angelo 2006). Kuh (2009) defines student engagement as the time and effort directly related to student college goals and institutional persuasions of such student activity. Fredricks, Blumenfeld, and Paris (2004) reported three dimensions of engagement: behavioural, emotional, and self-regulation, which contribute to students' learning success and information on the quality of the teaching and learning environment. Engagement together with the CoI framework (Garrison, Anderson, & Archer, 1999), which consist of three essential elements for a transactional learning environment: (a) social presence—participating in the community as an accepted individual, (b) cognitive presence—constructing meaning through community communication, and (c) teaching presence—teachers and students share responsibility for the education experience, contribute to online learning success. Incorporating the CoI model, components of traditional classroom engagement, and social constructivist notions of learning, Dixson (2010) developed an online learner engagement scale to measure online students' behaviours and thoughts in class, their feelings about their learning, and connections to content, instructor, and peers. The meta-analysis by Trowler (2010) found literature about student engagement generally takes for granted its benefits, but student input is usually absent as the literature is written about students for teachers, researchers, managers, and others. This study seeks to therefore investigate engagement from students' perspective, namely satisfaction.

3.1.3 Satisfaction

Tertiary education has also long been interested in student satisfaction. Pelletier et al. (2017), however, found no statistical relations between student engagement and overall satisfaction, so investigation of factors mediating the link between engagement and satisfaction could supplement research. The need to meet students' expectations and have students complete their studies is important in terms of attracting and retaining students (Elliott & Healy, 2001). In order to maximize student satisfaction of a higher education course, it is necessary to know which key factors led to that maximization (Roura et al., 2017). Elliott and Shin (2002) pointed out that student satisfaction has usually been measured by single questions: simple to (a) answer and (b) analyse about overall satisfaction, but these types of questions may not indicate student satisfaction with discrete aspects of their university experience. Reviewing literature on student satisfaction in tertiary education, Weerasinghe, Lalitha, and Femando (2017) point out that after the original use of industry satisfaction models, various higher education-based models and frameworks were developed to measure student satisfaction in different dimensions and different geographical areas. This resulted in contradictions in student satisfaction in the same dimensions as well as different dimensions reflecting similar student satisfactions. However, most previous research concerns face-to-face methodology, and literature regarding key factors in online education is rare but needed because successful completion of online learning relates to satisfaction (Roura et al., 2017; Sachs & Hale, 2003). As such, this study investigates online satisfaction from the relatively unexplored context of online EMI.

3.2 Participants

Currently most major universities in Seoul maintain EMI classes at 30-40% of all offered classes (Jon, Cho & Byun, 2020), which is less than L1 classes at universities in Korea. To investigate online EMI classes, EMI instructors from five different disciplines at universities in the greater Seoul area were requested to upload a questionnaire onto their EMI classes' online lecture rooms and then request students in their classes to voluntarily participate during the first semester of 2020, the first pandemic-induced switch to online semester. After reading the purpose of the research, students gave informed voluntary consent to participate or opt out of the survey. While the questionnaire had 353 respondents, participants who responded with language-based class titles such as *English for Engineers* or did not respond to a large number of questionnaire items were removed from the sample. For the above explained reasons, the study sample size is considered suitable for a study on online EMI class satisfaction, and future studies can give rise to a meta-analysis (Lakens, 2022). The final sample used for analysis consisted of 219 participants and was comprised of a university in metropolitan Seoul (n=52, 23.7%), a university in the greater Seoul area (n=139, 63.5%), and other (n=28, 12.8%) were grouped as: Arts (e.g. *Visual Studio*), STEM (e.g. *Modern Physics*), Business (e.g. *Human Resources Management*), Social Sciences (e.g. *English Teaching Methods*), and Literature and Languages (e.g. *Korean-American Writers and Culture Identity*). This dataset was also used in Lim et al. (2022) after a uniqueness analysis and determination that a new paper could

be written from the dataset (Kirkman & Chan, 2011). There were 200 Korean students (91.3%) and 19 international students (8.7%), 88 males (40.2%) and 131 (59.8%) females, and 3 native speakers of English (1.4%) and 216 (98.6%) non-native speakers of English. Table 1 summarises additional demographics and background information.

Table 1: Participant Particulars

Category	Item	n (%)	Category	Item	n (%)
Year	1st	29 (13.2)	Prior Online Learning	None	165 (75.3)
	2nd	46 (21)		1	28 (12.8)
	3rd	70 (32)		2	6 (2.7)
	4th	74 (33.8)		3	4 (1.8)
Discipline	Arts	19 (8.7)		4(+)	16 (7.3)
	STEM	24 (11.0)	Prior EMI Learning	None	80 (36.5)
	Business	31 (14.2)		1	39 (17.8)
	Social Sciences	92 (42.0)		2	40 (18.3)
	Literature & Languages	47 (21.5)		3	10 (4.6)
	Non-response/Other	6 (2.7)		4(+)	50 (22.8)

3.3 Survey Instrument

The online survey, offered in both English and Korean, allowed participants to respond in their preferred language. It collected demographics information and respondents' perceptions of (a) valuable IS and (b) AC (all 3 scale items) and AI (all 8 scale items), scales from the CPQ by Davidson et al. (2009). The survey also included the 19-item Online Student Engagement Scale (OSE) by Dixson (2015), and researcher-designed items for satisfaction (hereinafter S) (5 items such as 'satisfaction with instructor care' and 'satisfaction with outside class interaction'). Items were assessed on a 5-point Likert scale (0-very little to 4-very much) and modified to directly reference EMI. A link to the survey was uploaded onto the online lecture rooms of EMI instructors who agreed to allow the link. The link opened from week 5 to 10 of the 15-week spring 2020 semester. Students, after reading the purpose of the survey, voluntarily participated.

4. Results and Data Analysis

This study used Stata 14.0 for data analyses. The collected survey data were analysed using independent samples t-test to confirm significant differences among variables, correlation analysis to confirm relationships between factors, Structural Equation Modelling (SEM) to explore structural relationships between factors, and multiple regression analysis to assess the strength of those relationships. As Vardeman and Morris (2003, p. 26) argue: "you must absolutely never use any statistical method without realizing that you are implicitly making assumptions," researchers performed analysis using the tools mentioned above within those assumptions.

4.1 Results

RQ1: What instructional strategies do learners consider most useful?

Students most often used 'uploaded pre-recorded lecture videos' (IS2, 51.6%) followed by 'video conference calling software' (IS1, 48.9%) and then 'slideshows & uploaded lecture audio files' (IS3, 42.5%). They also made use of 'SNS messaging with professors & classmates' (IS4, 27.9%), 'emailing with professors & classmates' (IS5, 31.5%) and others such as YouTube resources, L1 use, and in-person feedback (IS6, 1.8%).

RQ2: What are the relations between learners' background, demographic variables, and variables of interest?

Significant ANOVA results are presented in Table 2. AC was significantly higher in national compared to international students, but international students used more strategies than national students. First-years' AI was higher than upper-year students'. Students with more EMI experience used more strategies, particularly students who took 4(+) prior EMI classes compared to only 1 (p = .028) or 2 (p = .039). IS was statistically significantly higher among Literature & Languages compared to STEM (p = .004), Business (p = .008), and Social Sciences (p =. 023). For S, 'with instructor care' was higher in Social Sciences than STEM (p = .037) and Literature

& Languages than STEM (p = .029), and 'with instructor warmth' was higher in Social Sciences than STEM (p = .009) and Literature & Languages than STEM (p = .003).

Table 2: Group Differences

	Category	Item	Mean	s.d.	F / Prob.
Academic Conscientiousness	Nationality	Korean	10.57	2.23	10.46**/.00
		International	8.79	2.86	
Academic Integration	Year	1st	29.38	4.35	2.76*/.04 1–3* 1–4*
		2nd	27.39	4.46	
		3rd	26.67	4.32	
		4th	26.70	5.08	
Instructional Strategy	Prior EMI Learning	0	2.10	1.21	3.29*/.01 4(+)–1* and 2*
		1	1.67	0.84	
		2	1.70	0.88	
		3	2.30	0.82	
		4(+)	2.38	1.38	
	Nationality	Korean	1.97	1.09	4.94*/.03
		International	2.58	1.57	
	Discipline	Arts	2.21	1.23	4.00**/.00 L&L–STEM*, B*, and SocSc*
		STEM	1.54	0.93	
		Business	1.68	0.91	
		Social Sciences	1.95	1.03	
		Literature & Languages	2.57	1.41	
Satisfaction	With class progress	Arts	3.42	1.02	2.36*/.04
		STEM	3.63	0.88	
		Business	3.68	0.75	
		Social Sciences	3.87	0.79	
		Literature & Languages	4.04	1.00	
	With instructor care	Arts	3.84	1.07	2.91*/.02 SocSc–STEM* L&L–STEM*
		STEM	3.63	0.88	
		Business	4.00	0.73	
		Social Sciences	4.18	0.78	
		Literature & Languages	4.26	0.82	
	With instructor warmth	Arts	3.89	1.05	3.57**/.00 SocSc –STEM* L&L–STEM*
		STEM	3.42	1.10	
		Business	3.87	0.76	
		Social Sciences	4.14	0.87	
		Literature & Languages	4.30	1.00	

Note: B: Business, SocSc: Social Sciences, L&L: Literature & Languages

RQ3: Academic conscientiousness (AC), academic integration (AI), and instructional strategy use (IS) could have a direct effect on satisfaction and mediate the relation between online engagement and satisfaction.

SEM was used to understand the effects of factors on S. Table 3 presents correlations to first understand their relationships. Relationships between skills and emotion, between emotion and participation, and between AI and S were found to have strong positive correlation (from 0.6 to 0.8). The relationships between skills and a) participation, b) performance, and c) AI, between emotion and a) performance and b) AI, and between participation and performance were found to have moderate positive correlation (from 0.4 to 0.6).

Table 3. Correlations Among Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1												
2	.08	1											
3	-.15*	.09	1										
4	-.03	-.09	.29***	1									
5	-.01	.00	.10	.24***	1								
6	.10	-.08	-.06	.16*	.11	1							
7	.02	-.12	-.14*	.08	.10	.71***	1						
8	-.06	-.07	-.08	.17*	.03	.46***	.64***	1					
9	.06	-.22**	.05	.19**	.03	.57***	.58***	.49***	1				
10	.13	.21**	-.05	-.01	-.01	.31***	.15*	.04	.25***	1			
11	.05	.01	-.16*	.03	.06	.44***	.48***	.38***	.32***	.34***	1		
12	.03	-.03	-.18**	-.01	.03	.35***	.36***	.25***	.20**	.24***	.73***	1	
13	-.11	-.15*	.08	.10	.001	-.01	.14*	.13	.10	-.12	.09	.20**	1

*p<0.05, **p<0.01, ***p<0.001

Note: 1:Gender, 2:Nationality, 3:Year, 4:Prior EMI Learning, 5:Prior Online Learning, 6:Skills, 7:Emotion, 8:Participation, 9:Performance, 10:Academic Conscientiousness, 11:Academic Integration, 12:Satisfaction, 13:Instructional Strategy.

The SEM variables were the average scores in sections. Endogenous variables included observed variables (AC, AI, S, and IS), and the exogenous variable was OSE. The model hypothesised:

- OSE has an indirect effect on S through AC, AI, and IS.
- AC, AI, and IS have direct effects on S.
- AC is correlated with AI and IS.

Results indicated good goodness-of-fit for the proposed model (X^2/df = .58/2 = .286, CFI = 1.00, TLI = 1.03, RMSEA = .00). Having established model fit, the results of SEM were investigated. The Cronbach's alpha coefficient was .663, suggesting that the five factors (observed variables) have relatively high internal consistency. Table 4 shows the effect results of model analysis, and Figure 1 shows the confirmed research model.

Table 4: SEM Analysis

Effect	Pathway			$\mathcal{B}$	S.E.
Direct	AC	←	OSE	-.24**	.08
	S	←	AI	.95***	.06
			AC	.16***	.05
			IS	.46**	.15
	AI	←	OSE	.44***	.05

Effect	Pathway			$\mathcal{B}$	S.E.
	IS	←	OSE	.04	.02
Indirect	S	←	OSE	.44***	.06
Total	AC	←	OSE	.24**	.08
	S	←	AC	.02***	.05
			AI	.95***	.06
			IS	.46**	.15
			OSE	.44***	.06
	AI	←	OSE	.44***	.05
	IS	←	OSE	.04	.02

*p<0.05, **p<0.01, ***p<0.001

The model indicates that the average score in S was directly influenced by AI, AC, and IS (positively), and indirectly by OSE (positively). OSE had a significant direct influence on AI and AC (positively). Also, AC was positively correlated with AI, but inversely correlated with IS.

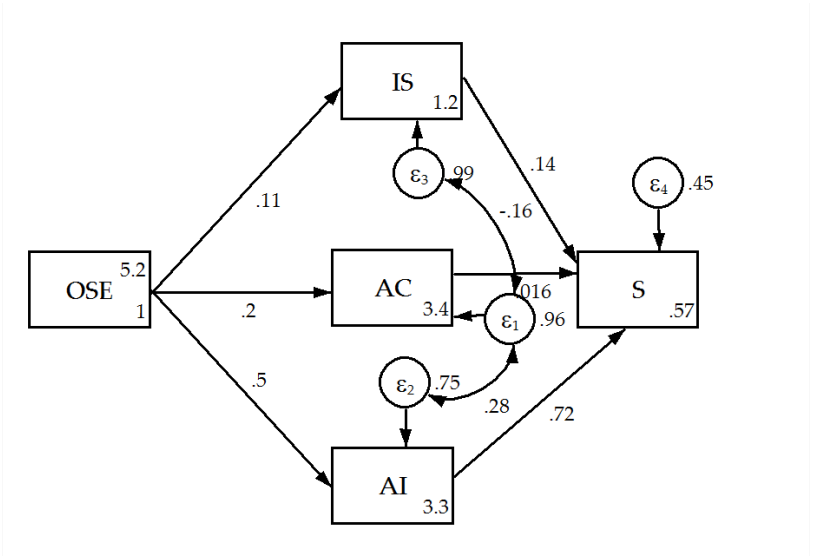

Figure 1: SEM Model

RQ4: What key factors influence specific aspects of online EMI learners' satisfaction with class?

SEM revealing the bigger picture prompted regression estimation calculations (Table 5) to investigate predictors of individual items of S. First, a collinearity test confirmed no collinearity in the estimation. Prior online learning was inversely associated with S3. IS variables are marked dummy variables if they used such strategies, and students were found to be more satisfied in S3 and S4 if they used SNS to consult with instructors and friends (IS4) while email correspondence (IS5) was found to be helpful in S4. OSE participation was inversely associated with S3, and if students frequently miss class (AC1), they may compromise S, especially S1 and S2. AI2, AI3 (especially), AI5, and A16 were positively associated with S.

Table 5: Satisfaction Regression Estimates

Variable Item	Satisfaction Items				
	S1	S2	S3	S4	S5
Gender	-.10	-.15	-.05	.19	.16
Nationality	-.08	-.02	-.10	.04	.03
Year	-.049	-.03	-.02	-.01	-.08

Variable Item	Satisfaction Items				
	S1	S2	S3	S4	S5
Prior EMI Learning	.01	-.03	-.03	-.01	-.01
Prior Online Learning	.05	-.02	-.09*	-.04	.07
Instructional Strategies (IS)					
IS1	.02	.12	.18	.03	.09
IS2	-.10	-.13	-.03	.04	.17
IS3	-.03	.02	-.10	.03	.14
IS4	.05	.04	.31**	.39**	.18
IS5	-.04	.06	.16	.30*	.11
OSE Component Factors					
Skills	.05	.18	.09	.14	.01
Emotion	.08	.06	.10	.14	-.19
Participation	-.05	-.16	-.20**	-.10	-.05
Performance	-.07	-.13	.01	-.09	.01
Academic Conscientiousness (AC)					
AC1	-.16*	-.20**	-.06	-.05	.07
AC2	.06	.08	.05	.00	-.05
AC3	.05	.08	.08	.06	-.01
Academic Integration (AI)					
AI1	.06	-.05	.08	-.10	-.01
AI2	.23**	.19*	.01	-.06	.34**
AI3	.38***	.39***	.31***	.43***	.25**
AI4	-.06	-.01	.14	.04	.14
AI5	.14*	.13	.01	.15	.13
AI6	-.00	.01	.08	.14*	.08
AI7	.03	.07	.07	.08	.07
AI8	.08	.00	.06	.07	.03
Constant	1.10**	1.75***	1.35**	0.77	0.45
Observations	219	219	219	219	219
R-squared	.60	.50	.54	.51	.46
Adj R-squared	.55	.44	.48	.44	.40

*p<0.05, **p<0.01, ***p<0.001

Note: S1:overall, S2:class progress, S3:instructor care. S4:instructor warmth; S5:instructor office hours & outside class interaction, AC1:Absent for reasons other than illness*, AC2:Assignment submission past due dates*, AC3:Disinterest & do as little as possible for class*, AI1:Understand instructor's thinking in lectures & when they ask students questions, AI2:Content with personal intellectual growth & class ideas, AI3:Content with quality of instruction, AI4:Instructor is

concerned with my intellectual growth, AI5:Interest in things said during class discussions, AI6:Connection between learning & my career possibilities, AI7:Instructor imposes unreasonable requirements & enjoys students' distress, AI8:Discontent with amount of instructor interaction*, *reversed

5. Discussion

5.1 RQ1: Instructional Strategies Considered Most Valuable

Our findings indicate that over fifty percent of students endeavoured to address their learning independently. However, like the Yang (2017), students offered differing opinions on the most effective strategies. Group discussions held via video conference proved to be an effective approach for elaborating their ideas. Approximately one-quarter of the participants sought concise and immediate feedback from both their peers and instructors, while a third opted to compose emails containing their questions. Overall, students demonstrated a preference for immediate feedback over-elaborated responses. This is comparable to Smimou and Dahl (2012) and Rois et al. (2018) as the needs of learners were being met, as well as Elkins and McDade (2021) who reported satisfaction with online learning related to students' opinions about course understanding. However, it should be noted that the study did not differentiate between feedback provided by peers and instructors, making it unclear which type of feedback was preferred by the students.

5.2 RQ2: Relations Between Learners' Background, Demographic Variables, and Variables of Interest

On the national ranking of conscientiousness, Korea ranked among the top 10 (Mõttus et al., 2012). A powerful cultural influence could be influencing Koreans students to have high AC. Korean students take EMI classes in their home nation, which has advantages but also disadvantages and pressures. As such, Korean EMI students might have Korean expectations from parents, instructors, and friends. Study situations and expectations differ among nations, and international students may be operating with different home cultural pressures. As the finding appears culturally influenced, supplementary studies are needed.

Similar to Rienties et al. (2011), this study also found that the AI of international students was not worse than national students. However, this study found first-years' AI higher than third and fourth years. As students mature as adults and develop as university students, AI perceptions could change. Future studies might examine AI in relation to year at school.

International students and students with more EMI experience used more IS. That is, local EMI class students will be in a familiar, or at the least, less unfamiliar, learning environment, and as such, simply may not need a broad range of IS to succeed. International students could be incorporating more IS to succeed (at the same level) as local students. These learners also need to navigate in English and Korean, both of which they may not have actively used before, and this situation could necessitate the use of more IS. In case of EMI class experience, it could be that students have learnt to incorporate the practice of more strategies in order to realise success because of exposure to different EMI instructors and their different approaches, personalities, and expectations. These students might have higher self-efficacy as IS learnt or employed in previous EMI classes may have become learning strategies; Diseth (2011) found that self-efficacy strongly correlates to learning strategies. Additional research, however, would shed clearer light on this.

Students in Literature & Languages might be using more IS as they are processing information differently than the other study disciplines. They may need to integrate information and skills in more emotional and abstract ways than what might be expected or done in the other disciplines. For instance, 'Why must Elizabeth Bennet marry?' differs from 'How is the lift equation calculated?' STEM course student satisfaction was found to be related to teaching methods, instructor organisation and attitude towards subject and students, and workload (Chang & Park, 2014). The findings for STEM students in this study appear to link to the argument of Rois et al. (2018) that good course design, methods, and attention to learner needs connect to satisfaction. In this study, STEM students were less satisfied with class progression and instructor care and warmth. It could be that these online EMI students simply are more concerned with lecture content; STEM students might be rating information and facts more highly. The most efficient instructor for STEM students may not need to be the warmest but one who can convey facts and connections clearly and efficiently. Discipline differences offer opportunities for further studies.

5.3 RQ3: Direct Effect and Mediated Effect on Satisfaction

Results suggest students have generated a positive cycle of success. That is, correlations suggest the more students learn, the more they can learn, and the better they get at something, the more positive the reinforcement they get. This is comparable to Kahu et al. (2020) who reported engagement led to satisfaction.

Moreover, the results lend support to the findings of Hwang and Wao (2021). While they did not report a causal relationship between satisfaction and engagement, they did report "that highly satisfied students tend to be engaged in educational activities and vice versa." The results also support Yüksel (2022) who found perceived interactional quality correlated to satisfaction, and Tian and Lu (2022) who reported students' emotional engagement level predicted their level of satisfaction.

Findings of this study support Farrell and Brunton (2020) who argued psychosocial factors influence online engagement and lend further insight to findings in Küçük and Richardson (2019) in which engagement: emotional, behavioural, and cognitive, were significant predictors of satisfaction. Engaged students were found to have higher AI and AC and that combined with use of IS influenced S. The model differs from the results of Liu and Liu (2004) who reported AI did not directly affect S but supports Stone and O'Shea (2019) who reported S was affected by positively perceived learning and support. Moreover, the model shows similar results with Keller and Karau (2013) who found individuals with high levels of conscientiousness were more likely to have favourable views of online classes and Bhagat et al. (2019) who reported conscientiousness had a large positive impact on online learning perception. OSE, however, did not directly influence IS, suggesting students may not need to engage in a variety of IS. The use of a limited number or one strategy could be all that is needed to feel satisfied. This conjecture could also account for a rise in AC bringing about a decrease in IS in the model. Students might have noticed what works for themselves and their peers, and from this, know what the instructor will and will not accept or tolerate. Oh (2021) also reported that in terms of instructional mode, participants in the study preferred non-real time instruction, in particular the class videos that contained a slideshow and instructor audio explanations, as well as the class notes and extra class materials that helped content understanding. Simplification might increase efficiency and decrease wasted time; they have a working strategy and that combined with high AC and AI, which increases when students are engaged, can increase online EMI satisfaction. Future studies might examine the use of specific IS and whether more or less influence satisfaction.

5.4 RQ4: Key Factors Influencing Specific Aspects of Online EMI Satisfaction

Two inverse associations between S (instructor care) and i) prior online learning experience and ii) participation OSE were unexpected. Students might not feel a caring attitude to be important. This is unlike Arbaugh (2001) who found the immediacy behaviours of instructors and prior online learning experience positively predicted satisfaction. It is also dissimilar to Tsai, Ku and Campbell (2021) who reported high online interaction with peers and the instructor resulted in more favourable perceptions of engagement and learning outcomes among students. Learners in this study might have had a harder time perceiving care in the unfamiliar (possibly new) environment. Other students could be prone to heightened anxiety, perhaps even fearing penalisation for not reaching (perceived) participation expectations and standards. Research on whether less and how participation expectation affects online EMI satisfaction is warranted.

AC1 (absence from class for reasons other than illness) was inversely associated with i) general and ii) class progression satisfaction. It could be the more a student is present, the higher the student perceives instructor expectations and the less they can avoid doing or engaging in required tasks. On the other hand, attending a teacher-fronted lecture necessitates being a passive learner. As such, students may perceive there to be no difference between attending class and group or alone study. Future studies might examine attendance and instructor policies regarding attendance.

In line with Kieng et al. (2021) who found faculty services positively impacted satisfaction, AI items in this study had positive associations with S. Personal fulfillment when combined with good instruction might result in higher satisfaction. Examining Chinese, Indian, and South Korean undergraduate students in the UK, Merola, Coelen, and Hofman (2019) also found AI explained over 14% of the variance in S. Given dissatisfaction issues, students might simply have wanted to feel they are getting what they paid for—quality instruction from interested organised instructors in a structured, welcoming atmosphere with support and encouragement from instructor and peers. Oh (2021) also found students did not perceive online instruction as offering more study opportunities or goals than the classroom. Moreover, AI cannot be underestimated, regardless of content or direction. For instance, facing a frightening and exciting future, upper-years' AI and S could certainly differ from those of lower year students.

Through email an instructor can expand communication beyond salutations to support and feedback whereas through SNS an instructor can provide more concise short notices. Both strategies are interactions that express interest and concern. Gaytan and McEwen (2007) also reported continual, immediate, and detailed feedback and appropriate use of emailing among the top three elements of quality online instruction. For instance, a

simple salutation may mean quite a bit to students, especially those new to EMI and online, as it indicates personal interest and openness to continued communications.

6. Conclusion

The concerns of the research questions were addressed in that for *RQ1*, online EMI learners found video live-stream conferencing and pre-recorded lecture videos were important. For *RQ2*, international students and students with more prior EMI learning experiences used more IS. IS use and S were found to differ amongst disciplines, the AC of national students was higher than international students, and the AI of first years was higher than that of 3rd and 4th years. Analysis of factor effects on S for *RQ3*, revealed AI, AC, and IS mediated the link between EMI distance learner OSE and S. Noteworthy, for *RQ4*, AC was inversely associated with IS and OSE did not directly influence IS.

Classroom Implications

Prior to the COVID-19 pandemic, education systems have been disrupted such as by the 2015 Hurricane Katrina, the 2010-2011 Canterbury earthquakes, and the 2003 SARS virus resulting in closures of schools and cancellations of classes from a few days to an entire school year (Casper et al., 2022). However, COVID-19 caused approximately three years of adjustment, stress, strict social distancing interventions. Nevertheless, it brought about increased familiarity with more online resources and alternatives for social or academic interactions such as online conference meetings that had been unavailable or uncommon earlier, and which had not been thoroughly exploited for academic purposes in the previous disruptions. Casper et al. (2022) argued that understanding the link between engagement and satisfaction can help provide quality online learning and reduce student stress connected to a lack of support and increase motivation necessary for self-directed online learning. Results suggest that an instructor perceived as supportive might be considered patronising by an upper year student looking beyond university to the future, yet a first-year might be seeking support, structure, and guidance from their instructors. For STEM students, they could be looking ahead to the next step whereas for instance, Literature & Languages majors will already know Romeo dies. STEM students could just be more concerned with work and verification; i.e., they seek more factual accuracy than warm fuzzy feelings from their instructors. Next, too much interaction could be making learners nervous. Polite requests to participate and genial concern is one thing, but intense continued requirement or pressure to participate may make students feel they are doing something wrong or that standards are higher for them. Last, emailing could allow for lengthy interactions or provision of helpful guidelines. Whereas SNS, as a faster, more convenient, and personal means of interacting, could facilitate short quick answers and encouragement. Students may simply wish to interact with their instructor. Moreover, students may feel supported but not stressed by a SNS message and respond more positively to simple social interaction (i.e., sometimes less is more). Next, SNS communications show interest, support, and warmth, so they could be viewed as more valuable than the actual conveyed information. Post-pandemic, Bozkurt and Sharma (2020, p. iii) also argued that "people will not remember the educational content delivered, but they will remember how they felt, how we cared for them, and how we supported them."

While the relationships cannot be interpreted as causal ones, the SEM model proposed for this study and its complement regression analysis provide important insight into and contribute to a general view of factors affecting online EMI learners' perspective of class satisfaction. Researchers also acknowledge that there are other factors affecting satisfaction besides those examined in this study. Nonetheless, results are important because online EMI could continue post-pandemic. The sample, however, contained few international students, for which the reason is speculated to be the smaller numbers in the nation at the time due to traveling difficulties because of COVID-19. While the effect of group differences is crucial in EMI learning, the sample size in this study was not large enough to run the SEM model by groups. Additional studies should consider these situations and aim to connect with a larger EMI academic community. Future studies should also compare EMI satisfaction between online and traditional and blended learning.

Acknowledgement

Fundings Sources: This work was supported by the 2020 Hongik University Research Fund, and 2022 The Catholic University of Korea Research Fund (M2022B000800096).

Data availability: The anonymized data used in the current study are available from the corresponding author upon request.

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Students' Agreement with QM® Rubrics as Benchmarks for Online Course Quality

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Abstract: Many factors should be considered when planning to provide an effective Online Learning (OL) experience. Of these factors, quality is the most noticeable concern that received considerable debate. Over the years, several suggestions for standards for ensuring online course quality have been suggested. Among these, Quality Matters (QM) is the most used and principally accepted rubric for quality assurance. Much research explored its potential and impact on maintaining online course quality, yet more research is needed to parallel the expansion of online learning post-COVID-19 pandemic. Additionally, as more students are involved in fully OL classes, it is perceived that their perceptions of QM would be more authentic as they are stemmed from actual experience. To this end, the present study explores students' perspectives towards QM rubrics as a benchmark for measuring OL course quality. The study adopted a mixed method where quantitative data were gathered by surveying 112 university students using a QM-based questionnaire of 42 items. Using average scores of the participant responses to the questionnaire, the researcher compared their evaluation to the QM general and specific standards. Furthermore, focus-group interviews were conducted to validate and justify the quantitative data. Frequencies of mentioning the most and least important standards were calculated. The findings revealed that the participants agreed to 71% of the QM rubrics. On the other hand, they overvalued standards related to learners' privacy, course introduction, assessment, and course technology while undervalued standards associated with learning objectives, learner support and accessibility. The participants' justifications for their judgments revolved around the importance of privacy in cyberspace, the vitality of online assessment tools, and their familiarity with the new technologies that made IT support a secondary standard for them. These results imply reconsidering OL course quality by focusing more on using variable technologies and tools that engage students in the experience, ensure their privacy, and facilitate their interaction with the course content. Further research that utilises larger samples and involves QM-based OL courses is suggested to support the present findings.

Keywords: Online learning, e-Learning, e-Learning quality, Quality matters, Quality rubrics

1. Introduction

As has been expected by many researchers, e.g. (Bach, Haynes and Smith, 2007; Selingo, 2013), Online Learning (OL) at the tertiary level has been normalised in most parts of the world. However, what was not expected was the speed with which this transformation took place. The outbreak of Coronavirus (hereafter the pandemic) imposed lockdown and social distancing that forced academic institutions around the globe to adopt OL. Many researchers considered this transformation abrupt and dramatic (Riley et al., 2021; Motz, et al., 2021; Saxena, Baber and Kumar, 2021). This perception entails a question: was the world ready for this change? Two years after the announcement of COVID-19, a global pandemic, and with the gradual return to face-to-face learning, many teachers and researchers can answer the question. It can be stated that OL was a successful solution. However, as sufficient time is the key factor that guarantees an effective transition to OL (Mestan, 2019), and as this time was not available in the recent transition (Marković, Pavlović and Mamutović, 2021), it is conceivable to assume that quality was sacrificed during shifting to the ad hoc OL in 2020.

Quality is one of the foremost constructs of OL that requires reconsidering (Weller, 2005). Much work has been done investigating the optimal standards for developing online courses. However, most of the research was conducted from the viewpoints of educators and course developers. Perspectives of the essential stakeholders of the learning process, i.e. students, regarding standards of quality online learning are also explored. However, quality issues studies from students' perspectives were more related to instructors' practice and technology use than overall course quality. The new reality imposed by the pandemic has made investigating the issue more urgent. After all, "providing pupils the highest quality of instruction is still paramount for institutions of higher learning even in times of worldwide emergencies" (Majewska and Zvobgo, 2023, p. 314). Revisiting the issue after implementing OL on a wide range is more insightful. Students can now provide their perceptions about OL based on their authentic experience with online courses and virtual classes as the only learning method for over two years.

Quality Matters Rubrics (QMRs) are utilised widely to assess online course quality. These rubrics have been used for almost twenty years, along which they remain the most used benchmark for measuring quality (Rohers, Wang and Kendrick, 2013). The rubrics have undergone continuous improvement following structured processes. These processes include reviewing the literature on online learning, peer reviewing the course that

Reference this paper: Sanosi, A., 2023 Students' Agreement With QM® Rubrics as Benchmarks for Online Course Quality, *The Electronic Journal of e-Learning, 21(3)*, pp 175-187, available online at www.ejel.org

met the rubrics, and statistically analysing the most frequently met and missed standards (Shattuck, Zimmerman, & Adair, 2014). Moreover, the process "involves focused input from a [r]ubric [c]ommittee composed of faculty and instructional staff with extensive experience using the QM [h]igher [e]ducation [r]ubric" (Quality Matters, 2023). The currently used version is the sixth, but this version will be updated to the seventh edition by early July 2023, according to the QM website.

As stated by many studies, these rubrics represent the optimal criteria that can be used to assure OL quality (Shattuck, Zimmerman, and Adair, 2014; Sadaf, Martin and Ahlghrim-Delzell, 2019). Subsequently, it is perceived that measuring the students' level of agreement with QMRs will explain how they perceive online course quality and reflect the level of concordance between QMRs and students' actual viewpoints about OL quality. To this end, the current study posed the following research question:

RQ1. To what extent do students' perspectives of online course quality agree with the QMRs?

2. Literature Review

2.1 Online Learning

There were many drivers for the vast growth of OL. Among these are the rapid technological change, globalisation, development of students' IT skills, student lifestyle, and the increase in the international higher education market (Bach, Haynes and Smith, 2007). On the other hand, numerous issues are related to OL (Mahyoob, 2020), and there are many hypes around them. Some of these issues are related to the globalisation and commercialisation of education. Others are about whether OL means the death of campus life and whether OL is proper for training, not teaching. Other concerns are related to limited social interactions and the need for extra skills (Psotka, 2022). However, the most important is the issue of the probable decline of standards that OL may lead to (Weller, 2005). The perceived decline may be caused by unplanned and rash shifting to teaching online. When switching to OL, it should be noted that this transition is "a complex process that requires serious planning and its success is influenced by several factors" (Marković, Pavlović and Mamutović, 2021, p.2). Careful consideration of these factors is the best way to retain learning quality.

Quality of OL can be considered a type of Quality of Service (QoS). According to Tomei (2010, p.185), QoS is "A set of defined levels of performance, requirements for achieving quality". Establishing QoS aims to ensure the proper delivery of data consumers. It comprises four levels: user, application, system, and network. Therefore, it is different from Quality of Experience (QoE), which is a "more subjective assessment of the satisfaction of the user with the service" (ibid). Accordingly, most OL course evaluations are QoE-based as they are always designed to reflect learners' opinions about their satisfaction with the OL course. According to Palloff and Pratt (2009, p50), most course evaluations directed to students are customarily executed to measure some form of a popularity contest where students reflect on their perspectives about instructor practice and their level of satisfaction rather than the course quality. For them, eight elements should be considered when evaluating an online course. These elements are (1) Perception of the overall online course experience, (2) Orientation to the course, (3) The content, (4) Discussion and interaction, (5) Self – assessment, (6) course management system, (7) Technical support and (8) Access to resources. Institutions producing various rubrics to measure OL quality use these standards and other similar ones. The most renowned and recent are QMR, the most known and applied rubrics used to measure OL quality.

2.2 Quality Matters

Quality Matters is "a faculty-centred, peer review process designed to certify the quality of online and blended courses" (Quality Matters, 2021). Since its first launch in 2003, the quality matters program has targeted three components: QM rubrics, peer review, and professional development (Budden and Budden, 2013). QM rubrics are validated and proven to reflect the best practice of OL (Sadaf, Martin and Ahlghrim-Delzell, 2019). The rubrics have undergone slight changes over the years. The sixth version (2020) includes 42 specific standards that are distributed, as shown in Table 1 below.

Table 1: General and Specific Review Standards From the QM Higher Education Rubric, Sixth Edition*

No.	General Standards	Specific Standards			
		Essential	Very important	Important	Total
1	Course overview and introduction	2	3	4	9
2	Learning objectives (Competencies)	5	-	-	5

No.	General Standards	Specific Standards			
		Essential	Very important	Important	Total
3	Assessment and measurement	3	2	-	5
4	Instructional materials	2	3	-	5
5	Learning activities and learner interaction	3	1	-	4
6	Course technology	2	-	2	4
7	Learner support	3	-	1	4
8	Accessibility and usability	3	3	-	4
Total		**23**	**12**	**7**	**42**

**Source. Quality Matters: https://www.qualitymatters.org/qa-resources/rubric-standards/higher-ed-rubric*

The specific standards are assigned points values ranging from essential (3 points), very important (2 points) and important (1 point). More than half of the specific standards are considered essential and distributed among the eight general standards. It is also noted that all the specific standards related to learning objectives are essential. Other standards, however, are deemed very important (12 standards) and important (7) standards. An online course is QM-certified only if the total points attained are ≥ 85% of the possible points. The general standards of QM can be explained as follows:

- Course overview and introduction: Straightforward course design helps students understand how to start the course (Sadaf, Martin and Ahlghrim-Delzell, 2019).
- Learning objectives: Provided as "advance organisers for learners, providing some level of scaffolding for the current lesson" (Brown, Lewis and Toussaint, 2018, p.175).
- Assessment and measurement: Used to evaluate the impact of new assessment methods, student engagement with them, and their performance on them (Riegel and Evans, 2021).
- Instructional materials: As it is believed that course materials are a basic factor that creates an interesting learning experience and increases students' engagement. (Schmidt and Stowell, 2017).
- Learning activities and Learner Interaction: The QM developers suggested this rubric as interaction is an "important aspect of successful online teaching" (Marković, Pavlović, and Mamutović, 2021, p.2). Accordingly, teachers are expected to utilise different techniques for discussion and use both asynchronous and synchronous teaching methods to help create a learning community
- Course technology: This provides technology standards students use to access the course material and receive the necessary support in LMS and counselling units (Rohers, Wang and Kendrick, 2013).
- Learner support: To assist students in accessing different forms of support to facilitate their learning and cast a sense of community (Al Zumor, 2015). This includes both infrastructure and pedagogical support, which are crucial to the effective application of quality online learning (Azila-Gbettor, Abiemo and Glate, 2023).
- Accessibility and usability: QM requires that "all learners must have access to the course materials to learn, including those individuals with disabilities" (Brown, Lewis and Toussaint, 2018, p. 174). However, meeting this specific standard may require further investigation as accessibility standards differ from country to country.

Faculty members face challenges in applying QMs rubrics. Some of these challenges are that they are time-consuming, and some of them are unclear. Moreover, some instructors reported that they do not improve their instruction and remove creativity from classes (Budden and Budden, 2013). However, most previous studies acknowledged their high capacities in validating OL course quality (Shattuck, Zimmerman, and Adair, 2014; Al Zumor, 2015; Brown, Lewis, and Toussaint, 2018; Lynch and Gaston, 2020).

2.3 Previous Studies

Several factors can contribute to students' satisfaction with OL and hence formulate their positive perceptions of OL. Kuo et al. (2013) reported some of these factors related to students' interaction with online instruction and content. Maintaining that student satisfaction is an essential marker of the quality of learning experiences, the research explored the perspectives of 111 students who studied 11 online courses. It was found that learners' interaction with instructors and content and internet self-efficacy predict students' satisfaction with OL. On the other hand, other factors, such as self-regulated learning and interaction among students, have no

reliable predictive power of students' satisfaction. This study is insightful as it traces OL quality and student satisfaction to extrinsic rather than intrinsic factors. It subsequently entails that investigating OL quality should be directed to the course design and delivery, the aspects that quality benchmarks aim to maintain.

Another explored aspect of OL is its effectiveness which can also predict students' positive perception of OL. A meta-analytic study (Prestiadi et al., 2020) reviewed 60 research articles about different aspects of OL learning effectiveness. The study has suggested that OL effectiveness is influenced by several factors, including quality as a primary influencer. Accordingly, students' views about quality standards are also envisaged to be of great value for validating quality benchmarks

With the advent of QM as a benchmark of online course quality assurance, researchers started to measure their validity and impact on OL quality. Although studies that targeted students' perspectives towards QM are relatively few, they can give feedback about how students viewed or reacted to quality standards (Kumar et al., 2022) QMRs. Concerning this, A study to measure student perspectives on quality was conducted by Ralston-Berg (2014). The research targeted a sample of 3160 students either enrolled in or had taken an online course. The participants were selected from 31 institutions distributed between 21 states in the United States. They were surveyed regarding QMRs and whether they would agree with them as quality indicators and contributors to success. The researchers used a survey based on QM and asked the participants to assign values from 0 to 4 for each standard. The study's findings showed that the participants considered all the QMRs important for success. Nevertheless, they appointed different values to the standards. This indicates that QMRs are perceived as proper contributors to success; however, they are perceived differently from the consumers of OL courses.

To evaluate student perception of the impact of QM on their learning and engagement, Sadaf, Martin and Ahlghrim-Delzell (2019) surveyed 50 students enrolled in QM-certified online courses. The study revealed that students considered course activities and learner interaction the most important standards impacting student learning and engagement. Moreover, they believed student support was the least important factor affecting student learning and engagement. The study utilised a robust method as students' responses pertain to QM-certified courses and hence are based on authentic experiences.

Another study (Lynch and Gaston, 2020) investigated the impact of two online courses redesigned according to QM on students' performance compared to online courses designed by faculty. The rubric for the comparison was students' scores in the QM and non-QM courses. Also, the researcher used end-of-course evaluation questions to explore the students' overall satisfaction with the courses. The sample was composed of 891 student scores. In addition to a slight increase in the students' marks in the QM course, the study reflected positive trends toward QM, although no clear procedures to control the course design were reported.

The rationale for selecting the QM studies reviewed above is mainly methodological. Studies that utilised a substantial sample size were elected as they were supposed to reflect more trustful results. The second criterion for selection was the authentic experience of the QM-based course. i.e., the participants study a QM-certified course or a course designed strictly following the QMRs. The resemblance of the approach followed in the studies was another criterion of choosing the reviewed study, i.e., to assess the rubrics from the students' points of view. The present study follows the perceived positive criteria of QM research, i.e., surveying a reasonable number of students who study QM-based courses for a considerable time through a QMR-based to generate comparable data.

Moreover, the new reality of OL imposed by social distancing due to the pandemic provides a broader setting for research on students' views regarding OL quality as the approach has become the norm. This suggests that the online courses and the new population included in OL after the pandemic differ. Learning was then achieved through fully online courses rather than partial or blended, as there were no other ways to communicate or deliver content to the students. Subsequently, students were likely to treat OL more seriously; hence, their responses would be more genuine and stemmed from a deeper comprehension of the nature of OL. These differences are crucial to this study as they reflect students' experiences with typical OL courses. They provide more authentic and trustful responses to assess students' evaluation of online course quality. This is perceived as a contribution that this study aims to provide

3. Methodology

This study adopted a mixed-method approach to answering the research question. Firstly, a quantitative research technique is used to explore the level of agreement between students' scores on the QMR-based survey and the points preassigned by QM. Secondly, the results were cross-checked by collecting qualitative

data elaborating on students' perspectives towards QMRs, as the quantitative data may not be sufficient evidence for students' perspectives.

3.1 Participants

The sample of this study incorporated 112 undergraduates who study English language and literature at the College of Sciences and Humanities, Prince Sattam Bin Abdulaziz University (PSAU) in Saudi Arabia. The sample was selected by following intact class clustering methods. The students were selected from levels five and seven to confirm that they studied the previous four semesters, which were delivered online, at the university. Given that these levels represent 25 % of the eight levels, it is considered statistically appropriate and can represent the university's research community. All the participants started fully online learning in March 2020. They have studied online for at least four semesters; some have studied more since enrollment in summer courses is optional. In brief, the least number of fully online courses studied by any participant is 12. The detailed characteristics of the participant are shown in Table 2 below.

Table 2: Participant Features and OL Learning Experiences

Gender	Total Participants	levels	Learning method
Male	44	5th & 7th	4 semesters online 1 semester blended*
Female	68	5th & 7th	semesters online

**Note. Some courses at the male campus were delivered partially online starting from the second semester of 2021.*

3.2 Instruments

3.2.1 The questionnaire

The quantitative data was collected using a questionnaire based on the QM standards, sixth Edition 2020. The rubrics were translated into Arabic by the researcher. Further, it was validated by two university professors who specialised in translation and Arabic linguistics. The raters were asked to check the draft for translation compatibility, linguistic errors, and naturalness. To match the QM evaluation rubrics, the participants were asked to state if each standard is *essential (*3 points*); Very important* (2 points); or *important* (1 point) to e-course quality; see Appendix A for the English version of the questionnaire.

As of March 2020, PSAU has adopted a fixed template on Blackboard LMS to be used by all faculty members. The template is based on the QMRs; therefore, students are believed to be aware of the application of each standard, and thus they can estimate its impact on the course quality. Figure 1 below displays the template used to provide online courses according to the QMRs.

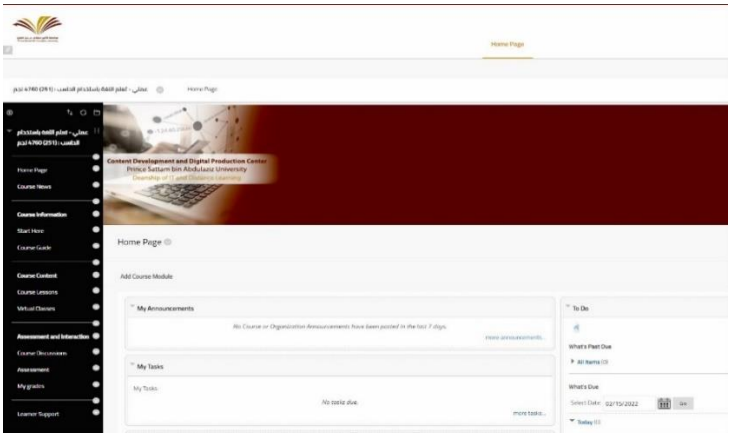

Figure 1: Template of Online Courses Offered by PSAU

As shown in Figure 1, the main course menu is designed to make all the offered courses meet QM standards. For example, the *start here* page contains sublinks to a *welcome message*, *course overview*, *course tour* and an *Ice breaker* forum. *Course guide* includes links to *course description*, *calendar*, and *policies*. Also, the expected learning outcomes, grading policy and learning resources are articulated there. The *course lessons* page is designed in module format. Faculty are provided with a template to fill each module's objectives, learning

outcomes, and assessment and upload the unit contents in different formats. The menu also contains links to *assessment*, *learner support* and *course announcements*. In brief, all the 42 QM standards are met when the template is used properly. Accordingly, the participants were asked to respond to the questionnaire regarding their experience in learning the courses provided according to the above template. Google Forms tool was used to design and distribute the questionnaire to students in each elected section. The completion rate was 87.5%, as some students did not complete the questionnaire for different reasons. It was clearly stated and maintained that no personal information is needed, and the data is just for research purposes.

3.2.2 Focus group interviews

As the differences between the average scores of the respondents and the QMRs would often be slight (between 1 and 2), it was envisaged that qualitative data is needed to support or refute them. Accordingly, focus group discussions were organised after the first phase of data analysis. The research sample was divided into ten groups (4 for males and 6 for females). Each group incorporated 9 to 12 students. The discussions were held online, and both open and closed-ended questions were used. The participants were first asked to state, in Arabic, the most and the least two important QM standards; then, they were asked to justify their answers.

3.3 Data Analysis

The questionnaire data were analysed using descriptive statistics. The mean scores of the participant responses to each general and specific review standard were calculated and compared against the QM points. To measure the level of difference between the students' evaluation of QMRs and the points assigned by QM to each general standard, a two-sample t-test (independent t-test) was performed. Further, a detailed analysis of the level of students' agreement to QMR assigned values was performed. According to the calculations, one of four statuses was identified for each result, as in Table 3 below.

Table 3: Interpretation of the Results

Status	Interpretation
Identical	The points assigned by QM and the participants for the specific and general standards are similar.
Equal	The total points assigned to the general standard are equal; however, the points of the specific review standards are different.
Overestimated	The average total points assigned by the participants is greater than that set by QM.
Underestimated	The average total points assigned by the participants is less than that set by QM.

As for the focus group interview data, the most frequently stated standards (the most or least important) are ranked. Moreover, the reasons for electing such standards are recorded according to their frequency of mention (reasons stated less than three times are not considered).

4. Results

The study's research question explores the level of agreement between the participants' perception of quality and the QMRs. First, the two-sample t-test yielded that there was no significant difference in students perception of the standards (M = 12.8, SD = 2.9), and the QM evaluation (M = 12.5, SD = 2.7); t(7) = -.664, p = .528. The results indicate considerable agreement between students' perceptions and QMRs. This overall compatibility of the participant scores with the QM-assigned points was further calculated yielding the results shown in Figure 2 below.

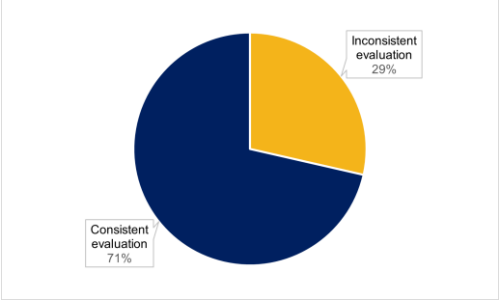

Figure 2: The Overall Compatibility Between the Participants' Scores and the QM Points

Figure 2 indicates that the participants agree to 71 % of QMRs. In other words, they disagree with some QMRs assuming that they are more or less impactful in determining course quality. The difference between the two evaluations is at the general and specific levels. Figure 3 outlines the comparison result.

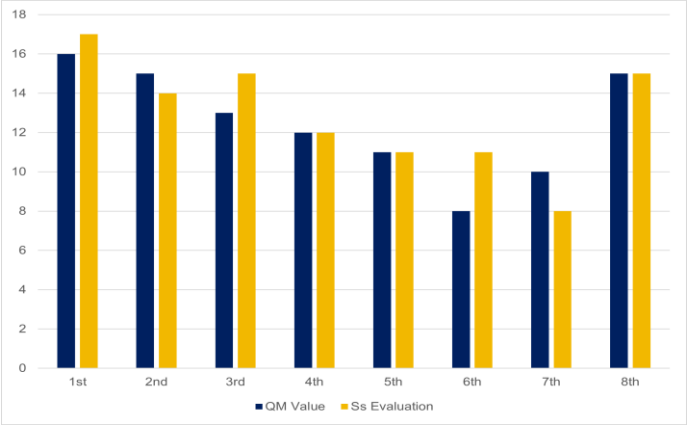

Figure 3: Participants' Scores Versus QM Points (General Standards)

The results show that the participants fully agreed to only three of the eight general standards. Their evaluation of the other standards varied. While they overestimate the effect of some standards on online course quality, they undervalue the impact of others. Table 4 elaborates on these findings.

Table 4: Participant Scores vs QM Points (General Standards)

No.	General Standards	QM points	Average Score by participants	Status
1	Introduction & Overview	16	17	Overestimated
2	Learning Objectives (Competencies)	15	14	Underestimated
3	Assessment and Measurement	13	15	Overestimated
4	Instructional Materials	12	12	Equal (different details)
5	Learning Activities and Learner Interaction	11	11	Identical
6	Course Technology	8	11	Overestimated
7	Learner Support	10	8	Underestimated
8	Accessibility and Usability	15	15	Equal (different details)

The findings revealed that the participants utterly agreed with the fifth standard *learning activity and learning interaction.* Their assigned values to the specific standards of this general standard are identical to those set by the QM. Furthermore, their evaluation of the fourth and the eighth standards, *Instructional Materials and Accessibility and usability,* respectively, are equal though the values assigned to the specific rubrics are slightly different. On the other hand, they overestimate the impact of the first general standard: *Introduction & overview; the* third one: *Assessment and measurement;* and the sixth one*, Course technology.* In contrast, the participants underestimate the remaining two general standards: the second: *Learning objectives (Competencies) and the seventh: Learner support.* Figure 4 details the agreement results to the eight standards suggested by Quality Matters.

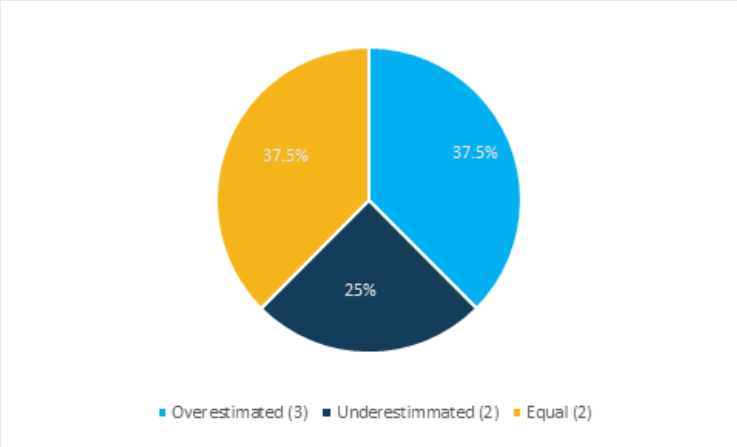

Figure 4: Participant Evaluation Results of the QMRs (General Standards)

A brief look at these details revealed that the participants underestimated the effect of two standards while overestimating three and agreeing to the remaining three.

It has already been shown that the participants agreed to 30 of the 42 specific standards, making 71 % of compatibility. Regarding the remaining 12 standards with which the participants disagree, it was found that they are distributed among seven general standards (given that the fifth general standard received identical values). Table 5 reports the standards with inconsistent evaluation.

Table 5: Specific Standards With Inconsistent Participants' Evaluation

No.	Specific standard	Participants score	QM Points	Status
1.4	Course and institutional policies with which the learner is expected to comply are clearly stated within the course, or a link to current policies is provided.	3	2	Overestimated
2.2	The module/unit-level learning objectives or competencies describe outcomes that are measurable and consistent with the course-level objectives or competencies.	2	3	Underestimated
3.4	The assessments used are sequenced, varied, and suited to the level of the course.	3	2	Overestimated
3.5	The course provides learners with multiple opportunities to track their learning progress with timely feedback.	3	2	Overestimated
4.2	T The relationship between the use of instructional materials in the course and completing learning activities is clearly explained.	2	3	Underestimated
4.4	The instructional materials represent up-to-date theory and practice in the discipline.	3	2	Overestimated
4.5	A variety of instructional materials is used in the course.	3	2	Overestimated
6.3	A variety of technology is used in the course.	2	1	Overestimated
6.4	The course provides learners with information on protecting their data and privacy.	3	1	Overestimated
7.3	Course instructions articulate or link to the institution's academic support services and resources that can help learners succeed in the course.	2	3	Underestimated
8.5	Course multimedia facilitate ease of use.	3	2	Overestimated
8.6	Vendor accessibility statements are provided for all technologies required in the course.	1	2	Underestimated

Most of the specific review standards are overestimated. Moreover, one specific standard, i.e. 6.4, is highly overvalued as the participants assign it the highest value while QM rates it with the lowest value.

The results of the focus group discussion showed a considerable match to the quantitative data results. Table 6 reports the findings of the closed-ended questions from the interviews.

Table 6: Students' Perspectives Regarding the Level of Importance of QM Standards

Most important standards	Freq.*	Per cent	Least Important standards	Freq.*	Per cent
(1) 3rd Assessment and Measurement.	73	75.2 %	(1) 8th Accessibility and Usability.	68	60.7 %
(2) 6th Course Technology.	67	59.8 %	(2) 7th Learner technical and academic support.	76	67.9 %

Note. Freq. stands for the frequency of assigning the stated rank to the specific standard

Each of the mentioned standards was mentioned as the first or second most or least important standard at least 67 times. Students stated different motives for their choice, which will be elaborated on while discussing the results.

5. Discussion

The present study investigated the level of agreement between students' perspectives of OL quality and the QMRs. The data was collected through a QM-based survey. The participants' evaluation of the specific and general standards was analysed and compared with the QM points.

The study findings demonstrate a considerable agreement with the QMRs reaching 71%. This result was not only expectable as many previous studies prove QM as an optimal benchmark for measuring online course quality (Rohers, Wang and Kendrick, 2013; El-Sabagh, 2015; Al Zumor, 2015; Lynch and Gaston, 2020). It was even expected that the participants would agree with QM to a greater extent. The result is also in line with previous findings concerning students' perspectives on QM impact on online course quality, e.g. (Brown, Lewis and Toussaint, 2018) and (Sadaf, Martin and Ahlghrim-Delzell, 2019). The compatibility of the participants' evaluation with QM is intuitive since this program was developed in the light of scientific research and is based on rigorous peer-review processes by faculty. Moreover, many benefits are related to applying these standards, as Buuden and Budden (2013) stated, which may raise students' satisfaction.

Likewise, previous studies revealed that the level of compatibility between the student's evaluation and QMRs is not complete and identical. This result is comparable to (Ralston-Berg, 2014), which demonstrated that while the students considered all the standards important, they ranked some items differently than QM-assigned values. In the case of the present study, only one general standard was evaluated identically to QM-assigned evaluation, i.e. the fifth standard, *Learning activities and Learner interaction.* This result is interesting as this very standard is also found to be the most important one that impacts learning and engagement by Sadaf, Martin and Ahlghrim-Delzell (2019). Moreover, in a study to validate a rubric formed to value the quality of online courses in the light of QM (Lee, Recker, and Yuan 2020), the researchers found that the only rubric that has a significant and positive effect on online learning is learner engagement and interaction. The participants' agreement to this standard implies students' eagerness to employ different activities that promote their learning and a clear plan statement for interaction between instructors and learners. Teachers and course developers should seriously consider such considerations.

The results also exposed overvaluing of some standards. It is noted that the standards that the participants overestimate are related directly to course structure and delivery. The participants thought that providing a comprehensive overview of the course and an excellent introduction to navigating it is highly important, i.e. general standard no. 1. They also value clear assessment policy and criteria, using different assessment methods and opportunities to track their learning progress, i.e., general standard no. 3. Moreover, the participants were enthusiastic about employing various techniques that promote active learning and engagement, as stated in the general standard no. 6.

The focus group interviews further supported the finding. The participants ranked the third standard, *Assessment and measurement,* and the sixth one, *Course technology,* as the two most important standards for OL course quality. When asked about the reasons for such ranking, most of them stated that various assessment

tools, a clear plan, and timely provision, of course, grades are vital for an excellent online course. Reem[1], one respondent from the semester 5 group, stated that for her, using online quizzes, uploading assignments through LMS, and getting instant feedback are the only things she likes about OL. Also, the participants frequently asserted that what they seek in OL courses is the effective use of technology that "enable [*them*] to participate and interact using different devices and applications, include multimedia, protect their data, and provide an easy and interesting learning environment" as one respondent stated. "The system is perfect," said Hind, the leader of the CALL section, "but the inadequate design of instructors and the use of complicated or few technologies harden the task for us. Sometimes we cannot use mobile devices to conduct specific tasks, which contradicts the basic aim of OL, which is flexibility, as I think".

This result is compatible with previous studies. For example, Ralston-Berg's (2014) findings showed that the highest values of student evaluation were assigned to standards related to assessment, instructional technology and course introduction. Notwithstanding, participants in that study also emphasised the importance of instructional materials and learning objectives. The participants of the current research devalued these two standards.

Learner Support is considered of high importance by QM. Ten points are assigned to the specific review standards that make up this general standard. Notwithstanding, the study participants seemed less enthusiastic about these standards (their average value for the standard was 8). According to the researchers' viewpoint, a logical justification for this finding might lie in the learner characteristics. To check this assumption, the respondents were asked in the focus group interview why they rate this standard as the least (or the second least) important standard. Most participants answered that they are acquainted with the LMS, accustomed to technology in general, and familiar with the university regulations; therefore, there is no need for technical or academic support. Few answers were extrinsic as Badr, a semester seven student, stated, "after all, if I called the technical support, all they would do is to ask me to switch the browser or restart my device; I can do that without being instructed".

Additionally, this result is not unprecedented or exclusive to this study, as a similar finding was yielded by Sadaf, Martin and Ahlghrim-Delzell (2019). In general, new generations of university students are technophiles who may not face difficulties dealing with sophisticated technology and gadgets. Hence, they think technical support is not critical for online course quality. However, their assumption is implausible as many post-COVID-19 studies found considerable challenges facing students during the emergency OL related to technology or communication, e.g. (Aguilera-Hermida, 2020; Mahyoob, 2020; Azila-Gbettor, Abiemo, and Glate, 2023). Therefore, technical support should be seriously considered as online course menus and content may not be complicated per se; however, accessing or navigating them may represent a real problem for some students. Institutions need to provide adequate services that convince the students of the importance and efficacy of technical support to foster the importance and efficacy of learner support.

The findings showed that the participants tend to overestimate the impact of most of the specific review standards they disagree with. The most prominent result is related to the specific review standard 6.4, which reads, *"The course provides learners with information on protecting their data and privacy".* The relatively high value assigned to this standard implies that learners are highly attentive to their privacy. Further, focus group discussion confirmed that this finding was not yielded by chance but attributable to this generation's high level of technological awareness. It seems that with the increased time spent by most students in cyberspace for gaming or on social media platforms, they are now more alert to privacy concerns.

Many participants, especially females, stated they did not feel secure enough during online courses. Abir, a level 7 student, stated that she thinks videoconferencing applications represent a high risk to students' personal information. "We all heard that [*she named a specific videoconferencing service]* is unsafe, and our videos and photos can be stolen easily". Other respondents stated that they cover their webcams with tapes; however, they are still concerned about their personal data stored on their computers or smartphones. Male respondents were also alert to the privacy and security measure. However, they were more concerned with potential attacks and data loss caused by viruses and hackers than breaching their personal information.

This result matches the heavy controversy raised during the pandemic concerning the potential breach of students' privacy that the quick transition to OL might cause. Few studies dealt with students' privacy and cyber security in OL; accordingly, this result implies considering this point further in designing online courses. A

[1]All names in this article are pseudonyms.

sensible suggestion may be to add rubrics that ensure clear instructions for applying privacy settings, using updated and secure software, and taking all the precautions to maintain students' privacy and security.

On the other hand, the participants undervalue the impact of specific review standards related to course objectives, instructional materials, learner support and accessibility. It is noted that two of these standards are related to the concept of *alignment* between QMRs. According to this concept, there should be an interconnection between the essential course components to ensure achieving the desired learning objectives for the course. In the focus group discussion, students frequently considered learning objectives the least or the second least important standard. When asked to justify their evaluation, most answers showed that the concept was unclear to the student. Fahd, a student at level 5, said that "I think these objectives are important for teachers to follow and tell us what to do". Other students stated directly that they did not understand what exactly meant by the specific standards of this general standard. Nevertheless, they do not think they are essential to make an OL course successful if the other standards are fulfilled.

As the concept of alignment between learning objectives and outcomes seems advanced and professional, the participants' assigned values are prospective. Nevertheless, instructors are invited to maintain alignment in their online courses to help achieve the learning outcomes, even if students do not recognise how it works or promotes the quality of the course.

The findings of this study imply that QM is an effective benchmark to ensure OL quality. It further indicated that students agree to most of the standards included. However, specific considerations should be presented both to the students and instructors to get the most out of the program. For students, it will be more valuable to enlighten them on how the process works, what is expected from them, and how they can benefit from them. As far as the instructors are concerned, they are expected to offer more attention to students' concerns regarding privacy, assessment and course technology.

One consideration limits the generalisability of these results. The QMRs are supposed to be applied in all the courses studied by the participants during the lockdown and after. The university provided a course template based on QMR; however, it was not possible to confirm that all the instructors applied the template properly. To avoid this limitation, a detailed description of general and specific QMRs was presented to the participants, yet complete comprehension of the rubrics is not guaranteed.

The fact that the study sample is uni-cultural may slightly affect the generalizability of the study to other socially or culturally different settings. The study was conducted in a conservative community where female campuses are taught by male faculty through videoconferencing apps and other modern virtual learning solutions. This reality might have a two-fold impact on the results. First, female participants were familiar with OL learning solutions long before the pandemic; thus, their evaluation might stem from a more profound comprehension than that of participants from other comparable communities. Second, female participants may overvalue standards relating to their privacy and communication with male faculty. Other than these considerations, no particular factors of the research sample that may limit the generalizability of the findings were supposed.

6. Conclusion

Quality Matters is a peer-review process to ensure course quality that has been proven effective for many years. Much research investigated applying it and its impact on OL quality. However, the new post-pandemic reality, which has made OL an everyday practice, requires more research on its impact and students' perception of it. The current study surveyed students who have studied several online courses designed according to a QM-based template. The aim was to explore the level of the participants' agreement with the rubrics.

The findings of this study can be summarised in that while students agree to a considerable extent with QMRs, their contrastive perceptions of some standards are noteworthy. They consider privacy an essential criterion to maintain course quality and overvalue standards related to course overview, assessment, and course technology. On the other hand, they devalue learner support and accessibility.

The generated results of the present study can be validated and supported by further research on students' perceptions of OL quality and QM. Reliable results can be generated by a research study investigating students' perspectives of QM-certified online courses. Other suggestions include exploring students' attitudes and performance through studies that adopt experimental and control groups. Based on the current study results, it will be fruitful to conduct studies investigating privacy issues in online learning settings as students are now more aware of these issues.

Acknowledgement

This study is supported via funding from Prince Sattam bin Abdulaziz University project number (PSAU/2023/R/1444)

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Appendix A: The Questionnaire[2]

Please rate the importance of each of the following criteria for making an online course. [3] Essential. [2] Very Important. [1] Important

Course Overview and Introduction

1.1 Instructions make clear how to get started and where to find various course components.
1.2 Learners are introduced to the purpose and structure of the course.
1.3 Communication expectations for online discussions, email, and other forms of interaction are clearly stated.
1.4 Course and institutional policies with which the learner is expected to comply are clearly stated within the course, or a link to current policies is provided.
1.5 Minimum technology requirements for the course are clearly stated, and information on how to obtain the technologies is provided.
1.6 Computer skills and digital information literacy skills expected of the learner are clearly stated.
1.7 Expectations for prerequisite knowledge in the discipline and/or any required competencies are clearly stated.
1.8 The self-introduction by the instructor is professional and is available online.
1.9 Learners are asked to introduce themselves to the class.

Learning Objectives (Competencies)

2.1 The course learning objectives, or course/program competencies, describe outcomes that are measurable.
2.2 The module/unit-level learning objectives or competencies describe outcomes that are measurable and consistent with the course-level objectives or competencies.
2.3 Learning objectives or competencies are stated clearly, are written from the learner's perspective, and are prominently located in the course.
2.4 The relationship between learning objectives or competencies and learning activities is clearly stated.
2.5 The learning objectives or competencies are suited to the level of the course

Assessment and Measurement

3.1 The assessments measure the achievement of the stated learning objectives or competencies.
3.2 The course grading policy is stated clearly at the beginning of the course.
3.3 Specific and descriptive criteria are provided for the evaluation of learners' work, and their connection to the course grading policy is clearly explained.
3.4 The assessments used are sequenced, varied, and suited to the level of the course.
3.5 The course provides learners with multiple opportunities to track their learning progress with timely feedback.

Instructional Materials

4.1 The instructional materials contribute to the achievement of the stated learning objectives or competencies.
4.2 The relationship between the use of instructional materials in the course and completing learning activities is clearly explained.
4.3 The course models the academic integrity expected of learners by providing both source references and permissions for use of instructional materials.
4.4 The instructional materials represent up-to-date theory and practice in the discipline.
4.5 A variety of instructional materials is used in the course.

Learning Activities and Learner Interaction

5.1 The learning activities promote the achievement of the stated learning objectives or competencies.
5.2 Learning activities provide opportunities for interaction that support active learning.
5.3 The instructor's plan for interacting with learners during the course is clearly stated.
5.4 The requirements for learner interaction are clearly stated.

Course Technology

6.1 The tools used in the course support the learning objectives or competencies.
6.2 Course tools promote learner engagement and active learning.
6.3 A variety of technology is used in the course.
6.4 The course provides learners with information on protecting their data and privacy.

Learner Support

7.1 The course instructions articulate or link to a clear description of the technical support offered and how to obtain it.
7.2 Course instructions articulate or link to the institution's accessibility policies and services.
7.3 Course instructions articulate or link to the institution's academic support services and resources that can help learners succeed in the course.
7.4 Course instructions articulate or link to the institution's student services and resources that can help learners succeed.

Accessibility and Usability

8.1 Course navigation facilitates ease of use.
8.2 The course design facilitates readability.
8.3 The course provides accessible text and images in files, documents, LMS pages, and web pages to meet the needs of diverse learners.
8.4 The course provides alternative means of access to multimedia content in formats that meet the needs of diverse learners.
8.5 Course multimedia facilitate ease of use.
8.6 Vendor accessibility statements are provided for all technologies required in the course.

2The questionnaire is based on QM Review Standards for Higher Education, available at: https://www.qualitymatters.org/sites/default/files/PDFs/StandardsfromtheQMHigherEducationRubric.pdf

Challenges and Problems of e-Learning: A Conceptual Framework

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Abstract: E-Learning has recently gained significance among researchers. Although it has long been used in parallel with traditional learning styles, it is still known to be in its early stages. E-Learning is a broad self-standing category with many sub-types. However, there is a prevalent tendency to interchangeably use various terms to refer to this domain. With the strike of the recent pandemic around the globe, nearly all educational bodies including universities, colleges, and schools were urged to shift to e-Learning mediums. The use of e-Learning suddenly gained a tremendous amount of significance. Therefore, studying the problems and challenges that could impact the effectiveness of this phenomenon seemed to be of great importance. Accordingly, this study aimed at reviewing the problems and challenges encountered by students and educators involved in the e-Learning process. Through a systematic review, data were collected from studies on e-Learning. Using the findings of the systematic review, a conceptual framework was created consisting of two broad areas, namely problems vs. challenges of e-Learning. Then, semi-structured interviews with 15 participants of different ages, genders, academic qualifications, positions, and locations were conducted in search of their lived experiences on e-Learning. The present work may shed light upon the e-Learning process, ultimately leading to the development and reinforcement of this rather complicated phenomenon. The framework developed in this study holds potential applicability in studying the e-Learning phenomenon in comparable scenarios, such as pandemics or a complete transition to e-Learning driven by future technological advancements.

Keywords: COVID-19 pandemic, Educational technology, e-Learning, Online education, Online learning, Online teaching, Phenomenology

1. Introduction

E-Learning has recently gained significant attention among researchers around the world (Holmes and Gardner, 2006). To date, several definitions of e-Learning have been presented. For Dalsgaard (2006), e-Learning falls somewhere beyond learning management systems. On the contrary, e-Learning and learning management systems are often regarded as two identical concepts that are closely interrelated and go hand in hand (Vovides *et al.*, 2007). For Keegan (2002), e-Learning is known to be a sub-type of distance learning (d-learning) with various sub-categories. For instance, mobile learning (m-learning) is one of these categories (Kearney *et al.*, 2012). Similarly, various strategies have been proposed regarding how to approach e-Learning (e.g., MacKeogh and Fox, 2009; Morrison, 2003; Rosenberg and Foshay, 2002).

E-Learning has long been used in parallel with traditional learning styles. According to Bell and Federman (2013), 31 percent of college students in the United States have taken at least one online course during the Fall 2010 semester. However, e-Learning is still known to be in its infancy (Tavangarian *et al.*, 2004). This could be due to the continuous challenges and problems reported by the individuals involved in the process of e-Learning.

The success of e-Learning depends upon several variables. Some examples may include how the teaching and learning platform is designed, implemented, and evaluated for possible developments and reinforcements (Derouin, Fritzsche and Salas, 2005). Promising results have been reported with special reference to e-Learning as an alternative option to traditional learning styles (Zhang *et al.*, 2004). However, e-Learning is still in its early stages and a lot more needs to be done in this area.

2. Literature Review

There are various concepts related to e-Learning. For instance, m-learning, a platform enabling students to access pedagogical materials through their mobile phones is a sub-type of e-Learning that has recently gained popularity due to its wide availability and accessibility among community members in general, and students and educators in particular (Kearney *et al.*, 2012). While e-Learning mostly focuses on functionality, m-learning accounts for mobility (Georgiev, Georgieva and Smrikarov, 2004). D-learning is another term closely related to e-Learning, encompassing a broader scope that includes e-Learning and its associated learning domains. (Georgiev *et al.*, 2004). Although these terms are interrelated, they should not be used interchangeably, as each would represent a self-standing notion.

Reference this paper: Nouraey, P. and Al-Badi, A., 2023 Challenges and Problems of e-Learning: A Conceptual Framework, *The Electronic Journal of e-Learning, 21(3)*, pp 188-199, available online at www.ejel.org

The challenges and problems of e-Learning and its associated phenomena have been subject to several investigations. The distinction between a challenge and a problem can be a subject of debate, and there is occasional interchangeability in the use of these terms. While the former has the potential to turn into a problem, it is not problematic on its own. Usually, challenges (also known as risks) are not harmful and do not directly affect a phenomenon negatively. However, these need to be taken care of through appropriate risk management criteria as well as risk mitigation plans; otherwise, the challenges have the potential to turn into systematic problems. The two categories studied in the present work (i.e., challenges vs. problems of e-Learning) could be readily distinguished by a risk factor analysis.

Edelhauser and Lupu-Dima (2020) conducted an interview by the end of April 2020, when nearly all educational institutions including universities had already translated the classic, traditional system of education into an online system due to the global spread of COVID-19. Their study highlighted some of the common online platforms used in Romania to implement e-Learning. They also showcased some of the challenges faced by the Romanians and suggested the recruitment of IT specialists to tackle the issues of relevant online platforms, virtual classes, and virtual libraries. In addition, the need for teacher training on how to upload the course materials, how to create and conduct online classes, and how to design e-tests and e-contents was highlighted.

In their study, Shahzad *et al.* (2020) conceptualized a theoretical framework to investigate the differences in the e-Learning portal accessibility among male and female students in Malaysia. System quality and use, service quality, information quality, user satisfaction, and e-Learning portal success were the criteria studied. Having collected 280 sets of empirical data, the researchers suggested that higher education institutions must ensure 24/7 accessibility to their e-Learning portals. In addition, the quality of the content and information provided to the students was suggested to have significant importance. It was also suggested to provide the students with training module materials relevant to e-Learning portal use. The need for a user-friendly design of the e-Learning portals and obtaining regular feedback from the portal users were also highlighted by Shahzad *et al.* (2020).

Aboagye, Yawson, and Appiah (2020) investigated the problems associated with the transition from traditional and/or conventional learning to online learning. The factor analysis of 141 data sets obtained from students in Ghana revealed 8 groups of constructs. These included social issues, lecturer issues, accessibility issues, learner motivation, academic issues, generic issues, learner intentions, and demographics (Aboagye *et al.*, 2020). Their findings also revealed that accessibility issues were the most significant challenges faced by the students, followed by social, lecture, academic, and generic issues. A blended mode of learning was suggested instead of the complete shift towards e-Learning to enable the students to keep pace with the new changes.

One year before the start of the COVID-19 pandemic, Hennig and Nazarkulova (2019) studied the benefits and challenges of e-Learning in Central Asia (Tajikistan, Kazakhstan, Turkmenistan, Kyrgyzstan, and Uzbekistan). Findings were obtained based on a survey, highlighting both the pros and cons of e-Learning in the aforementioned countries. It was suggested to provide awareness to those involved in the process of e-Learning in terms of the web-based tools utilized. In addition, further education was suggested to take place for the teachers in terms of the concepts, tools, and materials used in e-Learning. Internet connectivity, lack of motivation concerning self-study, and lack of adequate computer resources were also highlighted as the potential challenges of e-Learning in Central Asia.

A meta-study conducted by Truong (2016) highlighted the importance of replacement and/or integration of traditional teaching methods with more nascent methods such as e-Learning. Reviewing 51 studies, Truong (2016) reported various problems caused by the so-called integration, delving into various learning styles theories related to e-Learning (e.g., online learning style predictors and learning styles classifications and applications). The study offered insights into the achievements, developments, and problems of e-Learning.

In a study conducted by Fichten *et al.* (2009), the problems and solutions of e-Learning among students with disabilities studying in Canadian colleges and universities were addressed. The participants were the so-called students, e-Learning professionals, campus disability service providers, and educators. The four groups of participants were asked to fill out an online survey questionnaire, the results of which indicated problems related to a) websites and course/learning management systems accessibility, b) digital audio and video accessibility, c) inflexible time limits built into online exams, d) PowerPoint/data projection during lectures, e) course materials in PDF and f) lack of needed adaptive technologies. In addition, technical difficulties by students in using the Internet, and connecting to the management system and the website were reported. Similarly, poor use of e-Learning by educators and their lack of knowledge in the realm of online learning were reported. Finally, Fichten *et al.* (2009) reported that most of the participants were left with at least one unresolved e-Learning problem out of three.

In another empirical investigation, Kamba (2009) studied the benefits of, and the problems raised by e-Learning among Nigerian university students. Based on the findings of the questionnaire distributed among 18 universities, the awareness of e-Learning was found to be very high, although minimal efforts were made to develop an e-Learning application to be used by the universities. In addition, it was argued that most universities lacked a section on their websites or portals allocated for e-Learning. As a result, the staff and students were obliged to constantly use additional aids such as e-mail and other websites. In addition, statistically significant differences among the forms of e-Learning activities and the type of universities were reported by Kamba (2009).

Tynjala and Hakkinen (2005) aimed to highlight the applications of e-Learning in various contexts from a theoretical point of view. In doing so, theories of adult learning, learning at a workplace, and organizational learning were reviewed and the main pedagogical implications of these theories from an e-learning point of view were discussed. The findings of Tynjala and Hakkinen (2005) pointed out the need for the integration of research knowledge from various sources to develop e-learning solutions for the use of work organizations.

The present study aimed at classifying the challenges and problems of e-Learning from the viewpoints of its immediate users around the world (i.e., students and educators). Since the outbreak of COVID-19, several studies have been carried out worldwide. However, they mostly focused on a particular geographic area (e.g., certain countries, provinces, or cities). The present study, however, included participants from various countries. One might argue that the problems and challenges in question might vary from country to country. For example, there might be a huge difference in the quality and speed of the Internet between developed and developing countries. However, as the literature suggests, these issues might still be of concern even in developed countries. One example can be the United Arab Emirates, a high-income nation that is known to have good quality in terms of the Internet; yet, relevant issues were reported by Amarneh *et al.* (2021).

Through a mixed-methods approach consisting of a systematic review and semi-structured interviews, the present study aimed at answering the following questions:

- How can problems and challenges be distinguished within the context of e-Learning?
- What are the most common problems of e-Learning?
- What are the potential challenges to e-Learning?

3. Method

3.1 Design

The present work adopted a qualitative approach. To begin with, a systematic review of the literature was carried out based on the guidelines provided by Tranfield, Denyer, and Smart (2003). Then, semi-structured interviews with a phenomenological approach were conducted.

3.2 Materials and Instruments

Cardiff Metropolitan University's E-Library (MetSearch, 2020) was used to collect primary data. The search terms were (e-Learning OR online learning OR online education OR online teaching AND problems AND challenges). The final materials used in the present study (n=116) included theoretical articles (n=43), empirical reports (n=31), books (n=18), and other types of publications (n=24). Both open-access and subscription-based sources were used. The criteria for materials inclusion were a) the language (only English sources), b) publication time (not older than 2010), and c) relatedness (related to the challenges and/or problems of e-Learning). Consequently, a data bank was established for further use and analysis. Semi-structured interviews were then formed based on the findings of the systematic review.

3.3 Participants

Ten students and 5 educators participated in semi-structured interviews. Due to limited resources as well as the restrictions that were arisen by COVID-19 at the time the research was conducted, it was not possible to interview more participants. All interviews were conducted between the 28th of April and the 7th of May 2020. Each interview took around 15 minutes on average. Participants were selected from different educational levels, ages, and genders, and were all selected based on convenient sampling. To avoid possible bias, peers from different entities and institutions were requested to nominate participants from different countries. No conflicts of interest were reported between the researchers and the nominees at the time of research conduction. To have a global perspective, participants were selected from different nationalities residing in different countries all over the world. English was used as the medium of communication. Table 1 provides a demographic overview of the participants.

Table 1: Demographic Information of the Participants

Participant Code	Academic Qualification/Rank	Age	Gender	Country of Residence
Student 1	High School	15	F	Sweden
Student 2	High School	16	M	Iran
Student 3	Bachelor's	19	F	Oman
Student 4	Bachelor's	19	F	Germany
Student 5	Bachelor's	20	M	Oman
Student 6	Master's	24	M	UAE
Student 7	Master's	27	F	USA
Student 8	Ph.D.	32	M	Iran
Student 9	Ph.D.	42	M	Canada
Student 10	Ph.D.	33	F	Canada
Educator 1	Teacher	43	F	Sweden
Educator 2	Lecturer	45	M	Tunisia
Educator 3	Assistant Professor	37	F	Germany
Educator 4	Associate Professor	39	M	USA
Educator 5	Professor	52	F	USA
Total	15			

Due to the diversity in the participants' locations, all interviews were conducted through online meeting software and applications (e.g., Microsoft Teams, Zoom, Google Meet, WhatsApp, and Adobe Connect) based on the participant's preference. All interviews were recorded for further analysis. To abide by the health and safety protocols against the spread of the COVID-19 pandemic, the same procedures were followed for the participants living in the same areas as the data collectors did.

3.4 Data Collection and Analysis Procedures

Having collected the materials, some keywords were selected and searched, and the results were recorded subsequently. The keyword selection, categorization, and extraction procedures were adopted from a similar empirical study (Nouraey and Karimnia, 2015). Although there were several pieces of software available to carry out this task (e.g., Atlas, NVivo) in general, as well as keyword extraction in particular (e.g., MonkeyLearn, IBM Watson, Amazon Comprehend, AYLIEN), human processing was used due to more accuracy in keyword inclusion (Cohen, Manion and Morrison, 2013). Some lemmas used in the present study along with their possible derivatives are shown in Table 2.

Table 2: Examples of the Lemmas and Their Possible Forms

Lemmas	Other Possible Forms
learning	e-Learning, d-learning, m-learning, digital learning, correspondence learning, virtual learning
e-Learning	electronic learning, fixed e-Learning, adaptive e-Learning, linear e-Learning
education	distance education, online education
online learning	synchronous online learning, asynchronous online learning, interactive online learning, collaborative online learning, individual online learning
computer/Internet-*-learning/instruction	computer-managed learning, computer-assisted instruction, computer-aided language learning, computer-assisted language learning, computer-based learning, Internet-based learning
problem	problems, problematic
challenge	challenges, challenging, challenged, challengeable

After highlighting the text containing the challenges and problems of e-Learning (and other similar learning means), a conceptual framework was taxonomized. This framework aimed at providing a classification of the possible problems and challenges of e-Learning from the viewpoints of both students and educators and was later used in forming the semi-structured interviews. To conceptualize the framework, first, all duplicated items were removed and only the main lemmas were considered as individual entries. As an example, the terms "*interactive online learning"*, "*collaborative online learning"*, and "*individual online learning"* were all considered under the umbrella term "*online learning"*. The same procedure was adopted for the semi-structured interviews. Some items were not duplicates yet were very similar and/or interrelated. For instance, although the terms "*fixed e-Learning*", "*adaptive e-Learning*", and "*linear e-Learning*" vary functionally, they were all considered "*e-Learning*". Where possible, these cases were merged to form a single umbrella term.

4. Results

The findings of the literature review through keyword analysis formed the two main categories in question (viz. the problems vs. challenges of e-Learning). These results were then used in forming the semi-structured interviews held with the participants (both students and educators). The following section provides a comprehensive elaboration of the interview results obtained in light of the findings from the systematic review.

4.1 Problems Associated with e-Learning

The main problems associated with e-Learning were the following:

- *Unavailability of technical facilities*: Not every member had a suitable technological device such as a laptop or a PC. In addition, some functions of the software being used were inactive for smartphone users. This would in turn have a negative impact on the accessibility of the courses.
- *Internet connection issues*: No Wi-Fi connection and/or weak mobile data signals were reported by some of the participants.
- *Physical and mental presence*: In some cases, the students were not asked to turn their cameras on, which was linked to cultural issues. Therefore, the educator could not ensure whether the students were physically and/or mentally present in the classes, which would, in turn, affect attendance reliability.
- *Impossibility of teaching some modules online*: Some courses may not be taught online, including modules with laboratory activities and those requiring participation through workshops.
- *Limited level of interaction*: Face-to-face interaction among students and educators was far less compared to a normal classroom environment.
- *Monitoring class activities*: Monitoring class activities by educators was not possible in some cases. As an example, English language educators usually benefit from activities such as chain drills. However, doing such activities was reported as almost impossible or extremely challenging due to the lack of face-to-face interaction.
- *Excuses not to attend*: Students would hide behind excuses not to attend. E-Learning made it easier for students not to attend their courses either at all or regularly. The excuses (which were sometimes genuine and justifiable) were mostly related to a lack of Internet connection or having faced technical issues with students' devices.
- *Time waste*: It took some time to settle everything down and start the classes. Setting up the connection and waiting for the students to join the online calls would waste a few minutes of class time.
- *Lack of familiarity with technology*: Members did not know how to download, install, and efficiently use the software. Surprisingly, few educators also faced the same issue, as the shift to e-Learning was sudden and there was no time for preparation.
- *Students' preferences*: Students preferred not to use ready-made materials. Few of the participants referred to mathematics and believed it would be more practical to study in a real classroom environment rather than having ready-made materials in front of them. Based on the participants' opinions, the classroom context would in turn allow them to have real communications with their educators and/or peers, which would subsequently be more useful.
- *Lack of seriousness*: Students and their family members were reported to take online classes for granted. This caused a lot of difficulties for the students in finding a quiet and suitable place to have their online courses.

- *Course withdrawal and dropouts*: Some students were reported to apply for course withdrawal, hoping the situation would be over soon and things would go back to normal. In a few cases, student dropouts or intentions to do so were reported.
- *Members' freedom*: Educators' and students' freedom caused a lack of attention, eventually leading to partial class dismissal. This was particularly evident among students, as educators were the ones running the classes for most of the class duration. This factor was observed to vary based on the educational level. For example, Ph.D. students were mostly asked to give class presentations. Therefore, the students were the ones utilizing most of the class time and were busy enough not to be distracted easily.
- *Lack of equal accessibility*: The administrations did not provide equal access for the students and educators. In some cases, students did not have access to online materials and courses because their countries of residence were different from where they were studying. As a result of administrative decisions and to avoid security risks and potential cyber-attacks, some universities banned external access from other regions without taking into consideration that some students might live abroad.
- *Students' shyness*: Students (especially females) mostly felt inconvenient to participate in classes by sending voice messages to and/or holding video calls with their educators and peers during the online courses. These were reported by certain participants and seemed to be closely related to cultural beliefs as well as the regions where students lived.
- *Member's privacy*: Educators' and students' privacy was affected, as they had to provide their personal phone numbers and other details that they would normally prefer not to reveal. Similarly, most of the participants (both students and educators) reported the unintentional violation of their privacy during online classes. For instance, some unmuted their microphones and/or activated their cameras unintentionally. Other examples were the cases in which the microphones or the cameras were already active, yet members did not notice this. Some educators also complained about students calling or messaging them late at night, causing them inconvenience
- *Lack of space for data storage*: A large amount of data needed to be stored and members would sometimes lack enough space on their devices. One of the educator participants argued that she had to format her phone device at least twice a week, as she did not have enough time to delete all the downloaded materials one by one. This would subsequently cause some inconvenience such as data loss (including contact names and numbers, photos, videos, voices, music files, etc.), but seemed to be the fastest way to prepare for the rapidly approaching, upcoming courses.
- *Physical fatigue*: Using computers and other electronic devices for a long time caused fatigue, eye strain, dizziness, and other health issues. In some cases, students and educators had to visit clinics or take a rest to recover from the health hazards caused by e-Learning.

4.2 Challenges Associated with e-Learning

Accordingly, the main challenges associated with e-Learning were:

- *Finding a suitable place for teaching and learning*: This challenge was closely related to one of the aforementioned problems (i.e., lack of seriousness). Some of the participants reported difficulties in finding a suitable place for learning and/or teaching purposes. In some cases, they were unwantedly distracted by their family members.
- *Infra-structure and technical facilities*: The phenomenon of e-Learning requires a strong infrastructure backed by an expert IT and administrative team along with many other technical facilities. Some educational bodies, especially at smaller scales (e.g., schools) could not afford all these requirements. Based on the participants' responses, those who were working in large-scale organizations such as universities and colleges faced fewer difficulties.
- *Prior arrangements and liaison*: The establishment of e-Learning, along with its related phenomena, was reported to require multiple preparations and collaborations before and after its implementation. Few participants reported the numerous difficulties they faced in making all the required arrangements. Examples included, but were not limited to, a) making announcements on the website regarding the decisions about how the courses were going to be conducted, b) sending bulk emails and messages to students to ensure they have seen the announcements (as part of their academic advising responsibilities), c) keeping in touch with students and updating them regarding the revised timings, the software to be used, and other related issues, d) announcement on the course beginning, and e) updating the students' timetables, exam timetables, and academic calendar due to the possible gaps between the normal and online classes.

- *Cost*: E-Learning was reported to be costly by most of the participants. Some of the participants quoted students not attending classes, as they were waiting to get a new device. Some complained about the cost of Wi-Fi and mobile data subscription fees. In some regions, a monthly subscription fee for a Wi-Fi connection with an unlimited data plan would cost approximately $90 including taxes and additional charges. In the same region, a monthly mobile data plan of 1 GB would cost around $8. On the contrary, these prices were much lower in some other regions, ranging from $5 for Wi-Fi and $1 for mobile data connections with similar data plans, respectively (all in US dollars).
- *Recognition of efforts*: Based on the arguments put forth by some participants, they felt a lack of appreciation at the end of the day, as nobody truly understood the extent of their hard work and struggles in conducting online classes. Therefore, in some cases, educators felt that their efforts were neglected by the students and their families.
- *Assessments*: How to conduct the assessments was a huge challenge reported by both students and educators. In addition, assessment and examinations were at the center of attention of other stakeholders such as students' parents (and other family members), sponsoring bodies, and the organizations' management and administrative staff. Various challenges were reported regarding the assessments including a) what security measures had to be taken to ensure that students would attend the exams by themselves in a real exam environment, b) what types of questions would fit the online assessments in question, c) what measures had to be taken if the students lost connection during the online examinations and d) how to conduct assessments that were not merely of a question-and-answer type (e.g., listening comprehension tests, speaking tests, etc.).
- *Material development and approval*: The process of e-Learning required material development and administrative approval. In a few cases, the participants reported experiencing prolonged approval intervals by the approving bodies within their organizations (such as the Board of Directors, Board of Trustees, College Board, etc.). In some cases, obtaining the required approvals from external bodies such as ministries took longer than expected and therefore, the organization had to revise its academic calendar and other related timetables.
- *Boredom and fatigue*: E-Learning was reported to be more boring and tiring as compared to normal classes. This was associated with the lack of face-to-face interactions between the participants and their peers and/or educators. In some cases, students tended to lie down on a couch and would unintentionally fall asleep during classes, which in turn, could be related to a lack of physical movement.
- *Class duration*: Online classes were usually shorter as compared to normal classes due to various reasons. One of the possible reasons reported by a participant was the lack of managerial supervision on the start and end of class timings. Another reason reported was a lack of motivation among educators, as many students would not attend the online course, potentially leading to the early dismissal of classes.
- *Freedom at home*: The home environment was often more appealing and enjoyable as compared to conventional classroom environments, leading to a potential lack of attention from both educators and students. Due to a lack of direct supervision and face-to-face interaction, students and educators were distracted from time to time. As an example, students could use their phones without being monitored by their educators.
- *Unavailability of technical facilities*: Some students in particular regions did not even have mobile phones to join the classes, let alone computers or tablets. One of the participants explained how she struggled to convince a charity organization to purchase a few inexpensive mobile phones for students to be able to attend online courses.
- *Special Needs Students*: In some organizations, educators complained about the measures taken for students with special needs. For example, for deaf and hard of hearing students, an option of simultaneous interpretation with an interpreter's online video was available; yet, more actions were required to be taken in their support.

Figure 1 provides a conceptual framework of the e-Learning problems and challenges. This framework is based on the systematic review as well as the participants' responses during the semi-structured interviews.

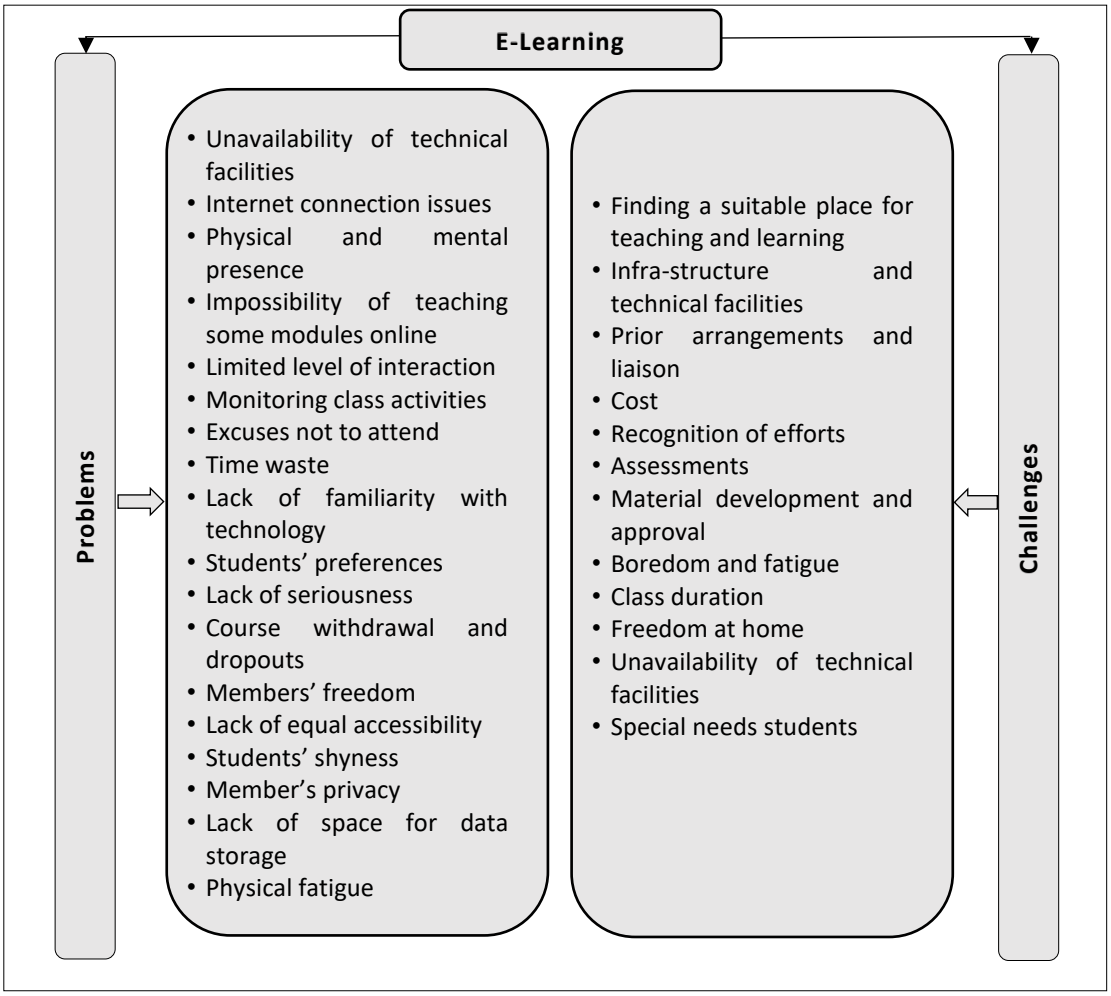

Figure 1: A Conceptual Framework on the Problems And Challenges Associated with e-Learning

5. Discussion

The problems and challenges reported in the present work were mostly in agreement with those of other studies. For example, lack of direct contact with educators, lack of information about the changes planned, lack of a suitable place to study at home, no Internet access, lack of educators' engagement in e-Learning, and no access to computer devices were frequently reported by students as part of the e-Learning requirements imposed by the COVID-19 pandemic.

In support of computer fatigue, Kamba (2009) reported some physical risks caused by excessive use of computers during the e-Learning process, including eye strain, back pain, and chronic pins and needles in the legs and feet. Regarding mental traits and personality factors such as self-confidence and shyness, conflicting results have been reported. For example, Tham and Werner (2005, p.15) have claimed that studying in an "invisible classroom", e-Learning may take away social and physical boundaries such as shyness, location, gender, and race. However, others have reported less participation in e-Learning courses due to shyness and lack of self-confidence (e.g., Al-Fadhli, 2008; Al-Rahmi, Othman, and Yusuf, 2015). The shyness resulting in a lack of participation and communication during the e-Learning process has mostly been reported among Asian students (Zhang *et al.*, 2012). As a solution, Ashour (2021) argued that any educational model of e-Learning should be first customized to the cultural, local, economic, and social context within which the education is taking place.

Chou and Chen (2016) have highlighted a few issues related to the privacy of members involved in e-Learning. The issue of members' freedom during online courses and how it might affect the successful implementation and effectiveness of e-Learning has also been studied (Quadri *et al.*, 2017). Dropouts and course withdrawals as results of e-Learning have been investigated by others, as well (e.g., Burgess, 2017; Kim *et al.*, 2017).

Poor Internet quality and difficulties in accessing printers, computers, and other technological devices have also been discussed (Digolo, Andang'o, and Katuli, 2011; Kamba, 2009). Similar to our results, studies have reported some other difficulties related to technology including insufficient computer and Internet skills, lack of experience in Internet-based teaching, insufficient support (especially technical support) from the organization, management, and/or home (or in some cases partner) universities (Fichten *et al.*, 2009; Kamba, 2009). Digolo *et al.* (2011, p.138) have used the term "technical shyness" for the lack of ability to use computers among students and educators, which has been classified as a challenge to e-Learning.

Some studies have investigated the costs associated with e-Learning (Chatterjee, Ghosh, and Chatterjee, 2020; Harris *et al.*, 2011; Scarafiotti, 2004). Based on the literature, most of the studies have reported these costs to be additional burdens to the e-Learning members, especially the host institutions, as they had to build (or strengthen) infrastructures before the establishment of the e-Learning phenomenon. Some researchers have conceptualized models to be followed to ensure the cost-effectiveness of the e-Learning process. As an example, Scarafiotti (2004) has highlighted five steps including a) identification of e-Learning costs, b) exploring ways to maximize human resources, c) implementing policies to aid course development and production costs, d) considering scale and scalability, and e) redesigning large-enrollment courses to reduce cost and improve learning.

One of the most important elements in the context of (higher) education is the assessment of students (Jalali *et al.*, 2018). In line with its significance, Lara, Aljawarneh, and Pamplona (2020) have recently conducted a literature review, citing different barriers faced by the people involved in e-Learning, including problems of self-assessment (e.g., Wong *et al.*, 2020), peer-assessment (e.g., Ng, 2016) and automated assessment (e.g., Barana and Marchisio, 2016). Lara *et al.* (2020) have suggested a few recommendations such as paying more attention to e-Learning assessments in Data Science projects, expanding the domain of research in terms of assessment and not adhering to education in a single area, and using new means to deliver assessments (e.g., through Blockchain technology).

Concerning the students with special needs, the results of our study were mostly in agreement with those of Fichten *et al.* (2009), who conducted an exploratory investigation on the problems of e-Learning faced by Canadian students with disabilities. Based on the findings of Fichten *et al.* (2009), students with disabilities faced several issues as a result of e-Learning, including problems in accessing the website, opening course materials, downloading, and using files, to name but a few.

Finally, a debating question remains as to what extent factors such as the student's background, ethnicity, culture, and other intervening issues may affect the learning process. To address this issue, researchers have claimed that ethnic factors may affect the learning process (e.g., Lundberg and Schreiner, 2004; Lundberg *et al.*, 2007; Okagaki, 2006; Ro, Knight, and Loya, 2016). A careful analysis was then required to investigate the intervening roles of culture and ethnicity on the learning output of students; therefore, these factors were not extensively discussed in the present work.

6. Conclusion

The present study was an attempt to investigate the effectiveness of e-Learning by delving into its possible challenges and problems reported by both students and educators. The beginning of 2020 witnessed a unique scenario where educational sectors worldwide were prompted to seek alternative teaching mediums in response to the global COVID-19 pandemic. All in all, the entire experience of e-Learning seemed to be challenging for educators, students, administrative staff, policymakers, management teams, and other relevant stakeholders, some of which have been discussed in the present work.

The e-Learning style is considered a big challenge among its users, as compared with the traditional learning styles they have usually experienced in normal classroom environments. Each challenge and problem highlighted in the present work could be extensively investigated and detailed, either individually or in pairs. It is noteworthy to mention that a few of the points discussed in the present study could be regarded as a challenge or a problem simultaneously. Some examples may be the unavailability of technical facilities and finding a suitable place for teaching and/or learning (c.f., the literature review section for differences between these two terms).

The main limitation of the present work was the number of interviews, which was due to our limited resources and the restrictions that were caused by COVID-19 at the time the research was conducted, although data saturation was reached for both interviewee groups (i.e., students and educators). Finally, knowing the challenges and problems of e-Learning may contribute to formulating solutions to be used in similar

circumstances in the future, or just to improve the e-Learning process as an alternative to the traditional means of teaching and learning worldwide.

Acknowledgement

The research leading to these results has received funding from The Ministry of Higher Education, Research & Innovation (MoHERI) of the Sultanate of Oman granted to Peyman Nouraey under the Block Funding Program (Agreement No. MoHERI/BFP/GULF/01/2020, Project Code BFP/RGP/EHR/20/504).

Ethical Approval

This study was conducted in accordance with the Gulf College Research Ethics Committee. The ethical approval of this study (Approval Code: GC/RD/REC/20/01) was obtained from this committee before collecting the data from participants as a prerequisite for conducting this study and all committee requirements have been fulfilled.

Informed Consent

Informed consent was obtained from all participants (or their guardians) prior to their participation.

Conflict of Interest

The authors declare no conflict of interest.

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The Dynamics of Access to ICT and Technology Practices of Secondary School Teachers

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Abstract: The COVID-19 pandemic highlighted the importance of access to Information and Communication Technology (ICT) for effective teaching and learning. Access to ICT is a complex and dynamic phenomenon that significantly impacts teachers' technology practices. There is a need for more extensive studies to explore the dynamics of access and teacher technology practices in various contexts. This study explored the influence of access on the technology practices of secondary school teachers in the Western Cape, South Africa. A qualitative online survey was used to explore the lived experiences of teachers during the COVID-19 pandemic. A diverse sample, in terms of gender, age, years of experience of teachers, and socio-economic status of schools, of 22 teachers voluntarily participated in the study. Van Dijk's cumulative model of access to ICT provided a useful lens to explore how and when the dimensions of access supported or hindered teachers' appropriation of ICT. This study found that most respondents were primarily exposed to traditional face-to-face teaching before March 2020. The suspension of in-school teaching, however, caused a dramatic shift in the way teachers interacted with technology, learning materials and learners. Three dimensions of digital inequality, associated with physical access, manifested in South Africa, namely the Virtual Classroom, WhatsApp, and Radio-Television groups. Most participants in this study returned to traditional teaching practices with increased use of technology when schools reopened again. The findings of this study suggest that access to technology is not a linear progression of successive stages that by default culminates in usage. This paper proposes a more holistic contextualised approach to access to create enabling environments for the use of ICT and empower teachers to use ICT in their teaching practices.

Keywords: Information and Communication Technology (ICT), Access to ICT, Teacher technology practice, COVID-19 pandemic

1. Introduction

The COVID-19 pandemic highlighted the importance of teachers' access to Information and Communication Technology (ICT) for effective teaching and learning. This study explored the technology-mediated teaching practices of secondary school teachers in the Western Cape, South Africa. This paper reports on how and when the dimensions of access supported or hindered teachers' technology practices during the pandemic.

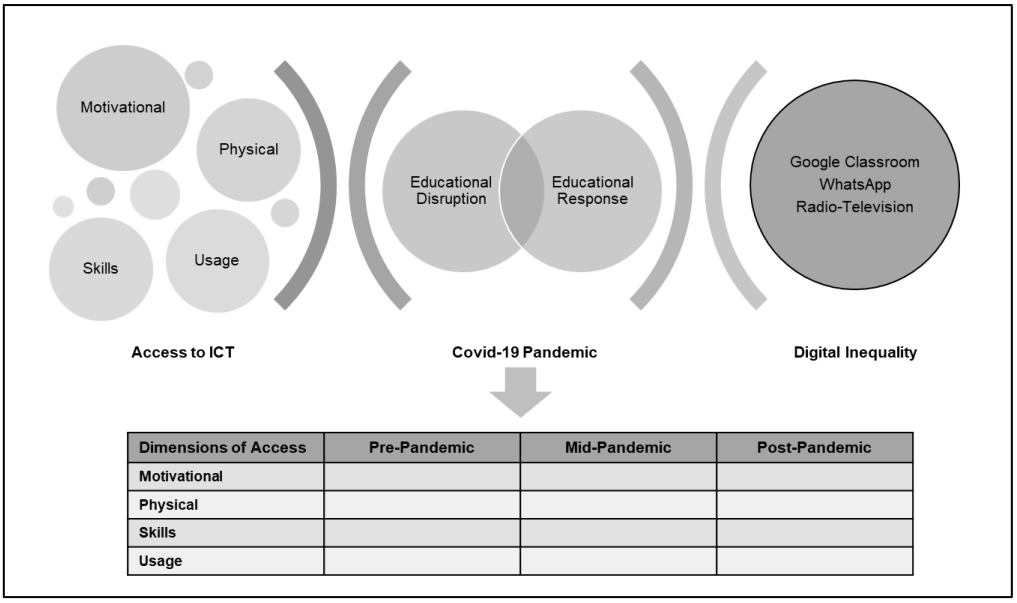
The concept of access refers to the process of appropriation of technology with the purpose of actual usage (van Dijk and Hacker, 2003). Before the COVID-19 pandemic teachers could decide whether they would use technology in their teaching practices (Giacosa, 2020). The pandemic brought normal classroom activities to an abrupt halt and compelled teachers to implement technology as a mitigating strategy (Bozkurt and Sharma, 2020; Hodges, Moore and Lockee, 2020).

Teachers suddenly found themselves in a new relationship with technology and teaching (Adov and Mäeots, 2021; Bond et al., 2021). The affordances of 21st-century technologies provided teachers with a substantive way to remain operational during the COVID-19 pandemic (Bozkurt and Sharma, 2020; Arnett, 2021). Despite emergency measures implemented by the South African government to ensure continued teaching and learning, most schools and teachers had insufficient access to ICT and were unprepared for technology-mediated remote teaching.

The phenomenon of access to ICT is complex and multidimensional and the theories of access have in recent years evolved to include more than just physical access (Czerniewitz, 2005; Soomro, 2018). This study addresses the need to further explore and uncover how and when the dimensions of access to ICT may influence teacher's use of ICT in their teaching practices in various contexts, for example, the COVID-19 pandemic (Jelińska and Paradowski, 2021; Moorhouse and Kohnke, 2021).

The theoretical and conceptual underpinning of this study is illustrated in Figure 1. Van Dijk's cumulative model of access to ICT, in conjunction with Jansen's dimensions of digital inequality, provides a useful lens to explore the role of access within the context of the COVID-19 educational disruption and response.

Reference this paper: Kennedy, I. and Cronjé, J., 2023 The Dynamics of Access to ICT and Technology Practices of Secondary School Teachers, *The Electronic Journal of e-Learning, 21(3)*, pp 200-210, available online at www.ejel.org



Dimensions of Access	Pre-Pandemic	Mid-Pandemic	Post-Pandemic
Motivational			
Physical			
Skills			
Usage			

Figure 1: Theoretical and Conceptual Underpinnings

This study aims to contribute to scholarship by uncovering how and when the dimensions of access influence teachers' use of technology. This knowledge is essential to create enabling environments for the use of ICT and empower teachers to use ICT in their teaching practices.

2. Research Problem

The problem driving this study is that despite enthusiastic national policy support for access to ICT in education, there is limited research dealing with ICT integration within an educational context during times of crisis (Mailizar et al., 2020; Sukendro et al., 2020). The current literature does not provide us with a clear understanding of the dynamics of the various dimensions of access to ICT and teachers' appropriation of ICT (Sadeck, 2016; Padayachee, 2017).

This study addresses this problem by exploring the dimensions of access to ICT and how they may support or hinder teachers' technology practices.

Question 1: How do the various dimensions of access to ICT influence teachers' appropriation of ICT in their teaching practices?

Question 2: When do the various dimensions of access to ICT influence teachers' appropriation of ICT in their teaching practices?

3. Literature Survey

This literature survey provides background regarding access to ICT and teacher technology. After considering the impact of and response to the COVID-19 educational disruption, the literature survey will consider access as a process of appropriation of ICT.

3.1 COVID-19 Educational Disruption and Response

To mitigate the spread of the virus in South Africa, President Cyril Ramaphosa declared a state of disaster. On 18 March 2020, South African schools closed for the first time bringing the normal classroom activities of an estimated 17 million learners to a sudden halt (StatsSA, 2020).

While 21st-century technological affordances enabled teachers to continue teaching remotely, technology-mediated teaching was new to most teachers (Sahin and Shelley, 2020). Schools and teachers struggled due to a lack of infrastructure and teaching practices that fell short of what was required to integrate ICT into teaching and learning (Hennessy *et al.*, 2021; Moyo *et al.*, 2022).

In South Africa, differing social and educational contexts had a significant impact on efforts to deliver education during the pandemic. Only a small number of well-resourced schools were able to shift seamlessly to remote

teaching (Landa, Zhou and Marongwe, 2021; Mbhiza, 2021). As a result of these digital inequalities, little or no teaching took place at most South African schools (Dube, 2020).

3.2 Access as a Process of Appropriation

Teachers' appropriation of technology depends on access to ICT (Maceviciute and Wilson, 2018). Van Dijk (2003) developed a cumulative model of access, whereby different kinds of access are experienced at successive stages and are conditional on one another. The relationship between the dimensions of access, i.e. motivation, physical, skills, and usage, are illustrated in Figure 2.

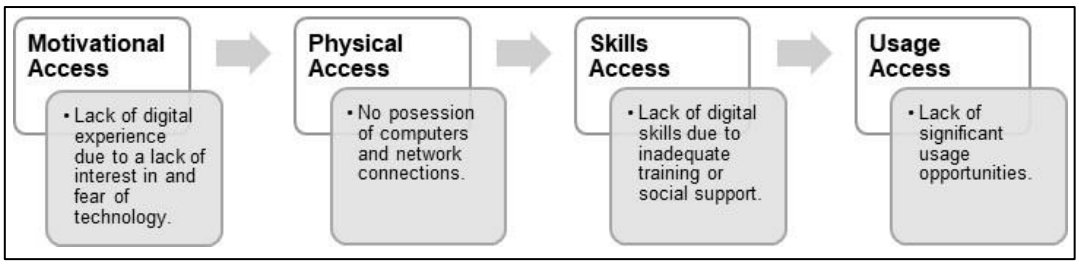


Figure 2: Access as a Process of Appropriation of ICT (Van Dijk, 2003).

3.2.1 Motivational access

Motivational access refers to the mental readiness and willingness to use digital technologies. While motivation plays a crucial role in the adoption and effective use of ICT, it is often ignored or neglected in practice. Motivational readiness drives individuals to develop competence in and adopt ICT. Ultimately, motivational readiness empowers individuals to leverage the potential of ICT for personal and professional growth.

3.2.2 Physical access

Physical or material access to ICT refers to the availability and provision of the necessary devices, infrastructure, and resources required to use ICT effectively. Physical access is an essential requirement for developing digital skills and ultimately using ICT. As a result, access to ICT as physical technology is also at the forefront of all accounts of access to ICT in the literature (Peters et al., 2020; Crompton et al., 2021).

Physical access to ICT in educational settings is essential for providing teachers and learners with opportunities to develop digital literacy skills and enhance their teaching and learning experiences. It enables teachers and learners to access digital resources, educational software, online libraries, and other educational materials. Physical access to ICT also allows teachers to incorporate technology into their teaching practices, promoting digital pedagogy and innovative instructional methods.

Jansen's dimensions of digital inequality

Jansen (2020), identifies three dimensions of digital inequality (associated with physical access) among teachers and learners in South Africa, i.e. Google Classroom, WhatsApp and Radio-Television groups. In this paper, the term "Google Classroom" is replaced with "Virtual Classroom" to include the use of other connecting platforms such as Moodle and Microsoft Teams. The dimensions of digital inequality, as illustrated in Figure 3.

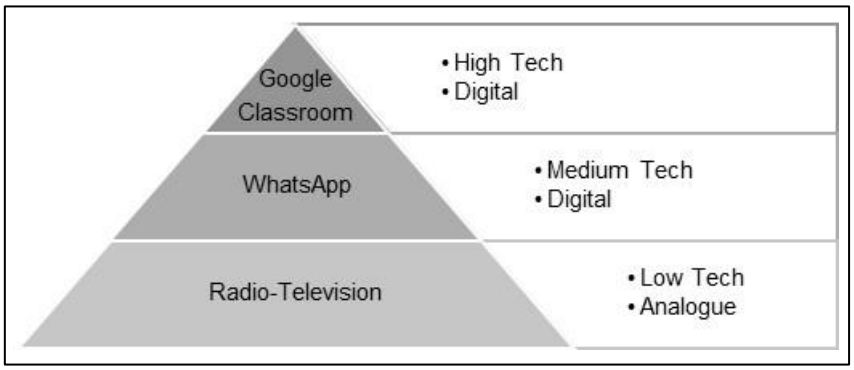


Figure 3: Dimensions of Digital Inequality (Jansen, 2020)

Virtual Classroom

This group refers to the small number of well-resourced schools. Many of these schools already offered some form of blended learning before the lockdown. As a result, they transitioned from face-to-face to remote teaching relatively smoothly and experienced fully online remote teaching and learning almost from the start of the lockdown. The percentage of individuals 5-24 who attended educational institutions that offered remote learning is summarised in Table 1. Approximately only one in ten learners (10%) were offered the option of remote learning, and approximately only 6% of learners participated in remote learning during the pandemic (StatsSA, 2020).

Table 1: Percentage of Individuals 5-24 who Attended Educational Institutions That Offered Remote Learning (StatsSA, 2020)

Geography type	Remote learning	No remote learning
Urban	14.7	85.3
Rural	7.6	92.4
RSA	11.7	88.3

WhatsApp

In practice, most teachers used the WhatsApp facility for educational interaction with learners. As illustrated in Figure 4, significantly more households with individuals aged 5–24 accessed the internet through mobile phones than other devices.

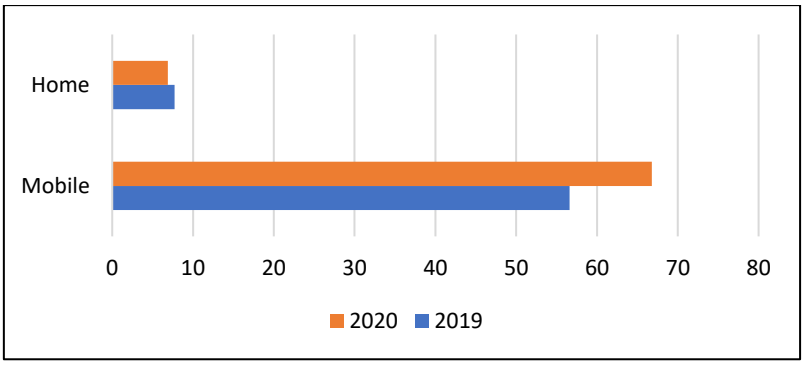


Figure 4: Percentage of Households with Individuals Aged 5-24 years by Internet Access in South Africa, 2019-2020 (StatsSA, 2020)

While WhatsApp enabled teachers and learners to interact remotely, the online uses of this application were rudimentary, and the learning process was often disrupted by the availability of devices, cost of data, and unstable internet connections. WhatsApp was, also, more suitable for secondary schools as the percentage of mobile phone ownership increased significantly by grade as illustrated in Figure 5.

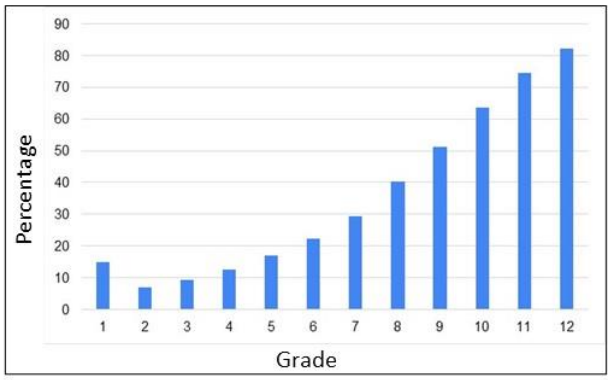


Figure 5: Percentage of Individuals Aged 10-24 years who Attended School and Owned a Functional Mobile Phone by Grade, 2019 (StatsSA, 2020)

Radio-Television

Most South African learners had no other option but to rely on educational radio and television programmes for remote learning. Due to the limitations of these broadcast media, the lockdown carried little if any academic benefit for this majority group.

3.2.3 Skills access

Skills access to ICT refers to the development and acquisition of digital skills and competencies necessary to effectively use ICT tools and resources. Skills access to ICT in education is crucial for developing digital literacy, fostering 21st-century skills, accessing educational resources, and enhancing learning experiences. Skills access consists of three levels:

- *Operational skills* - the ability to operate a computer and utility software.
- *Informational skills* - the ability to search, select, and process information in digital resources.
- *Strategic skills* - the ability to use digital technology as a vehicle to reach specific goals.

3.2.4 Usage access

Usage access to ICT refers to the ability and opportunity to effectively utilise ICT tools and resources in various contexts, such as education, business, or personal use. It thus refers to the deliberate decision to use digital technologies and is presumed to be the free choice of individuals determined by need, occasion, obligation, time, or effort to use ICT.

Within an educational context usage access to ICT enables teachers to incorporate technology into their teaching practices, leading to enhanced teaching and learning experiences. It allows teachers to use multimedia resources, interactive learning platforms, educational applications, and online tools to present information in engaging and interactive ways.

3.3 Critical Analysis

Access to ICT is essential for the successful adoption and use of ICT in teaching and learning. Unfortunately, the existing literature does not provide sufficient information on teachers' access to and use of ICT. While Van Dijk's model has been influential in exploring and understanding the complexities of access to ICT, the model also has some limitations and areas for critical analysis. One of the main concerns is its limited focus on human agency, i.e. how individual motivations, skills, and choices influence ICT access and use.

This paper argues that there is a need for a richer and more nuanced understanding of the multi-faceted concept of access to ICT that more accurately reflects how individuals actively engage with ICT in an increasingly technology-mediated society.

4. Research Design and Method

This exploratory study adopted a qualitative survey design to investigate the role of access in teachers' appropriation of ICT in their teaching practices before, during, and after the COVID-19 pandemic. An online survey, created using Google Forms, was used to explore secondary school teachers' lived experiences during the COVID-19 pandemic.

The survey consisted of six demographic questions, twelve open-ended questions, ten Likert-scale items, one select-all-that-apply item, and three multiple-choice items. A 4-point scale was used for the Likert-scale items (0=Low to 3=High). In terms of the content of the survey, the questions focused on teachers' experience of the transition to ERT, technological-pedagogical knowledge, and access to and use of ICT in their teaching practice. The survey included a consent statement and responses were submitted anonymously.

The study employed non-probability sampling to target secondary school teachers in the Western Cape since the researcher did not have a complete list of the population (Saunders & Lewis, 2012). This method is often associated with qualitative data collection (Saunders & Lewis, 2012; Taherdoost, 2016). The type of non-probability technique is purposive sampling. Purposive sampling is ideal for exploratory research design where the researchers use their judgement to choose who will best suit the objective of the research (Moser & Korstjens, 2018; Taherdoost, 2016).

A total of 22 teachers from government schools responded to the survey. The sample, illustrated in Figure 6, was diverse in terms of gender, age, years of experience of the teachers, and socio-economic status of the schools. The objective of this exploratory study was to do a small survey with the view of piloting for a larger

survey. A sample between 4 to 12 participants is likely to be sufficient in instances of homogeneous populations and between 12 to 30 for heterogeneous populations (Saunders and Lewis 2012).

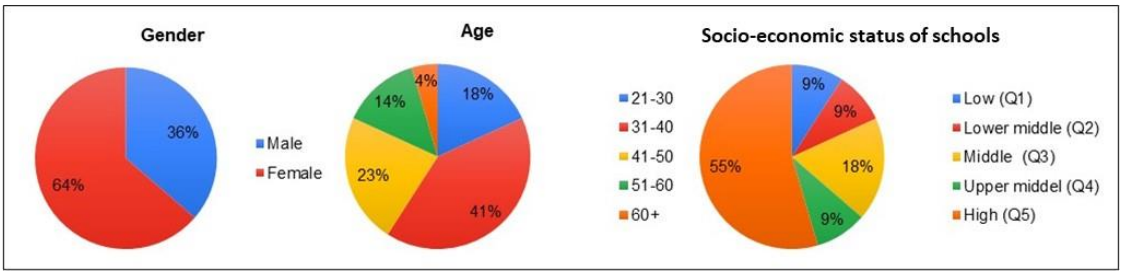


Figure 6: Respondent Demographics

5. Findings

Various interrelated factors promoted or hindered teachers' access to and use of ICT in their teaching practices. The findings of this study are reported and discussed with reference to the two research questions.

5.1 How did the Variables of Access to ICT Influence Teachers' Appropriation of ICT in Their Teaching Practices?

This discussion provides an overview of how the variables of access influenced teachers' appropriation of ICT in their teaching practices during the COVID-19 pandemic.

5.1.1 Motivational access

The respondents in this study confirmed, as illustrated in Figure 7, that despite having reasonable access to and proficiency in ICT, they had little or no experience of "teaching with technology" before the pandemic. The limited exposure to online and/or blended teaching and learning respondents can mainly be ascribed to a lack of mental readiness and willingness to adopt and use ICT. The following statement by a respondent aptly captures the fact that many teachers lack interest in and fear technology and consequently, prefer to teach the way they were taught:

> *"A lot of teachers are creatures of habit and don't like to try new technology - it scares them."*

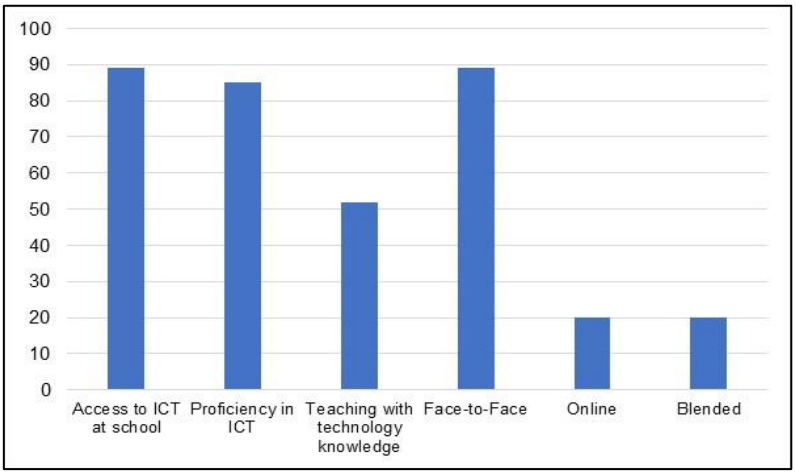


Figure 7: "Teaching with Technology" Before COVID-19

During the COVID-19 pandemic schools were forced to operate remotely and consequently teachers had no option but to use technology as the best alternative to ensure continued teaching and learning (Bozkurt and Sharma, 2020; Hodges, Moore and Lockee, 2020). The use of ICT in teaching practices was thus not by choice, but extrinsically motivated by the need to practice social distancing. The following comment by a respondent illustrates this externally forced obligation to use technology in teaching practices:

> *"I suppose being forced to make such radical changes to the way in which we do things*
>
> *was what we needed - it's very easy to have good intentions about using more or*

unfamiliar technology, but the pandemic made it essential."

Following the pandemic, most respondents displayed a more positive perception and understanding of the benefits of "teaching with technology" and acknowledged that increased incorporation of ICT into teaching practices is a step in the right direction. Unfortunately, most of the respondents returned to traditional teaching practices, with increased implementation of technology, when schools reopened again.

While the pandemic acted as an extrinsic motivation for "teaching with technology", it did not automatically translate into higher levels of intrinsic motivation to adopt and use ICT in teaching practices when schools reopened again.

5.1.2 Physical access

While most respondents indicated that they had relatively high levels of access to ICT for teaching and learning at their schools, the closure of schools caused a major shift in the way teachers and learners interacted with each other, technology, and learning materials. As a result of the postponement of classroom-based teaching, their schools implemented various initiatives to support teachers in transitioning to remote online teaching during the COVID-19 pandemic. Schools in this study assisted with material access to ICT by providing teachers with digital devices such as laptops and allowances for data and internet connection required to work from home.

The transition to technology-mediated education not only increased the need for and reliance on hardware devices but also appropriate software applications such as a Learning Management System (LMS) for the administration and delivery of educational programmes. Unfortunately, most schools in this study did not have an LMS in place before the COVID-19 pandemic. Only 2 respondents reported the use of a traditional LMS, i.e. Moodle and Blackboard.

In the absence of a functional LMS, participants in this study used Google Classroom as the best alternative. While Google Classroom lacks some features associated with a traditional LMS, participants rated it as the most efficient online collaborative tool during the pandemic. WhatsApp was the most widely used social media platform for teacher-learner interaction, primarily because most learners had access to and were already using this platform.

5.1.3 Skills access

During the COVID-19 pandemic, most schools implemented training initiatives to enhance the technological and pedagogical skills of the teachers. While schools offered part-time online training programmes during the hard lockdown and in-school programmes when schools re-opened, most teachers also took responsibility for enhancing their own skills levels. While there was a significant increase in the "teaching with technology" knowledge of teachers, respondents in this study still rated their "teaching with technology" knowledge lower than their operational proficiency in ICT.

5.1.4 Usage access

Before COVID-19 the use of ICT in teaching practices was optional, and ICT was largely regarded as a supplementary tool and a nifty helper in the classroom. Teachers mostly used ICT to support or replicate conventional classroom practices. The COVID-19 pandemic created a novel usage opportunity for ICT in teaching and learning. The educational crisis thus generated the need, occasion, obligation, time, and effort to use ICT.

Because of inadequate "teaching with technology" knowledge, there was limited and very basic use of ICT in teaching practices before and during the pandemic. ICT was mostly used to substitute or augment conventional classroom practices by replacing traditional activities and materials with digital versions, e.g., PowerPoint presentations and YouTube videos. Despite the increase in knowledge, there was no significant change in the way teachers use ICT in their teaching practices. ICT was still primarily used to support and enhance, rather than transform traditional teaching practices (Figure 8).

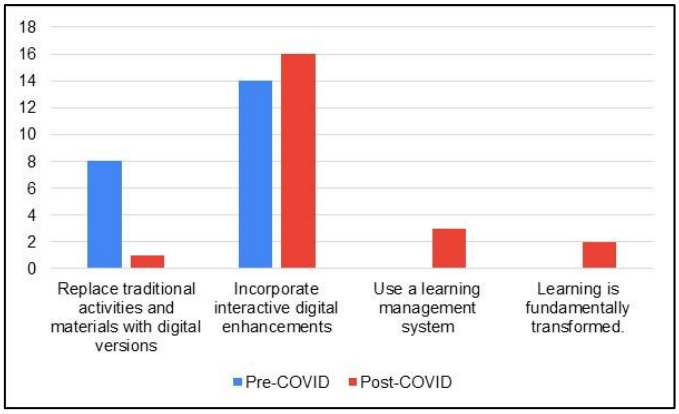


Figure 8: Use of ICT in Teaching Practice

While respondents developed a more positive perception and understanding of the benefits of ICT in teaching and learning, most returned to traditional teaching practices when schools reopened. The participants did, however, indicate that there was increased implementation of technology as a supplementary tool in a more blended approach to teaching.

5.2 When did the Various Dimensions of Access to ICT Influence Teachers' Appropriation of ICT in their Teaching Practices?

The influence that the dimensions of access to ICT had on teachers' appropriation of ICT, for example, promoted and/or hindered use, varied during the stages of the COVID-19 pandemic.

Physical access to ICT infrastructure and devices is essential for teachers to incorporate technology into their teaching during the pandemic. Most of the respondents indicated that they had reasonable to good access to devices and internet connectivity at their schools and home to integrate ICT into their teaching practices. The relatively high levels of physical access placed most participants, schools, and teachers, in this study in the minority "Virtual Classroom". These well-resourced schools and teachers were thus potentially well-positioned to transition from face-to-face to technology-mediated remote teaching and learning almost from the start of the lockdown.

Motivation plays a crucial role in teachers' adoption and effective use of ICT in teaching. Before the pandemic most respondents lacked the intrinsic motivation to enhance their teaching and engage students through ICT. This lack of motivation or perceived benefits of ICT hindered the adoption of ICT in teaching practices. During the COVID-19 pandemic, the shift to technology-mediated remote teaching necessitated a change in teaching methods, which required teachers to be motivated to adapt and integrate ICT tools into their practices. The pandemic thus acted as an extrinsic motivator. This extrinsic motivation plus the existing physical access enabled the teachers to use ICT for teaching and learning during the pandemic. Unfortunately, this temporary extrinsic motivation only translated into slightly higher levels of intrinsic motivation after the pandemic. As a result, most respondents returned to traditional teaching methods with a slight increase in ICT integration in their teaching practices.

Teachers' proficiency in using ICT tools and platforms is a critical factor influencing their appropriation of ICT in teaching. While respondents indicated fairly high levels of operational ICT skills before the pandemic, they had to quickly acquire or enhance their informational and strategic ICT skills to effectively utilise ICT for instructional purposes. Despite various training initiatives during the pandemic, most respondents in this study still rated their "teaching with technology" knowledge lower than their operational proficiency in ICT.

While the respondents rated teachers' access to ICT for teaching and learning at their school relatively high, they rated the school's use of ICT for teaching and learning significantly lower. Teachers' previous experiences and frequency of ICT usage also influenced their appropriation of ICT during the pandemic. Because the respondents were under no obligation to use ICT in their teaching practices before the pandemic, they had very limited prior experience with online and/or blended learning. Respondents who had prior experience integrating ICT into their teaching practices were more likely to adapt quickly to the technology-mediated remote teaching environment.

Unfortunately, the need, occasion, obligation, time, and effort to use ICT generated by the closure of schools was temporary. Despite the increased access to, skills in, and motivation to use ICT in teaching practices, most respondents returned to traditional teaching practices after the pandemic.

The influence of the dimensions of access during the stages of the pandemic is summarised in Table 2.

Table 2: Summary of the Influence of the Dimensions of Access to ICT

Stages	Promoted use of ICT	Hindered use of ICT
Pre-pandemic	Physical access (Operational) Skills access	(Intrinsic) Motivational access Usage access
Mid-pandemic	Physical access (Operational) Skills access (Extrinsic) Motivational access (Forced) Usage access	(Strategic) Skills access
Post-pandemic	Physical access (Operational and strategic) Skills access	(Intrinsic) Motivational access Usage access

6. Discussion

Before the pandemic, the use of ICT in teaching practices was optional, and respondents largely regarded ICT as a supplementary tool and a nifty helper in the classroom. ICT was mostly used to support or replicate conventional classroom practices. During the COVID-19 pandemic teachers were forced to use ICT to operate remotely. The use of ICT was thus extrinsically motivated by the need to practice social distancing. The participants did, however, have a more positive perception and understanding of the benefits of ICT after the pandemic. They also implemented technology in a more blended approach to teaching.

Participants in this study largely returned to traditional teaching practices when schools returned to “normal”.

There was no significant increase in the levels of intrinsic motivation to use ICT to its full potential. Motivation is thus not an automatic outcome of physical access, but rather a separate factor that drives teachers to explore and utilise ICT effectively. Motivational access to ICT implies that teachers recognise its value, perceive it as beneficial, and have the necessary pedagogical knowledge to integrate it into their teaching practices.

Overall, the findings of this study indicate that the relationship between teachers’ access to and usage of ICT is not a straightforward one. Physical access to ICT may be a primary condition, but it does not necessarily translate into actual use of the technology. Access is thus not a linear progression of successive stages. A more networked, relational perspective of access would be more appropriate and useful in developing enabling educational contexts that are conducive to using ICT.

6.1 Limitations

The study had a relatively small sample size of only 22 secondary school teachers in the Western Cape, South Africa. The results might not accurately represent the broader population. The study was also conducted over a short period which limits the ability to make conclusions about potential changes over time.

6.2 Further Research

The need for technology implementation in education will likely continue to grow, and access to ICT will continue to be critical. Further exploration of the 'new normal' within the context of this research would be valuable. A deeper understanding of access to ICT will inform and guide the development of policies and strategies to enhance technology integration in schools.

7. Conclusion

The ICT innovation triggered by the COVID-19 pandemic provided remarkable opportunities for blended teaching and learning approaches. The potential of this unique occasion should be harnessed by adopting a more holistic contextualised approach to access to transform schools into enabling environments that empower teachers to innovatively use ICT in their teaching practices.

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Self-Regulated e-Learning in Pre-Service Teacher Training for Realities of 21st Century Classrooms

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Abstract: Educators and students were unprepared for the suspension of face-to-face (f2f) educational activities due to Covid-19, specifically those less experienced in online teaching and learning. Students and educators were traumatised by the sudden switch to online teaching and learning. As such the transition from f2f to exclusive online learning prompted adjusted pedagogical methods and assumed measures of self-regulated e-learning (SRL). During this period researchers embarked on a longitudinal project in Information and Communication Technologies (ICT) called the 21st Century Project (21CP). The purpose of the study was to explore the SRL behaviours of pre-service teachers in online learning and to understand the extent to which a curriculum for technology integration alongside contextual factors influences SRL. As such our conceptualisation of the SRL framework adds two moderating constructs, these are, context and intervention to the core constructs of SRL. The sample of sixty six (66) students were drawn from a volunteer cohort of 166, 4th year pre-service students. Data were collected through interviews, surveys and online journal entries. The data was analysed qualitatively using narrative methods in which themes were identified and reported. The findings revealed that: the ICT integration curriculum represented a cornerstone for SRL development and shaped students' SRL behaviours; there were differences in the SRL practices that could be attributed to students' learning habits and attitudes to the ICT-based interventions. The findings of this study provide an understanding of interrelationships among SRL, context, and the design of an online curriculum. The study made three contributions to policy and practice. Firstly, SRL can be improved by providing activities that include clear guidelines for engagement through guided instructional methodologies. Secondly, the faculty curriculum developers should formulate guidelines to ensure that curricular iterations are developed as blended f2f/online modes to enable a quick and seamless transition for exclusive online use. Finally, course creators can improve student engagement by aligning learning outcomes and related activities with learning events.

Keywords: Self-Regulated e-Learning, Learning styles, Motivation, Online, Self-Efficacy, Qualitative-Data

1. Introduction

To alleviate the spread of COVID-19, the South African government instituted a national lockdown in March 2020. This resulted in the suspension of face-to-face (f2f) educational activities prompting institutions of higher education to resort to online education to save the academic year. Studies report students' and teachers' scepticism about online learning, citing challenges of online learning methods whose effectiveness they doubted ; anxiety about study success; difficulties owing to varying learning attitudes; technological challenges with online-blended engagements (Azis and Fatimah, 2020; Bao, 2020; Baloran, 2020). Similarly, Makhmudov, Shorakhmetov and Murodkosimov (2020) have shown that many educators are still not ready for true online teaching, and learning. This could be due to the belief among teachers that online learning may be less rigorous and effective than f2f learning in which teachers can present challenging ideas that engage students (Abe, 2020).

This paper reports on how a university, training pre-service teachers, responded to online learning through the design and delivery of an ICT integration curriculum, designed and developed for a blended f2f/online mode of delivery through the university learning management systems (LMS). Our paper is aligned with the study of Kim, So and Joo (2021). E-learning refers to online learning incorporating learning with and through digital technologies. Usually, e-learning occurs over the internet using several digital platforms which include LMS, cloud services and social networking services (SNS). This form of learning can be asynchronous (learner-paced) and synchronous (teacher-paced) engagements. The 21CP is viewed through a professional development lens and focused on the development of knowledge and skills through active learning.

Self-regulated online learning is an area which has received research attention as reported in a few studies. For example, Zhao and Song (2021) believe that the implementation of blended learning is closely related to the development or import of online courses and this can trigger self-regulated learning if managed properly. Another study which attempted to ascertain the effects of online learning on self-regulated learning was by Carter et al. (2020), which was conducted with K12 learners. Both studies provide the basic requirements for the

Reference this paper: Sadeck, O.,et al. 2023 Self-Regulated e-Learning in Pre-Service Teacher Training for Realities of 21st Century Classrooms, *The Electronic Journal of e-Learning, 21(3)*, pp 211-221, available online at www.ejel.org

transition from f2f to the online learner which are planning, performing, and evaluating (Carter et al., 2020; Zhao and Song, 2021). There are technological and technical limitations in transitioning from f2f to online education and these include the lack of access to well-functioning devices, poor connectivity, and ICT resources to support e-learning. The practical and pedagogical challenges are rooted in knowledge, skills and competencies in technology use, self-efficacy beliefs, self-regulatory attitudes and, learning styles (Abdous, 2019; Aziz and Fatimah, 2020; Bao, 2020). Various practical and pedagogical challenges may be attributed to tendencies to replicate f2f methodologies; replication of traditional classrooms in online environments; the indiscriminate use of technologies, systems and services, despite many technical issues, and lack of cognitive access and competencies.

Online learning is aligned with learning with and through technology, using blended methodologies. According to Zhao and Song (2021), blended learning methodologies are likely to become the most prevalent mode of education delivery in higher education. Studies suggest that the basic success of online e-Learning lies in SRL (Azis and Fatimah, 2020; Pham et al., 2019). It is assumed that online learning is more effective than f2f learning because it takes in environments which support SRL, where students are more likely to develop skills, and need to control their learning (Azis and Fatimah, 2020). Some researchers challenge the assumption by arguing that students have negative attitudes to online learning which can result from limited access to the internet as well as methods of online education which are viewed as inferior and unsuitable by students (Baloran, 2020; Bao, 2020; Azis and Fatimah, 2020).

The research gap addressed by this study is how SRL in South African pre-service teacher training is influenced by online learning during the COVID-19 pandemic. The study was guided by two research questions stated as:

- How does online learning influence self-regulated e-learning among pre-service teachers?
- To what extent do the 21CP contextual factors enable self-regulated learning?

Existing studies for online learning support the notion of support for students after f2f learning. The significance of this study stems from its contribution to the knowledge of how a curricular design for online learning contributes to SRL. This longitudinal study used real-time online learning in which the researchers did not interfere with students when learning online but provided support and guidance. The limitation of this study was its confinement to 4th-year pre-service students enrolled for the academic year 2020.

2. Literature Review

2.1 Theoretical Underpinning

The contextual circumstance of the impact of Covid-19 inadvertently suggested self-regulated e-learning. As such two actionable processes are highlighted: one, the need for students to take more responsibility for their learning and two, for teachers to provide appropriate support for student learning. Zimmerman (1990, pp. 3) maintains that SRL "has profound implications for the way teachers should interact with students…" This implies a shift from learning as fixed traditional processes to students' agency. Accordingly, the SRL framework was used as it comprises the [core] "cognitive, metacognitive, behavioural, motivational, and emotional/affective aspects of learning" (Panadero, 2017, pp. 1). A range of variables are understood to influence SRL: attitude, self-efficacy, volition, cognitive strategies, feedback loops, outcome expectation, contextual circumstances and intervention processes. In this study, the 21CP was the intervention.

According to Zimmerman, (1990, pp. 4) "Systematic use of metacognitive, motivational, and/or behavioural strategies is a key feature of most definitions of self-regulated learners." Cleary and Zimmerman (2004), further note that a "self-oriented feedback loop" and "an indication of how and why students choose to use a particular strategy or response…. unless the outcomes of these efforts are sufficiently attractive, students will not be motivated to self-regulate (Zimmerman, 1990, pp. 5). As active participants in their learning, Cleary and Zimmerman (2004) maintain that to domesticate SRL, "attention must be directed toward developing all three dimensions of self-regulated learning in students: metacognitive, motivational, and behavioural." Figure 1 presents our conceptual framework of SRL.

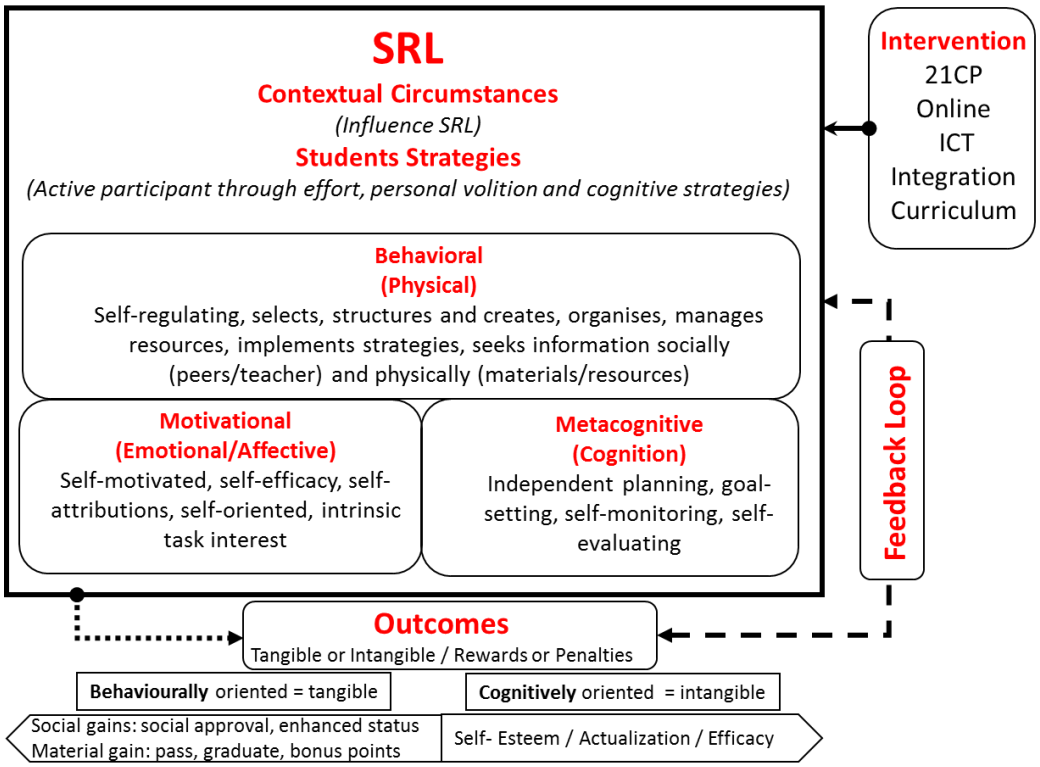

Figure 1: Authors' Conceptual SRL Framework

According to the conceptual SRL framework, the behavioural and physical elements indicate that preservice like any other student can actively seek important educational information, resources and strategies that are helpful to their success. Self-regulated learning requires such efforts where individuals become actively seek various ways of organising their learning using online technologies and resources. This is played out individually and socially and is representative of visible manifestations of actions. The motivational element is intertwined with learning processes. One specific aspect is perceptions of self-efficacy, which according to (Schunk, 1984 & 1989) provides both a motive to learn and iteratively successful learning contributes to self-efficacy beliefs. According to Zimmerman (1990), SRL tends to stimulate strong metacognitive elements among students which urge them to understand selves as agents for learning. Such metacognition makes students eager to realise their strengths, academic capabilities, and shortcomings and ultimately seek strategies to solve the potential challenges by themselves.

The proponents of self-regulated learning assert that self-regulated learners tend to accept greater accountability for their attainments because the achievement can bring about some tangible or intangible personal benefits (Zimmerman, 1990). Two approaches identified toward achieving desired outcomes are behavioural, targeting tangible material or social gains (Mace, Belfiore and Shea, 1989), and cognitive approaches targeting intangible concepts such as self-actualization, and self-efficacy (McCombs, 1989). Efforts ought to be sufficiently attractive for student pursuit. Efforts result in two opposing ends of a continuum – one conditional on external rewards (social approval, boosted status, material gain) (Mace, Belfiore and Shea, 1989), and the other inspired by personal gratification (self-esteem, self-actualization) (McCombs, 1989). In the cycle of behaviours based on expected outcomes, students respond to feedback. Cleary and Zimmerman (2004, pp. 8) regard the feedback loop as "the process in which students monitor the effectiveness of their learning methods or strategies and react to this feedback in a variety of ways, ranging from covert changes in self-perception to overt changes in behaviour".

Our conceptual SRL framework adds two moderating constructs: context and intervention. Students' SRL takes place in contextual circumstances that may be the source of enablement or disablement of SRL. The content and the interaction of teachers and students manifest as an enabling environment, which we refer to as the intervention.

According to Zimmerman (1990, pp. 6) self-regulated students need to proactively engage and extend efforts, be self-directed and self-motivated signalling that "skill and will are integrated components of self-regulation".

Weiser, Blaub and Eshet-Alkalaia (2018, pp. 50) maintain that the rate of voluntary participation is determined by learning style (personality traits). Outside of social and contextual circumstances, students' willing engagement can be understood through attitudes and self-awareness. Self-awareness as an agency contributes to self-efficacy and competency beliefs which iteratively include a sense of motivation. Approaches to SRL from the social cognitive school of thought focus "on perceptions of self-efficacy as the ultimate source of students' motivation" (Zimmerman, 1990, pp. 11). According to the theory of planned behaviour (TPB) by Ajzen (1991), attitudes, subjective norms and perceived behavioural control determine the intention to perform a behaviour. Intention and behaviour concerning SRL is a tension between inner forces and the environment in a network of reciprocally interacting influences (Bandura, 1989; Zimmerman and Schunk, 2011.).

Behaviour is tempered by personal motivational and feedback factors. The strength with which an attitude is held is often a good predictor of behaviour (McLeod, 2018; Nortvig, Petersen and Balle, 2018). If students are not motivated by outcomes and do not experience social inclusion and acceptance, they may be less motivated to engage in SRL. Weiser, Blaub and Eshet-Alkalaia (2018, pp.15) focusing on teachers, speak of the "importance of adapting the teaching methods to the learners' characteristics" and recommend using "types of teaching-learning interactions that have been found to increase participation, such as students' presentations and explicit encouragement of participation by instructor-student interactions."

2.2 Design: 21st Century Project

The 21CP was designed and developed for a blended f2f/online methodology. Inherent in the design was our attention to the flexibility of the learning environment to meaningfully engage students in the enterprise of learning. Aspects of our design find concurrence with the recommendations of Kim, So, and Joo (2021, pp. 13) – these included "time for students to reflect"; "elaborate on what they learned"; "interaction with other students" and "provide appropriate scaffolds to students". At the onset of the Covid-19 lockdown, the 21CP continued exclusively online via the LMS and SNS. The framework of the six modules in 21CP encompassed:

- Modules set out to scaffold learning with module outcomes, learning outcomes, assessment grids, and rubrics;
- Alignment among assessment-outcome-activity;
- Inclusion of modern teaching methodologies (instructivist, constructivist and connectivist) in activities and engagement alongside detailed engagement guidelines;
- Repository of multi-media resources;
- Tools for submitting tasks on LMS;
- communication/collaboration tools (discussion forums, email; WhatsApp); provision for reflective learning (journals/exit tickets)

The changed circumstances required us to rethink the 21CP and how to facilitate reciprocating engagement among students and lecturers. We were critically aware of Kim's (2020, pp. 156) assertion that various phases need to be accomplished whether online or f2f.

Students and teachers experience acute technological limitations and challenges, in the South African context. Sadeck et al. (2020, p. 595) reported that many students reiterated the heavy draw on data and high data cost with some noted difficulties with connectivity, and of devices not being well suited for the high-end requirements of digital learning environments. Our first consideration was technological challenges, focused on affordable, efficient and preferred means of communication and support. We settled on continuing with the LMS and increased our use of WhatsApp. We based this on a finding that students used and preferred WhatsApp and Blackboard (Sadeck, et al., 2020, pp. 594 & 597; Chaw, and Tang, 2023). Blackboard was zero-rated except for video streaming, and all students had access to WhatsApp at a low cost with proven efficiency for quick responses. We felt it necessary to reduce the task load; increase the engagement and submission times; permit alternative submission modes and increased WhatsApp usage.

3. Research Methods

A qualitative research method with purposive sampling was used in this study. Participation was voluntary and 166 out of the population 244 responded positively. Qualitative data were collected from 66 of the 166 respondents using journal entries, surveys and interviews. Information was gleaned from the combination of data sets.

The researchers informed students early in the study that they were not members of the staff of the University and only researchers in the project. The purpose of the data collection was explained, and student volunteers

were invited. Anonymity was assured and students were free to withdraw at any time. Permission to conduct the research was obtained from the relevant university authorities. All data was discussed with the co-researchers and member checks were done to ensure accuracy. Four data sets were triangulated - journals, surveys, interviews and classroom observations – classroom observations are not included in the analysis as they were too few to provide substantive findings.

We used an open-ended format for the journal as we believe that this would closely replicate the realistic conditions of the participants' SLR. Usable journal data was availed from 64 respondents. The surveys, at the end of each module, are largely open-ended with a few close-ended questions specifically as prompts to understand students' use of the learning outcomes and assessment guidelines, key learning takeaways and clarity of instructions and guidelines. Usable survey data was availed from 66 respondents. Thirteen (13) one-to-one virtual interviews and 1 virtual focus group (4 participants) interview were conducted.

Data from the three sources were gathered categorised and coded (Atlas ti). We deductively atomised data under themes of SRL, context and curriculum intervention. Inductive processes comprised alignment with SRL theory (metacognition, behaviour and motivation), contextual enablers and distractors, and curriculum design, layout and delivery. The key codification method was organised to provide us with findings related to the questions of inquiry, that is how students responded to online teaching and learning, and the extent to which the design and layout of the 21CP and contextual factors enabled SRL. All data was discussed with the co-researchers and member checks were done to ensure accuracy. The findings and analysis in this paper are confined to themes of SRL, context and intervention.

4. Findings and Discussion

4.1 Self-Regulated Learning

This theme centres on the use of behavioural and cognitive strategies in learning online. Feedback and outcomes are included as they influenced both behaviour and cognition. There appeared to be general satisfaction with the predominantly personal, immediate, and long-term gains in the journal entries data.

> *"It taught us to think more deeply" "I was 20% as far as ICT was concerned and then I got the 80%" "To see the benefits from actually using it… and I'm going to use it in the future"*

It is reasonable to assume that people engage in behaviours based on outcomes, e.g., expectancy (Vroom, 1964). The data showed alignment with Mace, Belfiore and Shea (1989) and McCombs (1989), who maintain that expectancy outcomes are cognitively/behaviourally oriented with tangible or intangible gains.

According to Zimmerman (1990, pp. 5) metacognitive "processes enable them [students] to be self-aware, knowledgeable, and decisive in their [students'] approach to learning". Student agency appeared to emerge in 4 of the interviews:

> *"I constantly bounced between self-esteem and self-actualisation…I'm constantly looking at something more that I can be than what I was yesterday" "project has allowed me to identify my strengths and weaknesses"*
>
> *"need to discipline yourself as to when to learn and how to learn…have to go an extra mile about your studies" "project taught me to be responsible…I've taken charge of my learning"*
>
> *"I have to plan to make things easier because I'm not a very structured person"*

Two intervention design elements (journals and surveys) were noted as contributing factors leaning towards the metacognition and motivational elements in responses.

> *"The survey at the end of each module provoked my thinking"*
>
> *"The journals help me reflect on everything that I've done and how I can better myself…to see my progress in learning…I have moved from point A to a certain point"*
>
> *"You see what you've gained"*

Paraphrasing Dewey's (1916) notion that 'we do not learn from experience, we learn from reflecting on experience', data from students evidenced instances of self-awareness and self-reflection aligned with Zimmerman's (1990) self-monitoring and self-evaluating. Pressley and Ghatala (1990 in Mansfield, 1990, pp. 9) concluded that student awareness of learning outcomes is critical to continued strategy use.

Students voiced positivity on what appears to indicate personal intrinsic motivation and self-efficacy factors, related specifically to self-attribution and how they managed challenges.

> *"We were forced to go out to explore…so figuring it out by myself has taught me a lot more, so that made us more independent"*
>
> *"We're working on our own, not dependent on anyone"*
>
> *"We had to teach ourselves…it was self-centred learning, and it helped us to get out of the comfort zone"*

Students' internal recognition and self-acknowledgements may have arisen from satisfaction with their own SRL efforts and our intervention processes. Such self-efficacy beliefs align with Bandura's (1982, pp. 22) articulation of, "judgments of how well one can execute courses of action required to deal with prospective situations"

> *"has prepared me…helping me learn… to be cognisant of how I structure my planning and studies...I'm very confident now" "when people ask me because they feel that I would give an appropriate answer…that motivates me to want to help"*
>
> *"made me more confident in using and applying technology in class"*

students' beliefs of self-efficacy appear to promote renewed confidence towards tangible outcomes.

> *"I'm more equipped with knowledge that will help me"*
>
> *"I'm able to use technology" "feel like my capabilities have increased…the technical skill that I feel I've developed enhance my efficiency and effectiveness in teaching…It's allowed me to be more effective in the class"*

Researchers have noted over time that self-regulating students display behaviours of structuring and building learning environments to optimize their learning (Wang and Peverly, 1986; Zimmerman and Martinez-Pons, 1986). The interview data returned students' behavioural processes aligning with SRL's self-regulation and management of time/resources.

> *"I developed a very unique way of study" "we were helping each other… I can ask one of my classmates"*

These findings are consistent with Rohrkemper (1989) who notes that self-regulatory behaviours are typified by students looking for help and information from people and spaces from who/where they are most likely to learn and follow through by self-teaching and self-monitoring their progress. One student who appeared to manage well noted in the survey that:

> *"I didn't experience any problems…hasn't been too challenging and the ones I had, I managed to resolve by communicating with friends or the lecturer"*

Coping in the current situation necessitated active student agency. In the context of this paper, the agency is confined to self-regulation and resilience which are not independent of one another. Emerging from the data was that some students possessed and some were starting to develop self-regulatory skills in varying degrees in different ways. The SRL processes in the data suggest alignment and confirmability with related theories such as cognitive (Piaget, Bruner), and, motivation and expectancy (Vroom, Bandura, Parijat and Bagga). Students' actualisation of SRL was evidenced through their experiences of the intervention through cognitive and affective articulations regarding their beliefs, attitudes and feelings.

4.2 Context

In this section of the moderating constructs, we turn our attention to broader contextual and situated learning (intervention). The context that frames this study typifies current South African educational realities and provides insight into why students pursue particular SRL strategies. These include very low-quality internet connectivity (where available); high data cost; non-access to personal computing devices and, rampant load shedding/power cuts. The social circumstances encompass the contexts of, policy imperatives, technological challenges/enablers and learning habits that provide the background to understand the SRL narrative.

4.2.1 Policy

The South African national education department and the decisions by the university to continue educational activities remotely necessitated a move from f2f to online education. This represented a policy imperative which elicited the following:

"was quite challenging" "was not fair…we were on our own…we had to do everything online…we had to now teach ourselves" "It was challenging at the beginning…hard for us…was so frustrating"

Some students were not averse to online education as noted:

"This is how it should be done" "it was online learning from the beginning" "you could do the work at your time" "The online elements of this curriculum provide an advantage to continue"

The policy imperative meant that students had no option but to regulate their learning instantaneously notwithstanding their comfort level, familiarity, and skills with online digital learning. Students who are not familiar with online learning or with reasonably developed SRL strategies, appear to experience negative feelings of frustration. The data highlighted that the opposing was also true; students who appeared to possess experience and SRL strategies did not seem to hold negative feelings about the imperative.

4.2.2 Technological challenges

Technological and technical challenges were the focus of responses to challenges in online learning. Access to data based on high cost and connectivity quality was highlighted as the most challenging. Some difficulties connecting and/or accessing learning online with personal devices were noted.

"Challenges…is the internet connection, the data, the affordability…and network specifically" "if you want to use applications, like Blackboard you couldn't"

Different social standing and circumstances suggest that not all experienced challenges the same way.

"It didn't affect my studies, because I had data"

Studies by Baloran (2020) noted similar issues of poor connectivity. Physical access to learning in an online environment is contingent on reasonably reliable connectivity. The exorbitant cost of data, access to the internet and poor-quality connectivity is highlighted as a problem in South Africa. The proliferation of different low-cost affordable technologies does not appear to be well-suited for the high-end requirements of current/evolving online environments. This could have accounted for device limitations or quality of connectivity for particular resources, and applications.

4.2.3 Enablers and learning habits

Engagement in learning is predicated on learning styles/learning-study habits. Ajzen (1991, pp. 181-182) notes that one's flexibility to perform behaviours is contingent on the level of volitional control over the behaviour. Students were in full control of their SRL, with opportunities to learn and develop strategies best suited for their desired outcomes.

"I'm not a fan of being taught by the PC or WhatsApp" "I prefer to have face-to-face lessons…that's just my learning style"

Students who preferred the online mode said:

"I could take charge of my learning…It's my personality to push myself" "I prefer online learning because it was less pressured…allowed for me to [engage] in my own time and reply"

The data also showed that some students were able to operate with some comfort in both modes based on their learning habits:

"I prefer face-to-face, but I also prefer to figure it out on my own" "I prefer a blend"

The data yielded unexpected though not unfamiliar factors related to learning, i.e., learning preferences and unfamiliarity with online learning. This challenged our assumptions of students' digital literacy.

"It is difficult not to sit in a classroom and be taught" "I am not used to reflecting on my learning after each session"

"Have not had opportunities to learn online" "not been exposed to seeing what is expected and going to happen"

Our findings align with Abdous (2019, pp. 34) who noted as the "transition from a face-to-face to an online learning environment unfolds, online students are likely to feel anxious about their ability to succeed in an unfamiliar learning environment". We inferred that students' experiences of online learning appear to be rooted in the use of digital tools/technologies through traditional/institutionalised methodologies.

The online expectations represented a uniquely unfamiliar learning environment and as Abdous (2019, pp. 39) contended "online students are often pressed to unlearn longstanding learning habits and to engage in new ways of learning". The notion that a 'net generation/digital native' student, in a fourth-year degree course, would be reasonably comfortable with learning digitally was challenged.

4.3 Intervention

4.3.1 Guidelines, instructions and engagements

The curriculum intervention theme focuses on the embodiment of online learning - representing a shift from traditional learning processes to student agency. It is through the effects of the 21CP that SRL was explored to understand how it enabled or challenged students. The intention was to assist students to take charge of their learning by deliberately developing, designing and presenting the 21CP modules for 'blended' digital engagement. This necessitated pedagogically sound levels of detail in guidelines, support, instructions and engagements significantly different from any curriculum that could have been presented f2f. The journal and survey data from students related to the course modules, layout and delivery, and access to learning drew mixed reactions.

> *"Module outline with the guidelines are useful…found it relatively easy, interesting, and very interactive…the information was very specific and detailed"*

Comments seem to indicate that some students were able to engage with what was presented and understand it from a learning perspective. They also seemed to find it useful for self-engagement with little or no lecturer mediation. However, not all students were satisfied/comfortable with the design and presentation of 21CP.

> *"Why are they making our lives difficult with all this work for the entire year" "feel the layout wasn't orderly, a bit confusing"*
>
> *"With the modules available at once…[was] an advantage to work at my pace" "useful to know and see the different modules' learning outcomes…help manage my learning by knowing" "was useful to be given the mark breakdown for all tasks upfront"*

4.3.2 Support, instructions and engagements

Key comments in this category are located in learning habits, preferences and experiences. The counter comments capture our design thinking, i.e. where we wanted to allow for faster and slower students. The sections and modules while atomised units of work, were all interrelated and scaffolded, providing for students to go back and forth to pick up on aspects as needed. Additional comments focused on support from lecturers, peers, and the modules themselves.

> *"had friends who were so supportive whenever I need help" "They [peers and lecturers] assist at any time…you just WhatsApp them"*

The support, availability of content, guidelines, and online engagements all appeared to have served the purpose to assist students with their learning. This aligns well with skills noted by researchers such as collaborative problem-solving (Castro, Kelly and Shih, 2010); help-seeking (Sharplin, O'Neill and Chapman, 2011) and personal traits such as perseverance, pragmatism and collaboration (Ebersöhn, 2012).

4.4 Summative Findings

Our summative findings align with many previous research and relevant literature. The findings of this study provided 3 insights:

- The pivotal role of sound design principles of intervention in facilitating movement along an SRL continuum.
- The influence of context on SRL variances.
- Uptake and resilience in involuntary situations.

4.4.1 The pivotal role of sound design principles of intervention in facilitating movement along an SRL continuum

The 21CP, not specifically developed for exclusive online engagement, does not claim SRL as its theoretical underpinning. It does however claim alignment with the notion of design as espoused by Byungura et al. (2018: pp 6) who noted that learning environments need to be designed to help learners intentionally and consciously

regulate their learning behaviours". As such we argue that the conceptual underpinning of the initial blended design was useful to progress SRL.

Some students struggled a bit with the changed design, and layout and suggested online engagement. While some appreciated the revamped look and approach, some appeared to merely tolerate it. The 'new' design completely flipped the 'drip feed and dump' of materials/content and instructions, and the 'notice and post-box use of the LMS for due dates/reminders, grading and submissions. Notwithstanding how theoretically sound the design of the online learning environment is, if it does not provide cognitive or physical access through a clear roadmap and induction/orientation, students less experienced in online learning are likely to feel and experience apprehensiveness. Bozkurt et al. (2020, pp. 10) noted that this represents a "real challenge which ended up with unsatisfactory learning experiences".

Transitioning from face-to-face to online, and gradations within online learning requires sustained efforts to challenge and break the fetters of traditionalism, typified by mere transferences to online learning environments. Azis and Fatimah (2020, pp. 24) contend that "good e-learning must be designed through regular online contact with tutors". In this study, given the blended design was to transform into an exclusive online, we deemed it essential to provide a 'clear roadmap and induction' with multiple opportunities to assist students to become self-regulated and self-directed. Our roadmap/induction in the intervention bears an extraordinarily strong similarity to Abdous' (2019, pp. 37) online learning orientation. The 21CP design elements included:

- Comprehensive guidelines, and reminders through text, forums and WhatsApp support to ensure and clarify the requirements and expectations of 21CP;
- Progressive use of Puentedura's (2012) Substitution, Augmentation, Modification and Redefinition (SAMR) model levels to introduce students to the exclusive online environment, its tools and technologies. The introduction of technologies such as discussion forums, and blogs could help students from progressing from asynchronous to synchronous or in moving from in-class f2f situations to online learning environments.
- Providing access to resources in multiple and different formats to assist students in taking charge and developing strategies to access resources, seek help and reflect on their learning and strategies.

From these insights, we recommend firstly that opportunities for engagement and support in an online environment be the default 'modus operandi' for all disciplines at tertiary and school levels. Secondly, we suggest that online engagements include those best suited to learning and developing discipline-specific concepts. Our third recommendation is there be a clear 'roadmap' and 'induction' to online learning for both teachers and students.

4.4.2 The influence of context on SRL variances

Evaluations of contexts in which online interventions play out are often reduced to technical deficit factors. The political, socio-economic, cultural, pragmatic realities, technical factors and personal factors all feature in contextual realities. In an unequal educational milieu, the majority of students in this study experience unprecedented socio-economic challenges. The effect of these manifests in a lack of access to funds and technological devices.

This study was undertaken in 2020 when Covid-19, a mere circumstantial 'event' hit the world. According to Alhawsawi and Jawhar (2021), such events affect the way people responded to changes through their thinking and behaviour. Alhawsawi, Alhawsawi and Sadeck (2021, pp. 11) furthermore contend that policy-like implications of going online are influential in altering behaviours. Such was the case in this study where we found students adjusting and altering (self-regulating) their learning behaviours. Skills to engage, varying learning styles, attitudes, motivation, learning habits and self-efficacy beliefs of students provide a personal level context. Personal level context intertwined with the lived context of the students thus functions as a moderator of enablement or disablement in shaping SRL.

Based on the findings, it is recommended that access to online learning should consider the participant's context. Institutions and individual teachers must use a variety of alternative technologies, systems and services that best provide students with access to learning.

4.4.3 Uptake and resilience in involuntary situations

This study showed fluctuation in students' feelings of positivity and negativity. Positive feelings were traceable to behavioural and cognitive outcomes and opportunities afforded to them through the intervention. Negative

feelings were noted partly on account of the pressures of the involuntary situation and personal contextual factors.

The mix of feelings resulted in varying levels of online learning uptake. These findings are similar to Zembylas's (2008, pp. 82) "emotions in online learning …. influenced adults' learning experiences", and, Beltman and Mansfeld's (2018, pp. 6) "resilience is shaped by individual, situational and broader contextual characteristics that interrelate in dynamic ways". Behaviours can vary over time on account of a range of reciprocal push-pull influencing factors.

The insight into feelings and behaviours suggests a need for a 'pedagogy of care' that embraces curricula and social elements, as opposed to the need for curriculum content coverage. According to Vaccarelli (2018, pp. 29) a pedagogy of care is potentially central to combining the "psychological, social, and community dimensions that are usually kept separate". This leads us to recommend that all educational activities be framed within situations that allow for: time flexibility; guidelines/clarity; safe spaces and opportunities to speak and receive feedback and empathetic responses. A practical way to achieve this is through an online learning ecosystem comprising: curricular and psychological support and physical and cognitive access to teaching and learning.

5. Conclusions

We conclude, that contextually, SRL behaviours were shaped by the online learning intervention in which preservice teachers worked on their own. The three core elements of SRL represent personal contextual factors on which, the intervention had only some influence. There were clear differences in the SRL practices on account of students' deeply rooted learning habits and the quality of the intervention. In this study, we offer that the intervention (21CP) represented a cornerstone for SRL development. We offer that providing sufficient quality opportunities to develop SRL is necessary to hedge the chances of developing and progressing online learning. In an era that is bound to experience other educational disruptions and global developments, our educational endeavours ought to be pro-actionary and not re-actionary.

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A Cross-Sectional Study on Student Experience and Contentment of Online Learning During Covid 19 Lockdown

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Abstract: The delivery mode of the lessons was transitioned from face-to-face to online/e-learning in response to the Covid-19 lockdown across the Middle East, particularly in Oman. The University of Technology and Applied Sciences, Al Musannah (UTASA), also adopted this approach, which brought forth both opportunities and challenges for the academic community, including teachers and students. However, no systematic studies were conducted across various departments at the university to gain insights into the implications of full-time online/e-learning. Therefore, this study was designed to comprehend the perceptions of cross-sectional UTASA students regarding the effectiveness of e-learning, encompassing their experiences and satisfaction with participating in it. The study employed a combination of quantitative and qualitative data collection methods, utilizing a survey questionnaire and a descriptive question. The participants included both male and female learners (N = 212) from departments such as IT (Information Technology), Business, Engineering, and ELC (English Language Centre). The analysis encompassed both descriptive and inferential statistical analyses of the quantitative data, as well as a descriptive thematic analysis of the qualitative data. The results revealed that over half of the participants held a clearly positive impression of their e-learning experience and satisfaction during the Covid-19 lockdown. Furthermore, the analysis of qualitative data shed light on the reasons behind both negative and positive sentiments towards e-learning, along with suggestions for potential enhancements. The diverse reactions of the participants to the survey questions have assisted researchers and interested parties in gaining a comprehensive understanding of both the favorable and unfavorable aspects of the procedure. A subset of the participants held a pessimistic view of online learning due to factors such as receiving low grades, encountering inadequate technical assistance, and observing a lack of commitment. In contrast, a different group perceived online learning as advantageous, citing its provision of a convenient and adaptable learning environment, along with convenient access to recorded lectures. Additionally, certain survey respondents put forth recommendations for enhancing online learning, including the need for better training, improved Internet connectivity, and enhanced interaction between teachers and students, as well as among fellow students. In summary, the study yielded valuable insights into the experiences and contentment levels of learners engaged in the online teaching and learning process. The findings and ensuing discussion provide essential recommendations for stakeholders and future researchers alike.

Keywords: Online learning, Experience, Contentment, Covid-19 lockdown, e-Learning, Satisfaction

1. Introduction

Covid 19 presented both challenges and opportunities across sectors, especially in the education sector. Students and teachers who used to teach face-to-face classes had to switch to online learning globally following the Covid outbreak announcement by WHO (World Health Organization) in 2020 (Nikolopoulou, 2022). This trend of transitioning to online learning took full momentum in educational institutions in the Middle East in general and Oman in particular. Meanwhile, the University of Technology and Applied Sciences, Al Musannah (UTAS-A), also adapted itself to the online mode of teaching and learning quickly. According to Jose (2022), UTAS-A ELC learners had a positive impression about their adaptability and acceptance of online learning. In addition, the study (Jose and Jose, 2021) using the technology acceptance model found that the university learners' perceived ease of use, perceived usefulness, perceived attitude, and their intention to use the online platform for future studies were positive. These studies were limited to the acceptance and adaptability of the online platform, i.e., MS Teams, and the perception of a limited number of participants from ELC (English Language Center) on selected areas. Since the online mode of study was administered across all departments at the university, the researchers felt that a cross-sectional quantitative descriptive and qualitative study design on student experience and contentment of online learning during the Covid 19 lockdown at UTAS-A had an increased scope, and it would draw better insight into the effectiveness of online learning among cross-departmental learners (IT, Business, Engineering, and ELC) at the university level, and thus, filling the knowledge gap in the research area.

Reference this paper: Jose, J. and Jayaron Jose, B.J. 2023. A Cross-Sectional Study on Student Experience and Contentment of Online Learning During Covid 19 Lockdown, *The Electronic Journal of e-Learning, 21(3)*, pp 222-233, available online at www.ejel.org

2. Research Objective

The research objective is comparing perceptions of cross-sectional students from IT, Business, Engineering and the English Language Centre at University of Technology and Applied Sciences, Al Musannah in terms of their experiences and contentment of attending online classes. Furthermore, the study aims to find out whether there is any statistically significant difference between the perceptions of students from four different departments, and it also aims to determine the relationship between the learners' experience and their contentment of online learning. Finally, the goal of the study is to get deeper insights into participants' perception by collecting their comments for improvement and reflections about the online learning qualitatively.

3. Research Questions

RQ1. What are the cross-sectional student perceptions of transition to online learning during the Covid 19 at UTASA?

RQ2. Is there a statistically significant difference between cross sectional student perceptions of their experience and gratification in attending online classes?

> *H_0 (Null Hypothesis). There are no statistically significant inter-group differences, or all group means are statistically equal.*
>
> *H_a (Alternative Hypothesis). There is a statistically significant difference between all groups.*

RQ3. Is there a statistically significant correlation between students' experience and contentment of online learning?

> *H_0 (Null Hypothesis). There is no statistically significant correlation between student experience and contentment.*

RQ4. What are learners' comments or opinion about their experience of learning online?

4. Literature Review

Global student enrolment to online courses is increasing in numerous higher educational institutions in public and private sectors (Wolverton, Hollier, and Lanier, 2020), and stakeholders take initiatives to measure student experience and contentment of the process for quality purposes and improvements. Student experience or engagement can be defined as "a positive, fulfilling, work-related state of mind characterized by vigour, dedication, and absorption" (Schaufeli, et al., 2002, p.74). Student experience represents their attitude towards participating in learning. The term further refers to the amount of student efforts, and the extent of students' thoughts, feelings, and activities in the process of learning (Hong, Song, and Lee, 2021). Moreover, student experience in terms of active learning and involvement is considered essential for the transition to tertiary level education to be a feasible venture (Murray, 2018). According to Edglossary (2023), learners' degree of interest, curiosity, optimism, attitude, and passion shown when they study or are taught. This is the reverse of the state where learners are disengaged, bored, disaffected, or dispassionate and measuring student experience and improvement are common educational goals of academics (ibid.). Contentment is generally defined as the pleasure or satisfaction one feels when they accomplish some work or receive what they need or want (Collins, 2023). Students' contentment at a university is explained as satisfaction or happiness that students get when their expectations or needs are met (Venkateswarlu, Malaviya, and Vinay, 2020). Student contentment regarding online or e-learning in the study, therefore, means that how satisfied learners are with respect to different determinants under the construct of student contentment or satisfaction.

A study by Panigrahi, Sreevasthava and Panigrahi (2021) found that learners' online participation had positive impact on the learners' engagement, and it resulted in better academic performance. Furthermore, there are many factors that impact e-learning such as teachers' online presence, student-teacher interaction and clarity of content, and effectiveness of maintaining a connection between online e-learning and face-to-face teaching as possible (Nortvig, Peterson, and Vinay, 2020). Another study (Nikolopoulou, 2022) found that the online education had both positive and negative impacts on teachers and students. The advantage is that students get acquainted with technology to learn and contact with teachers, while teachers face technical challenges of lack of resources and support, and their students' lacking electronic devices to join classes. In addition, the recent conceptual study on e-learning or online learning through a review of a good amount of literature demonstrated that online learning, despite challenges, has impacted tertiary level students positively, and the online learning

process enabled the participants to better achieve their learning outcomes enhancing their performance (Jose and Jose, 2022).

The research findings by Yen and Nhi (2021) revealed that the online learning helped teachers and students to interact uninterrupted in the process of learning and teaching, to share files and instant feedback and giving opportunities for quarantined to students to attend lessons. In addition, online learning enabled teachers to create assignments and quizzes, and track their learners' progress. Majority of learners could attend online classes and complete all assignments. They could actively interact in the chat box. Some challenges faced by learners and teachers online are interruption in Internet transmission, limited possibilities of presenting an active and lively lesson, and monitoring students' participation, and lack of students' awareness. Furthermore, students faced psychological and social problems, technological inequality (no equal opportunities), and lack of technology (Milla, et al., 2021). Furthermore, Hidalgo-Camacho, et.al. (2021) reported that online engagement impacts learners' academic achievement with respect to pedagogical practices and assessments, affective factors, learning outcomes and learners' impression regarding merits and demerits of online learning. Other demerits of online learning as listed by Debych (2023) are lack of electricity or Internet connection, misusing the system for fun and bad intentions, distraction such as engaging in video games, chatting, and visiting social media platforms, and hardware and software issues as outdated or worn-out devices and un-updated versions, respectively. By contrast, online learning has benefits such as flexibility of study time, affordability, no physical limitations, and easy access.

5. Research Methodology

The study utilized a mixed methodology involving quantitative and qualitative data collection and analysis to address the research question.

5.1 Study Design, Scope, and Limitation

This cross-departmental study was conducted among students at the university of Technology and Applied Sciences Al Musannah (UTAS-A) across four departments - Information Technology (IT), Business (BUS), Engineering (Engr.) and English Language Centre (ELC). It used a validated 5-point Likert scale survey written in English and disseminated to respondents through MS Forms. The survey included an open-ended question to get some descriptive qualitative responses from participants to get deeper understanding about their thought process. The scope of the study was confined to students enrolled in four specific departments, who were actively engaged in online learning within the university setting. This focus revolved around exploring the constructs of the experience and the contentment of online learning relating to selected variables in the quantitative data, and derived variables/ themes in the qualitative data.

5.2 Criteria Inclusion and Exclusion

Students who were actively enrolled in the university and participated in online/e-learning were included in the study. Four main departments at the university were selected for the survey, namely: Information Technology, Business, Engineering, and the English Language Centre. To ensure an equal number of participants from each department, respondents who exceeded the count of 53 in each department were excluded from the survey.

5.3 Instrument and Sample Size

The survey questionnaire, comprised of 27 items, was meticulously prepared and subjected to validation and reliability piloting. The questionnaire was structured into three distinct sections: a) demographic items, b) items indicative of student experience, and c) student contentment. The study ensured the inclusion of an equal number of participants (n = 53, N = 212) from each department, and the data collection process spanned over a period exceeding six months, aimed at securing a sufficient number of respondents. Additionally, the questionnaire featured an open-ended question, prompting participants to offer general or specific comments concerning e-learning or online learning.

The questionnaire included four parts.

- Part 1: This section encompasses items related to the demographic information of the participants (Table 2).
- Part 2: Comprising eighteen items, this segment aims to gather learners' perceptions of online learning during the Covid-19 lockdown with regards to their experience (EX) (Table 1).
- Part 3: Consisting of nine items, this part seeks to gather insights into learners' perceptions of online learning concerning their contentment (CT) (Table 1).

- Part 4: Included is an open-ended question intended for learners to articulate their opinions about e-learning (3.3).

Table 1 summarises the 5-point Likert Scale Items (parts 2 and 3).

Table 1: Survey Items

Student experience level (EX)	
EX1	I make sure to study regularly.
EX2	I put forth efforts in online classes.
EX3	I use class notes between getting online to make sure I understand the material.
EX4	I am organized in online learning.
EX5	I take good notes over readings, PowerPoints, or video lectures.
EX6	I listen/read carefully online.
EX7	I find ways to make the course material relevant to my life.
EX8	I apply course material to my life.
EX9	I find ways to make the course interesting to me.
EX10	I really desire to learn online materials/courses.
EX11	I have fun in online chats, discussions or via email with the instructor or other students.
EX12	I participate actively in small-group discussion forums.
EX 13	I help fellow students/ classmates.
EX 14	I get a good grade in Online learning.
EX 15	I do well in online tests/quizzes
EX 16	I engage in conversations online (chat, discussions, email).
EX 17	I post in the discussion forum/ chats regularly.
EX 18	I am good at getting to know other students in online classes.
Student contentment level (CT)	
CT19	I was able to learn through the medium of Computer-mediated communication (CMC).
CT 20	I was able to learn from the online discussions.
CT 21	I was stimulated to do additional reading or research on topics discussed in the online course.
CT 22	I learned to value other points of view.
CT 23	As a result of my experience with the online course, I would like to participate in another online course in the future.
CT 24	The online course was a useful learning experience
CT 25	As a result of my participation in the online course, I made acquaintances electronically in other parts of the country/world.
CT 26	The diversity of topics in the online course prompted me to participate in the discussions.
CT 27	I put a great deal of effort to learn the system to participate in the online course.

A reliability test was conducted using SPSS to assess the validity and reliability of the questionnaire, revealing a Cronbach's alpha value of .946, indicating excellent reliability. Furthermore, the construct-wise testing, i.e., for experience and contentment, yielded Cronbach's alpha coefficients of .946 and .879, respectively. Gliem and Gliem (2003) explain that the Cronbach's alpha reliability coefficient typically falls within the range of 0 to 1. A coefficient closer to 1.0 signifies a higher level of internal consistency among the elements within the scale. Additionally, in terms of validity, a Pearson's correlation bivariate test was carried out in SPSS to assess the validity of the questions. The analysis demonstrated that all the questions are significantly valid.

5.4 Data Collection and Analysis

The survey items were digitized using MS Forms, and survey links were generated. These links were then distributed to participants across different departments through communication platforms like MS Teams chats, WhatsApp, and email. Subsequently, the data was exported to an Excel sheet for further analysis.

As the study encompassed four groups of students (IT, Bus, Engr., and ELC), One-Way ANOVA in Excel was employed as a statistical tool to assess the significance of differences among each item. Moreover, descriptive statistics were utilized to determine the central tendencies of the survey items. Furthermore, a Pearson r correlation test was conducted to ascertain whether there existed a statistically significant relationship between participants' levels of experience and their levels of contentment.

6. Results

The subsequent sections elucidate the study's findings, which have emerged from the analysis of both quantitative and qualitative data obtained through the questionnaire and open-ended questions.

6.1 Quantitative Findings

The forthcoming sections analyse the participants' demographic information, their overall perceptions of experience and contentment, the differences among cross-sectional learner perceptions, and the correlation between learner experience and learner contentment.

6.1.1 Demographic Information

The survey was conducted among 212 students (N = 212) at UTASA. As evident from Table two, both male (46%) and female learners (46% and 54%, respectively) took part in the survey. The number of participants from each department was equal, with 54 students from IT, Business, Engineering, and the English Language Centre (25% each). Regarding the devices used for attending online classes, while 8% of students utilized desktop computers, more than half of the students (55%) used laptops. 31% of learners reported using smartphones, while only 8% used tablets to access online lessons. In terms of Internet speed, nearly half of the participants (49%) indicated having a fast Internet connection, whereas 22% mentioned having a slow Internet speed. Over a quarter of the respondents (29%) stated that their Internet speed fell somewhere in between, not too fast nor too slow. The participants hailed from diverse living backgrounds, including villages (44%), towns (27%), and cities (29%), which could have influenced their Internet speed and choice of devices (Table 2).

Table 2: Demographic Information

Category	Items	n	%
Gender	Male	98	46%
	Female	114	54%
Departments	IT	54	25%
	Business	54	25%
	Engineering	54	25%
	ELC	54	25%
Devices	Desktop pc	17	8%
	Smartphones	65	31%
	Laptops	117	55%
	Tablets	13	6%
Internet Speed	Good	104	49%
	Bad	46	22%
	So-so	62	29%
Place	Village	94	44%
	Town	57	27%
	City	61	29%

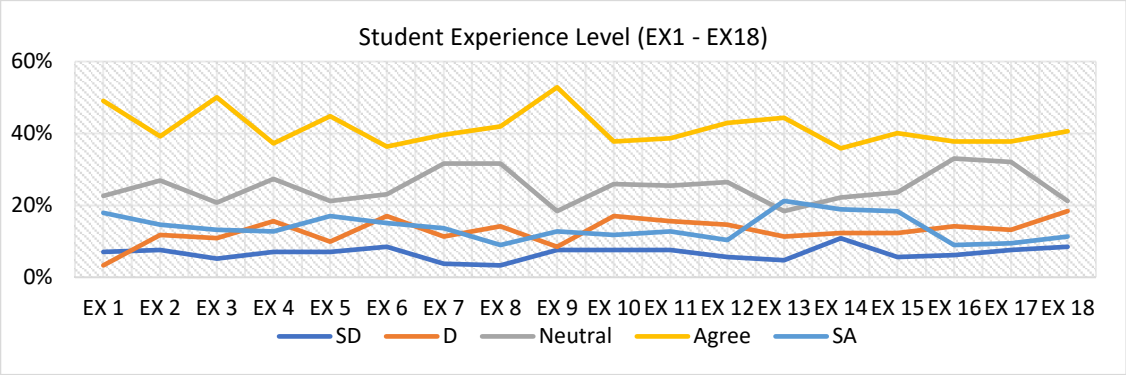
6.1.2 Learners' overall perception: experience and contentment

The researchers aim to determine UTASA students' overall perceptions concerning their learning experience and level of contentment. When considering various items comprising the construct of learners' experience (Tables 1 and 3) in attending online classes, it is apparent that more than half of the participants either agreed (A + SA) moderately or strongly with all items as illustrated in Table 3 and Figure 1. Notably, the highest percentage of participants (66%) concurred that they can find ways to make online classes interesting (EX9), while the same item (EX9) had the lowest percentage of undecided responses (18%) falling within the neutral range of 18% to 33% of respondents who remained neutral across all items. In contrast, 33% of participants did not have a definitive viewpoint on engaging in online conversations such as chats, emails, and forum discussions (EX16). On a less positive note, the highest percentage (26%) of students expressed opposition (D + SD) to the notion that they excel at getting to know other students in online classes (EX18, Table 3). Conversely, the smallest percentage of respondents (16%) disagreed with EX9.

Table 3: Student Experience Level (EX)

Items	SD	D	Neutral	Agree	SA	TOTAL
EX 1	7%	3%	23%	49%	18%	100%
EX 2	8%	12%	27%	39%	15%	100%
EX 3	5%	11%	21%	50%	13%	100%
EX 4	7%	16%	27%	37%	13%	100%
EX 5	7%	10%	21%	45%	17%	100%
EX 6	8%	17%	23%	36%	15%	100%
EX 7	4%	11%	32%	40%	14%	100%
EX 8	3%	14%	32%	42%	9%	100%
EX 9	8%	8%	18%	53%	13%	100%
EX 10	8%	17%	26%	38%	12%	100%
EX 11	8%	16%	25%	39%	13%	100%
EX 12	6%	15%	26%	43%	10%	100%
EX 13	5%	11%	18%	44%	21%	100%
EX 14	11%	12%	22%	36%	19%	100%
EX 15	6%	12%	24%	40%	18%	100%
EX 16	6%	14%	33%	38%	9%	100%
EX 17	8%	13%	32%	38%	9%	100%
EX 18	8%	18%	21%	41%	11%	100%

Note. EX- Experience; SD- Strongly Disagree; D-Disagree; N-Neutral; A-Agree; SA-Strongly Agree



Note. EX- Experience; SD- Strongly Disagree; D-Disagree; N-Neutral; A-Agree; SA-Strongly Agree

Figure 1: Student Experience Level (EX)

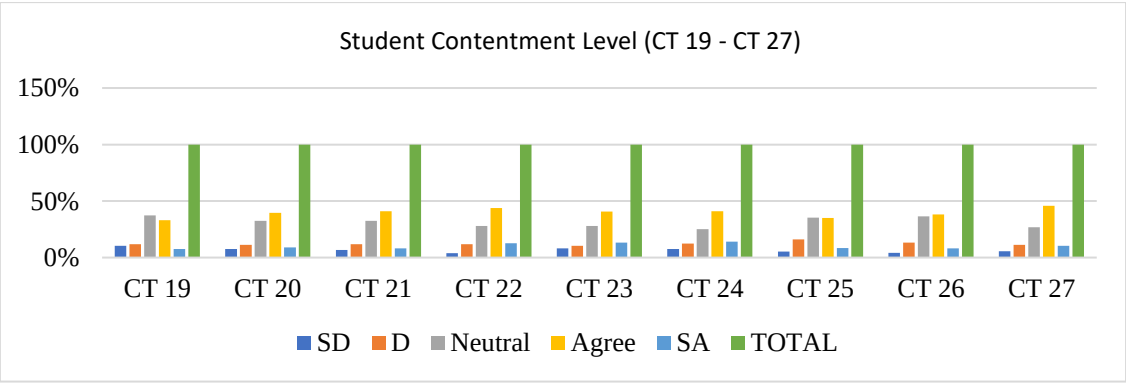
In addition, as depicted in Table four and Figure two, concerning the construct of learners' contentment with online learning (CT 19 – CT 27), the substantial majority (57%) of respondents (A + SA) concurred that they developed an appreciation for alternative viewpoints (CT22, Table 4, Figure 2). Following closely, the second-highest proportion (56%) of respondents indicated that they invested a considerable amount of effort to understand the system for participating in the online course (CT27).

Within the range of 25% to 37% of participants, there was a lack of clear opinion expressed for any of the items, as they remained neutral. However, a noteworthy percentage, ranging from 16% to 21% (D + SD), opposed all items falling under the construct of student contentment (Table 4, Figure 2).

Table 4: Student Contentment Level (CT)

Items	SD	D	Neutral	Agree	SA	TOTAL
CT 19	10%	12%	37%	33%	8%	100%
CT 20	8%	11%	33%	40%	9%	100%
CT 21	7%	12%	33%	41%	8%	100%
CT 22	4%	12%	28%	44%	13%	100%
CT 23	8%	10%	28%	41%	13%	100%
CT 24	8%	12%	25%	41%	14%	100%
CT 25	5%	16%	35%	35%	8%	100%
CT 26	4%	13%	36%	38%	8%	100%
CT 27	6%	11%	27%	46%	10%	100%

Note. CT – Contentment; SD- Strongly Disagree; D-Disagree; N-Neutral; A-Agree; SA-Strongly Agree



Note. CT – Contentment; SD- Strongly Disagree; D-Disagree; N-Neutral; A-Agree; SA-Strongly Agree

Figure 2: Student Contentment Level (CT)

6.1.3 Difference between cross-sectional learner perceptions

Furthermore, the investigation's second objective was to determine if there is a statistically significant difference among cross-sectional student perceptions regarding their experience and satisfaction in attending online classes. To address this, an ANOVA statistical test was conducted to compare the data from the four groups. The summary of values for sum, average, and variance can be found in Table 5 under the "Summary" section.

Table 5: Overall Analysis - Anova

Summary						
Groups	*Count*	*Sum*	*Average*	*Variance*		
IT	54	177.1852	3.281207	0.53071		
Business	54	184.6296	3.419067	0.692695		
Engineering	54	181.5926	3.362826	0.449796		
ELC	54	187.7407	3.47668	0.331239		
ANOVA						
Source of Var.	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	1.124848	3	0.374949	0.748237	0.524471	2.647188
Within Groups	106.2353	212	0.50111			
Total	107.3602	215				

Concerning the F-statistics, it's worth noting that a larger F-statistic indicates a greater variation between group means compared to the variation within the groups (Zac, 2021). In the present study, the F-statistic is recorded as merely 0.75, which is lower than the critical value of F (2.65). This indicates that there is 0.75 times more variability between groups than within groups, with a p-value of less than 0.53 (Table 5, ANOVA). Given that the p-value is 0.53, which is greater than the significance level of 0.05, one can conclude that there exists no statistically significant difference between the groups. Therefore, the null hypothesis is accepted, while the alternative hypothesis is rejected (3.2).

6.1.4 Correlation between learner experience and contentment

In Excel, a Pearson r correlation coefficient statistical test was conducted to ascertain the relationship between students' online learning experience and their contentment. The average scores of all items within both the experience and contentment constructs were analysed to compute the correlation coefficient. The test yielded a Pearson's r value of 0.837 (p = 1 to -1), indicating a robust positive correlation between learners' online learning experience and their contentment. This finding suggests that as learners' degree of positive experience increases, their level of contentment also increases, and conversely (3.3; Figure 3).

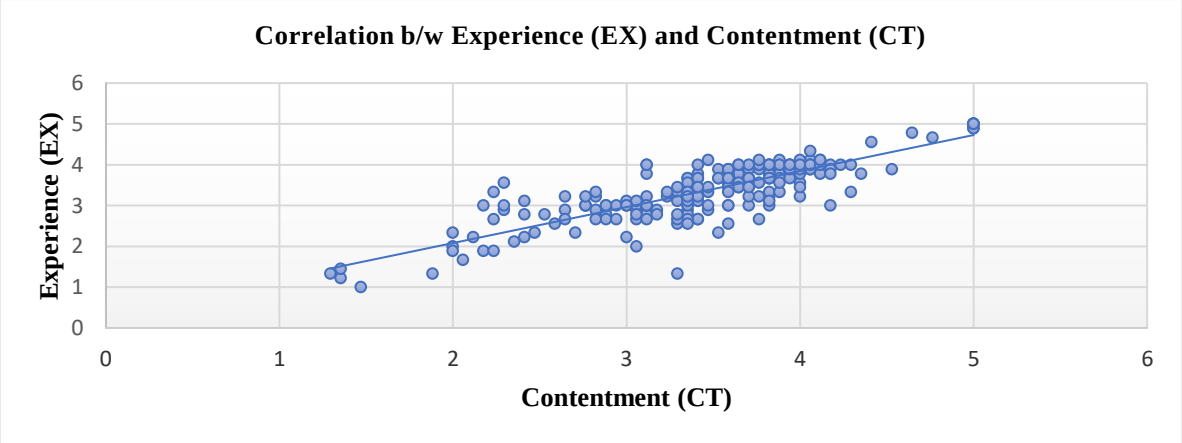


Figure 3: Relationship Between Student Experience and Contentment

6.2 Qualitative Findings: Learners' Comments or Opinion

The section below summarises learners' descriptive comments to the open-ended questions and informal interviews about how they felt about online lessons during Covid 19 lockdown (Table 6).

Table 6: Qualitative Findings: Summary

Criteria/ Themes	Reasons/ sub areas	Sample verbatim extracts
1. Negative experience	Low grades Cannot understand Bad internet Not effective No seriousness	S1- I hope not to go back to online learning because it spoils the student's grades. For example, the superior student gets low grades, and the non-achieving student gets high grades through cheating. S2- I am not into online learning I prepare offline learning. S3- … I can't understand the lessons online. S4 - ... It is better to receive instruction directly from the teacher than to receive it online. S5 - I wish there will be no online classes ever again. S6- I don't want to learn online because of the Internet is bad, and I don't understand anything. S7 - … online teaching not effective sometimes to get good marks. S8- It was a good idea to save people from the pandemic but now I don't think so. I think studying in school/University is better. S9 - Some my friends not serious about online classes S10 - Online learning is not good for all students
2. Positive experience	comfortable Own learning pace and flexibility Balance of work and studies Time saving Easiness Good grade Recorded lectures	S11 - The best and comfortable study … We prefer the study of online. S12-…- Online education enables the teacher and the student to set their own learning pace, and there's the added flexibility of setting a schedule that fits everyone's agenda. As a result, using an online educational platform allows for a better balance of work and studies, so there's no need to give anything up… S13... It helps us a lot. We will save our time because the lectures will be recorded, and all activities are online. The world is developing and most universities and colleges around the world use e-learning. S14- i do 4 this idea about transition to online learning because it saves time and gives the student freedom to learn with different learning sources. S15- I think online learning will be quite easy to us. S16- Online study is very good because you can get good grades. S17 - I like online class because I can again the lecture when I want.
3.Improvement and suggestions	Teacher-student interaction Better Internet speed Audio-video quality Turning on cameras Training	S18… Explanation should be more effective, as the teacher should make the students interact with him. S19 - If I have good internet will study online. S20- … Improve audio and video quality.… S21 - Teachers need to turn on their camera while teaching. S22- I want to connect more with Ms or Mr in the online learning. S23- Choosing the right teachers for online learning. S24 - Students may be trained to engage in online classes.

The qualitative data, acquired through open-ended questions and informal interviews, underwent analysis to address the research inquiries. Table six presents exemplar verbatim statements along with the themes extracted from each statement.

In total, 52 participants shared their comments regarding the Covid-19 online courses. Among these, most comments (46%) expressed opposition to online learning, while 28% conveyed a favourable perspective. The remaining 26% of comments took the form of recommendations for improvement or reflections on how online courses benefited learners (Table 6). Notably, it is intriguing to observe that some respondents provided detailed explanations for both their support and opposition to online classes.

7. Discussion

The study facilitated researchers in obtaining an overall perception from learners across various departments. The cross-sectional analysis, as indicated in Table 5, revealed that no statistically significant difference existed between the groups. Nevertheless, the descriptive statistics provide stakeholders with insights that slightly more than half of the participants agreed with all items within the constructs of experience and contentment. However, a significant portion of participants – nearly half – either remained undecided or disagreed with every item in the study. This diverse range of responses highlights the need for further investigations, particularly concerning students' neutral or negative opinions on various parameters. For instance, almost a quarter of participants expressed disagreement with all items within both the experience and contentment constructs. Similarly, more than a quarter of respondents maintained a neutral stance regarding different survey items (Tables 3 and 4; Figures 1 and 2). These negative and neutral responses could potentially stem from certain psychological and technological challenges faced by the learners (Milla, et al., 2021).

The qualitative data analysis (Table 6) yielded insights into the factors that likely influenced learners' positive or negative responses to various items within the constructs of students' experience and contentment (Tables 3 and 4; Figures 1 and 2). The analysis ultimately identified three key themes: negative experience, positive experience, and improvement and suggestions (Table 6). Concerning learners' negative experiences or experiences of online learning, certain participants perceived a lack of objectivity in grading students' performance. These participants felt that diligent learners were not adequately rewarded, with S1 stating, "it spoils the student's grades. For example, the superior student gets low grades, and the non-achieving student gets high grades through cheating." Additionally, respondents like S3, S6, S7, and S9 held negative views about online learning due to reasons such as lack of comprehension among students, poor Internet connectivity, ineffectiveness, and reduced seriousness in attending lessons. S4 expressed, "It is better to receive instruction directly from the teacher." (Table 6.1). These underlying reasons may have contributed to respondents' negative responses within the quantitative data (Tables 3 and 4; Figures 1 and 2).

Furthermore, the demographic profile of the respondents reveals that approximately half of them lacked access to reliable Internet services. Similarly, a significant proportion of learners hailed from rural areas, and many did not possess smartphones (Table 1). Consequently, these factors could have contributed to a negative experience of online class participation for certain learners (Nikolopoulou, 2022). In contrast, learners from more advanced locations, such as towns and cities with better Internet speed, might have had more positive experiences and contentment, as noted by Panigrahi, et al. (2021).

In contrast, Table 6.2 illustrates the reasons behind learners' positive experiences and contentment regarding online learning. They expressed positivity due to: a) comfort, b) personal learning pace and flexibility, c) balancing work and studies, d) ease of use, e) achieving good grades, and f) the ability to review recorded lessons. These themes align with the advantages of online learning outlined by Debych (2023). For instance, S12 highlighted, "Online education enables the teacher and the student to set their own learning pace, and there's the added flexibility of setting a schedule that fits everyone's agenda," while S17 mentioned, "I like online class because I can again the lecture when I want" (Table 6.2). These reasons might underlie the agreement of more than half of the respondents with variables within the constructs of student experience and contentment as observed in the quantitative results (Tables 3 and 4; Figures 1 and 2). These positive responses resonate with the findings of the study conducted by Yen and Nhi (2021), which reported that learners had a positive experience with online learning.

Finally, participants in the research offered valuable suggestions for improvement, encompassing: a) enhancing teacher-student interaction, b) ensuring better Internet speed, c) improving audio-video quality, d) encouraging camera usage, and e) providing training (Table 6.3). These recommendations can guide stakeholders in addressing specific shortcomings and enhancing the online learning system. These areas of enhancement

correspond with challenges previously identified by researchers (Debych, 2023; Jose and Jose, 2021; Milla, 2021).

S7 suggested, "Explanation should be more effective, as the teacher should make the students interact with him," while S12 advised, "Students may be trained to engage in online classes" (Table 6.3). Addressing interaction, it is crucial to promote student-to-student interaction, given that more than a quarter of responses indicated a lack of socialization with classmates (Table 3, Figure 1). Moreover, S19, S20, and S21 emphasized the importance of "good internet … audio and video quality … turning on their camera while teaching" (Table 6.3) for enhancing online classes. By incorporating these recommendations into future research and practice, stakeholders and upcoming researchers can gain insights into the factors contributing to respondents reporting neutral opinions regarding various variables within the quantitative aspect of the study (Tables 3 and 4; Figures 1 and 2).

8. Conclusion and Recommendations

In summary, the study successfully achieved its objectives of exploring the perceptions of UTASA learners across departments regarding learner experience and contentment. This process has offered researchers valuable insights into the implications of online learning within these domains. The learners' varied responses to the survey items have facilitated investigators and stakeholders in comprehending both the positive and negative facets of the process. Drawing from the analysis, findings, and discussion, the subsequent recommendations are put forth for stakeholders, including the administration, teachers, and students.

- Teachers should find make use of variety of online tools such as general posts, chats, group channels, survey, quizzes, etc to employ different teaching and learning techniques to ensure learners 'optimum class participation.
- Students should be made aware of and encouraged to participate actively in online learning activities to interact with their peers and teachers.
- Administration and public authorities should carry out a need analysis to find out students' backgrounds and learning needs with respect to Internet speed and connectivity, learning devices, and their ease of use of learning management system (LMS) for online lessons.
- Learners may be provided with training to use the online learning platforms after analysing their learning needs.
- In addition to the initial need analysis, stakeholders should conduct follow up investigation to learn how effective are the measures taken to meet their needs, and what further improvements should be done.
- Online audio and visual clarity should be checked and ensured by teachers during the process of online teaching and learning.
- Further studies should be carried out to determine learner perceptions of the process of the online learning in terms of gender and its cultural implications as participants included both males and females from closed to open cultural contexts.
- Future studies can also focus on the implications of online learning on UTASA students from different backgrounds (Towns, Cities, and villages) using different devices (Smart phones, Desktop, laptops, and tablets).

Acknowledgement

The authors acknowledge that the study was conceptualized with the assistance of Dr Jansi Natarajan, Lecturer in Fundamentals and Administration at Sultan Qaboos University, Oman.

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Mobile-Assisted Language Learning to Support English Language Communication among Higher Education Learners in Thailand

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Abstract: The ability to use English has become essential for functioning in the 21st century; not only the basic skills (reading, writing, listening, and speaking) but broader skills in communication and collaboration will be necessary for future success in global environments. Digital transformation in learning via mobile devices helps create authenticity in English language education. They can interest and engage learners, both in and out of the classrooms, while promoting uninterrupted learning, especially during the COVID-19 pandemic. Moreover, advances in mobile applications and virtual learning environments have become important components of developing English language skills, allowing for asynchronous learning in convenient, flexible, and interactive environments on any of a learner's devices. This paper reports the results of using a mobile-assisted language learning interactive environment (MALLIE), a chatbot-based application, to support the development of English language communication skills. Quantitative data were acquired from 546 higher education learners in Thailand. The information was used for the exploratory factor analysis which shall serve as a baseline for innovation development. The study briefly examined the students' experiences with any type of mobile learning before focusing on the students' and a group of experts' ratings of the intervention in this study. Preliminary studies were conducted with 10 students and experts to identify factors they believed were most relevant for measuring the effectiveness of the MALLIE for English language learning in a virtual learning environment. Exploratory factor analysis of 70 variables extracted four factors with loadings that exceeded .30: MALL, VLE (virtual learning environment), 4Cs for the four basic components of language learning, and ELCS for English language communication skills; the factor loadings ranged between 0.55 and 0.81. Additionally, in-depth interviews were conducted to collect qualitative data, and the results of preliminary studies were used to design and develop the MALLIE application and test its learning effectiveness. Next, an opinion survey was administered related to a group of 105 students and experts regarding their acceptance of the MALLIE and their intentions to use it or something similar in the future; the main topics of the survey related to the perceived usefulness of the MALLIE, its ease of use, respondents' attitudes towards its use, peer influences on respondents' use, and respondents' use behaviour and intention to use. The aim of the study's surveys and analyses was to assess the effectiveness and efficiency of learning the English language via mobile language learning applications available for use on any device.

Keywords: Mobile-Assisted language learning, Virtual learning environment, English Language communication skill, Higher education, 21st-century learning, Digital disruption

1. Introduction

Learning in the 21st century is focused on learners using technology to promote skills for life, including English language communication skills (ELCS) (Dede et al., 2010; Fraga and Flores, 2018; Griffin and Care, 2014; Khlaisang and Songkram, 2019; Kukulska-Hulme, 2018; Tkach, 2017), which learners can acquire using mobile-assisted language learning (MALL) applications. Mobile devices with such applications installed grant learners access to learning resources without time or space limitations and provide rich, real-time experiences both inside and outside of class (Fraga and Flores, 2018; Kukulska-Hulme, 2018; Law et al., 2007). MALL applications improve language learners' achievement by developing their communication skills in listening, speaking, reading, and writing (Miangah and Nezarat, 2012; Ozer and Kiliç, 2018; Thongsri et al., 2019).

Researchers have examined MALL applications for non-native languages in terms of learning achievement, cognitive load, and acceptance of mobile learning tools and found greater student learning achievement, decreased cognitive load, and high acceptance and enjoyment of the learning tools (Ozer and Kiliç, 2018). MALL applications let learners set their learning goals and manage their own learning (Guodong and Xinghua, 2016; Humanante-Ramos et al., 2015). This integration of formal and informal learning into individual learning experiences using social networks, computer technology, and communication technology helps learners create their own learning experiences at their own convenience (Dabbagh and Fake, 2017; Miangah and Nezarat, 2012). Mobile applications have greatly expanded current language learning, teaching, and evaluation including foreign language learning. Balula et al. (2020) studied MALL in business English learning among undergraduates. They found that MALL can develop learners' ELCS. However, the writing skills still required further development. Additionally, Li (2023) explained MALL features that complement effective language learning which include

Reference this paper: Khlaisang, J. and Sukavatee, P. 2023. Mobile-Assisted Language Learning to Support English Language Communication among Higher Education Learners in Thailand, *The Electronic Journal of e-Learning, 21(3)*, pp 234-247, available online at www.ejel.org

ubiquity, social interactivity, authenticity, multimodality, and motivation enhancement as well as attitude and acceptance towards MALL use, all of which contribute to learners' English language learning achievements (Ebadi and Raygan, 2023; Alhadiah, 2023).

However, knowledge content alone is not sufficient for life and work in the 21st century. The World Economic Forum's (2016) framework for 21st-century learning requires the integration of content knowledge and communication. This extends to promoting learners' knowledge, skills, and competencies, especially communication skills. Another important component is ELCS because English is a primary language for broad communication worldwide (Hameed et al., 2012; Ministry of Education, 2016; Newton et al., 2018; Sungjaisom, 2016). English language learning includes developing the four areas of listening, speaking, reading, and writing, together with communication and collaboration skills (Chang et al., 2018; Cresswell and Beutel, 2017; Hadinugrahaningsih et al., 2017; Khlaisang and Songkram, 2019). One strategy for promoting English language skills is using mobile technology to expose learners to English usage in virtual contexts, which increases English learning without limiting any exposure to the native or target language (Lan et al., 2013). In keeping with this concept, the focus of this research was developing a mobile-assisted language learning interactive environment (MALLIE) that incorporated a chatbot and the iReview web application and then evaluating participants' responses to the MALLIE.

With reference to the situations and need assessments regarding instructions to enhance ELCS, this study examined the effects of a MALLIE for supporting English language learning and communication among higher education learners in Thailand with the aim of developing 21st-century English language skills. The objectives are, firstly, to study the existing instruction landscape and factors influencing mobile application design for learning in virtual contexts to enhance ELCS among higher education learners in the 21st century. Secondly, it aims to develop and study the usage results of this mobile application in the areas of perceived usefulness, ease of use, using behaviour, peer influence, attitude to use, and intention to use.

2. Literature Review

2.1 English Communication Skills in 21st-Century Higher Education Learning

Developing ELCS among a non-native-English-speaking nation's population—such as Thailand—has a crucial role in expanding the country's incorporation into world society. The process entails learning language rules and applying them appropriately (Byrne, 1990; Gabillon and Ailincai, 2013; Grabe, 2009; Harmer, 2001; Littlewood and William, 1995) and needs to focus not only on developing the four communication skills above but also collaboration and communication skills, which will create knowledge and work skills (Khlaisang, 2018; Vockley, 2007). Researchers have synthesised various learning components for promoting ELCS, including learning and understanding language rules and meanings, using them appropriately for the situation, and training students to practice the language they are learning; students in the studies cited above practiced in pairs or groups, and exercises combined language learning both in and outside of classrooms (Gabillon & Ailincai, 2013). In this study, the language learning skills consist of the set of skills that can assist learners to understand and produce appropriate and efficient spoken languages for communication. The four skills are listening, speaking, reading, and writing (English Language Communicative Skill). The focus is on individual learning development that can be integrated with the 21st-century skills concepts of communication and collaboration. The focal point is clear communication and collaboration that builds on knowledge to create tangible outputs. The assessments include (1) self-evaluations in terms of communication skills development (listening, speaking, reading, and writing), (2) analyzing behaviors and tracking digital footprints on communication skills development that exists in the system, and (3) analyzing the output that signifies their ability to integrate the skills. Application of technology for the development of English language learning takes various forms such as Computer Assisted Language Learning (CALL) which allows learners to learn and interact via computers. However, CALL poses problems wherein there is a gap between taught contexts and forms versus real-life practices. Therefore, Meihami (2023) involved situated learning in English language learning via CALL to help reduce the limitations. Aside from CALL, another technology used for English language learning is Mobile Assisted Language Learning (MALL). Shortt et al. (2023) reviewed literature that gamification in MALL can ignite learning motivation and enhance foreign language performance.

2.2 The use of MALL to Support ELCS

Mobile Assisted Language Learning (MALL) is learning via mobile devices that facilitates learning behaviours of those who have easy and convenient access to the internet, especially via personal mobile phones, smartphones, or Bring Your Own Device (BYOD) practices. The adoption of mobile applications has altered instructional

methods to fit learners of diverse age groups and levels from around the world (Kalogiannakis and Papadakis, 2020). MALL applications respond to student behaviour and have been accepted as suitable for language learning (Fryer et al., 2020). In particular, these applications can be used on students' existing mobile devices and feature flexible, interactive, and systematically organised learning with materials available online (Ally, 2009; Avenoğlu, 2005; Ozdamli and Carvus, 2011; Kaewkiriya, 2010). In addition, the important components that enable learning are the instructor, the learner, the content, a flexible (including asynchronous) learning environment, and a method of evaluating learners' abilities (Chen, 2018; Gafni et al., 2017; Viberg and Gronlund, 2013; Wilken et al., 2016). The authors of one exploratory study found that students were satisfied with the mobile language learning application and reported positive experiences (Xu and Hu, 2020). Ebadi and Raygan (2023) studied the facilitating conditions, perceived ease of use, and perceived usefulness of applying MALL to English language learning. They found that perceive usefulness influenced perception towards MALL while facilitating conditions affected perceived ease of use. In addition, Alhadiah (2023) studied performance expectancy, facilitating conditions, hedonic motivation, and social influence toward acceptance of MALL among higher education English as a Foreign Language (EFL) learners. Structural equation modeling (SEM) found that performance expectancy, facilitating conditions, hedonic motivation, and social influence were indicators of the intention to use MALL.

3. Research Question

A virtual learning environment (VLE) is an online teaching and learning environment that is made available to students via their mobile devices or other available technologies for providing education resources. VLEs support mobile language learning via access to learning materials on portable devices, suitable learning content and activities, and effective measures for assessment and evaluation (Shi et al., 2010; Weller, 2007). This study examined the effects of a MALLIE for supporting English language learning and communication among higher education learners in Thailand with the aim of developing 21st-century English language skills. Specifically, the following research questions guided this study:

RQ1. How well does the MALLIE support acquiring ELCS among higher education learners in Thailand?.

RQ2. What factors contributed to the development of the MALLIE application to support ELCS among Thai higher education learners?

RQ3.How do Thai higher education learners feel about accepting a mobile application that supports ELCS?

Figure 1 presents the conceptual framework for the study.

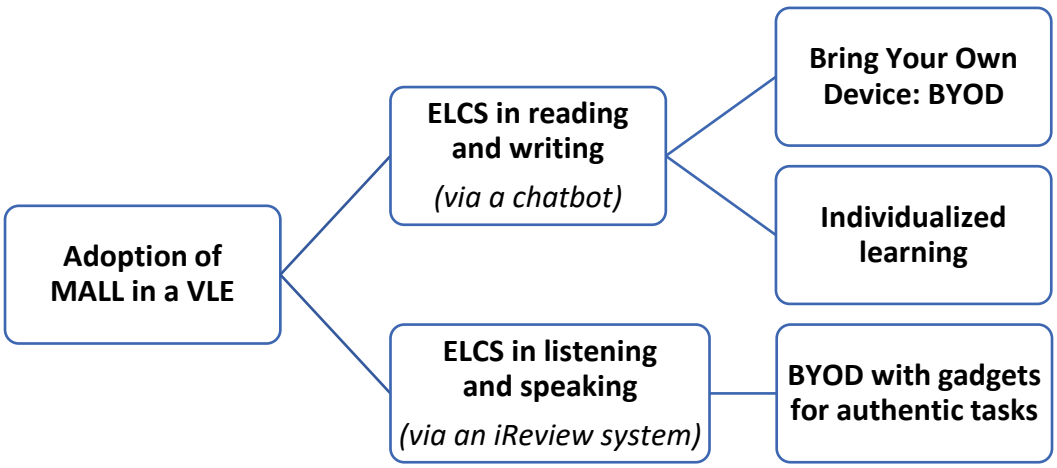

Figure 1: Conceptual framework of a MALLIE for supporting ELCS

4. Method

With regards to the literature review about the application of MALL in English language development, it shows that most studies focus on communication skills or one skill at a time. Therefore, this study adopts the R&D design to develop a mobile application for learning in virtual contexts to enhance ELCS for higher education learners in all 4 skills of listening, speaking, reading, and writing. The factors analysis will be used for innovation design prior to experimenting with learners. Furthermore, the information on technology acceptance will be

used for future application design. The research consists of 3 phases namely (1) English language learners' needs on the use of MALLIE, (2) Developing the MALLIE, and (3) MALLIE application findings.

The MALLIE for this study was developed in response to the needs of higher education English language learners in Thailand, and the results were subjected to exploratory factor analysis (EFA) and principal component analysis to check the suitability of the proposed components for the proposed language learning innovation. Qualitative data using person interview method were also collected from experts in education technology and higher education English teaching for more in-depth input.

Next, the quantitative and qualitative data were synthesised to create the MALLIE, which consisted of an incorporated Facebook Messenger chatbot and the iReview web application. Students completed missions assigned by the chatbot related to reading and writing English, and after they completed the missions, they developed their listening and speaking skills in iReview; when the students had completed all the missions, their English skills were evaluated. In addition, the students were interviewed to collect in-depth qualitative data on their opinions of the MALLIE.

4.1 Sample

The sample for the quantitative data for this study consisted of 546 higher education learners from four regions throughout Thailand using a cluster sampling method. Table 1 presents their details, specifically, the number of learners with a smartphone, their ability to connect the device to the internet, their experience in learning with mobile applications (Table 1), their time spent studying via social media (Figure 2), and the types of media they used for mobile learning (Figure 3).

Table 1: Participants' demographic information (n = 546)

Learners' Experiences	Yes	No
1. Learners with a smartphone for use	99.5	0.5
2. Ability to connect the device to the internet	99.6	0.4
3. Experience in learning with mobile applications	100	0.0

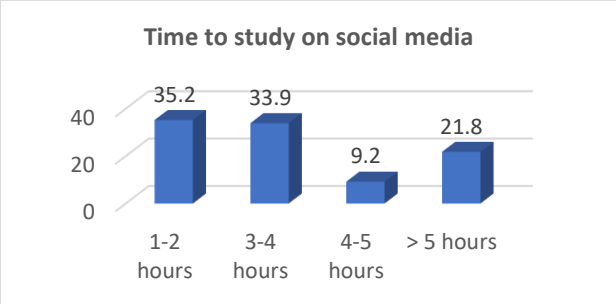

Figure 2: Participants' time spent studying via social media

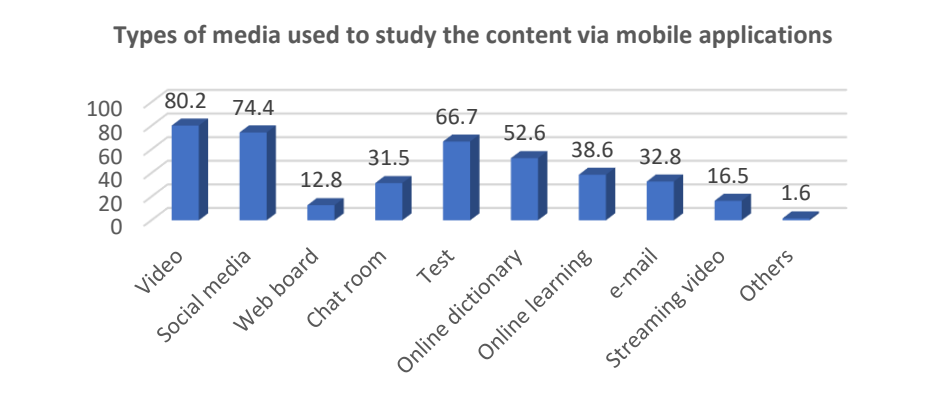

Figure 3: Types of media students used to study online content

4.2 Measurement

The research instruments for this study were a questionnaire to gather factors to incorporate into the system, lesson plans developed for the application, and an opinion survey on the acceptance of MALLIE for supporting ELCS in higher education learners. The factors students rated were the perceived usefulness of the MALLIE, its ease of use, the students' actual usage behaviour, the effects of peer influence, students' attitudes toward using the MALLIE, and their intention to use a future MALLIE.

Stage one: English language learners' needs regarding the use of MALLIE

Section 4.1 details how the student sample's needs were obtained for their incorporation into the MALLIE; these data were analysed using EFA and Priority Needs Index (PNI) to refine the MALLIE. Additionally, qualitative data were collected from interviews with 15 higher education instructors with expertise in innovative mobile applications and ELCS in a Thai learning context. The data collected indicated that the learners in this study had experience in learning with mobile applications; therefore, the focus became designing the application to be suitable for studying English via mobile applications. It was also found that learners in this study used social media to study, and therefore, the MALLIE application was developed for access through retrieval- and rule-based chatbots in Facebook Messenger.

Stage two: Developing the MAALIE

The innovative MALLIE application was developed to support English language learners' acquisition of reading, writing, understanding, and speaking skills as well as 21st-century skills related to communication and collaboration. The system consisted of server- and client-side scripts. Figures 4 and 5 show schematic representations of the system architecture and the use cases, respectively.

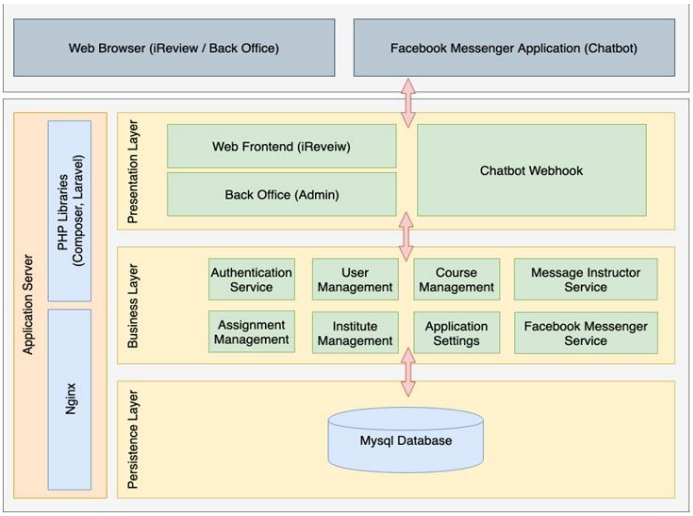

Figure 4: Schematic representation of the system architecture

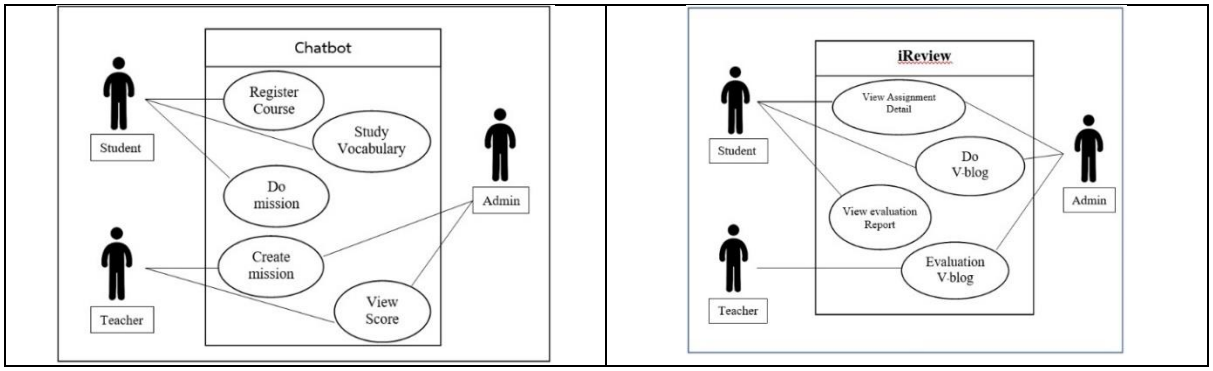

Figure 5: Schematic representation of the use cases for (left) chatbot and (right) iReview

The two subsystems of the developed MALLIE were the Facebook Messenger chatbot and iReview, an Android application. Via the chatbot, instructors presented students with learning missions using media such as pictures,

videos, and website links in order to stimulate learners' knowledge acquisition. The chatbot also displayed the learners' progress in the form of their learning status, their completed missions, and their upcoming due dates (learning progress; Figure 6).

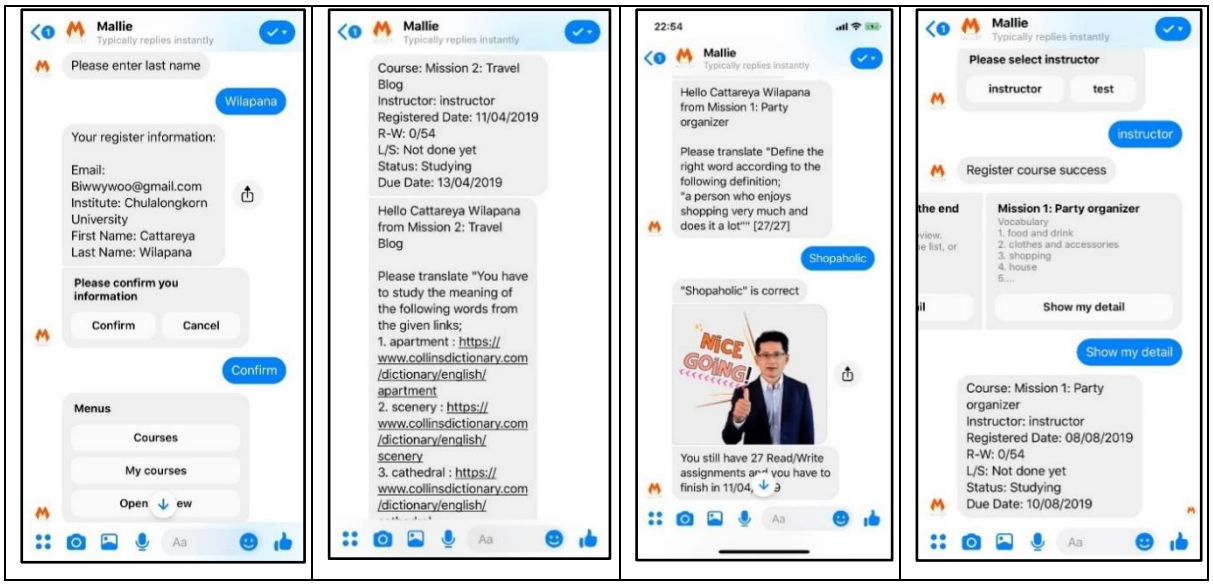

Figure 6: The study chatbot system showing, from left to right, interaction with learners, their learning missions, positive reinforcement, and their learning progress

The iReview system, an Android mobile application, allows learners to create video blogs (vlogs) of their work via avatars as well as create text and image content (Figure 7). Learners' completed work is sent to the iReview back office for evaluation, and students receive ratings of Pass; Reject, which returns the work to the student for revision; or Fail, which necessitates repeating the assignment.

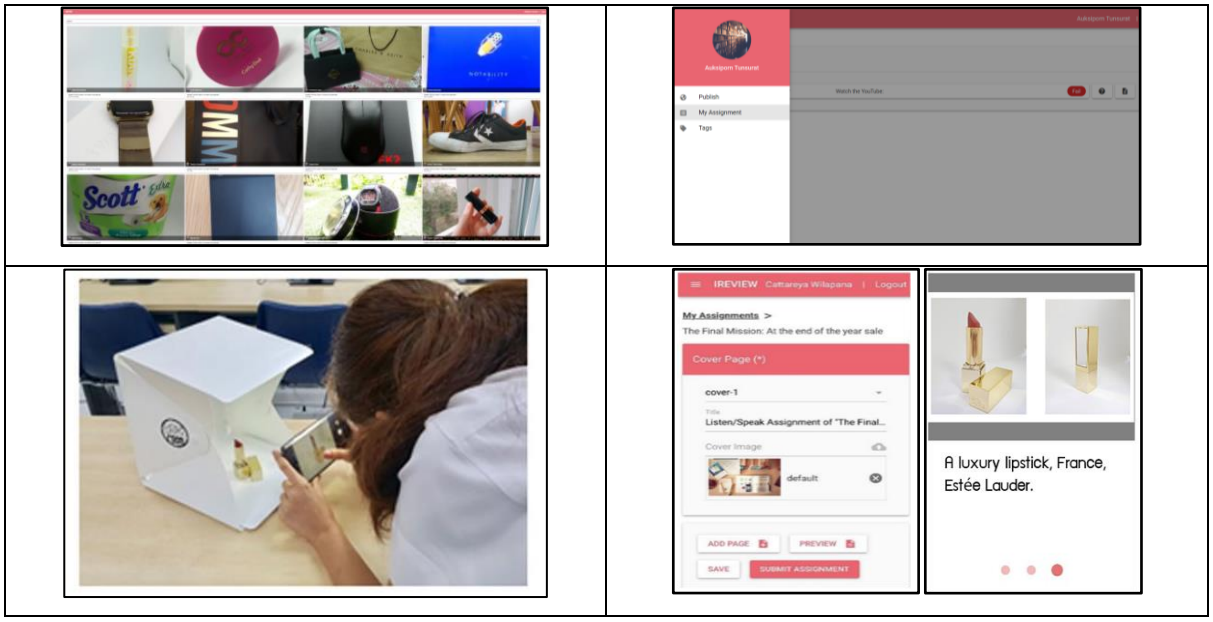

Figure 7: Overview of iReview

Stage three: MALLIE application findings

A group of 105 higher education learners from both public and private higher education institutions participated in the MALLIE trial for developing 21st-century ELCS. Before beginning the MALLIE trial, learners' ELCS was tested using the three missions for vocabulary level B1 according to the Common European Framework of Reference for Language standard (Cambridge, 2019). After finishing the learning process, learners completed a self-assessment, and a rubric was completed for them as well. Table 2 presents the self-assessment and rubric ratings for the participants in the MALLIE condition.

Table 2: Demographic information of the MALLIE innovation learners (n = 105)

Variable	Detail	Frequency	Percentage
Gender	Male	32	30.5
	Female	73	69.5
Year	Year 1	9	8.6
	Year 2	16	15.2
	Year 3	55	52.4
	Year 4	24	22.9
	Year 5	1	1.0
Subject Field	Science	54	51.4
	Humanities and Social Sciences	51	48.6
University type	Public	51	48.6
	Private	54	51.4
GPA	Lower than 3.01	41	39.0
	3.01 – 4.00	60	57.1
MALL using experience	Yes	21	20.0
	No	84	80.0
Number of subjects studying via MALL	1 subject	35	41.7
	2 subjects	18	21.4
	3 subjects	27	32.1
	4 subjects	4	4.8

Instruments and procedure

For this study, learners worked on developing listening and reading skills and vocabulary by completing exercises using the chatbot and an online dictionary (Collins) in each mission (Figure 8). The students then worked on developing their writing and speaking skills by creating a product review; they were allowed to create a vlog using their own images or avatars to represent themselves (Figure 9), and their works were scored. In addition, in-depth interviews were conducted with instructors and learners to gauge their intent to use other MALLIE applications based on the technology acceptance model (Davis, 1989). This model describes the main factors in accepting technology, including its perceived usefulness and perceived ease of use, which directly affect the (3) intention to use and (4) usage behaviour.

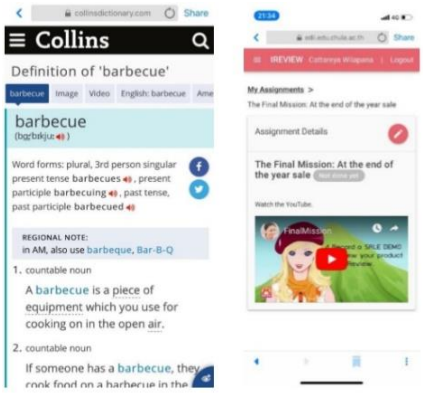

Figure 8: How MALLIE develops listening and speaking skills

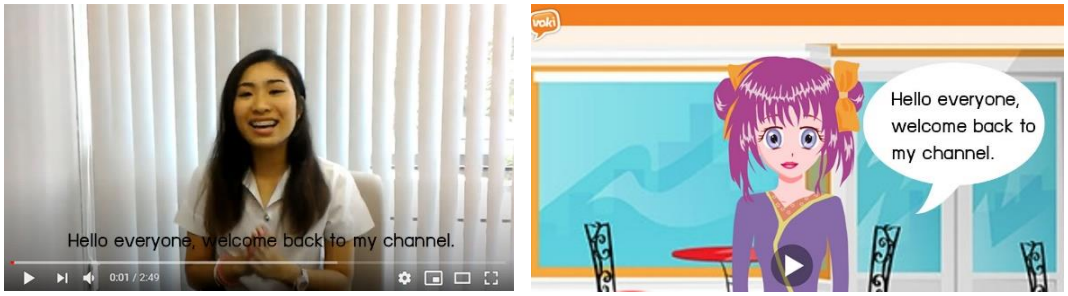

Figure 9: Sample vlog product review (left) and sample vlog with user's avatar rather than the real image (right)

5. Research Findings

The results of this study on an innovative mobile application to support ELCS among higher education English language learners in Thailand can be summarised under each research question as below.

5.1 Research Question 1

The ability of the MALLIE application to promote ELCS in higher education students was evaluated separately for the chatbot, iReview, and the back office, using an EFA of the quantitative data from 546 learners who had experience in using MALL and the qualitative data collected from interviews with 15 experts. The system has three distinctive features for promoting ELCS: a Facebook Messenger chatbot with exercises that teach vocabulary and grammar (Figures 3 and 5); iReview, an app that develops listening and speaking skills by having students create vlogs (Figures 4 and 6); and the back office system through which the instructors create and set up learning activities. Figure 10 graphically displays how the back office system tracks and displays students' progress.

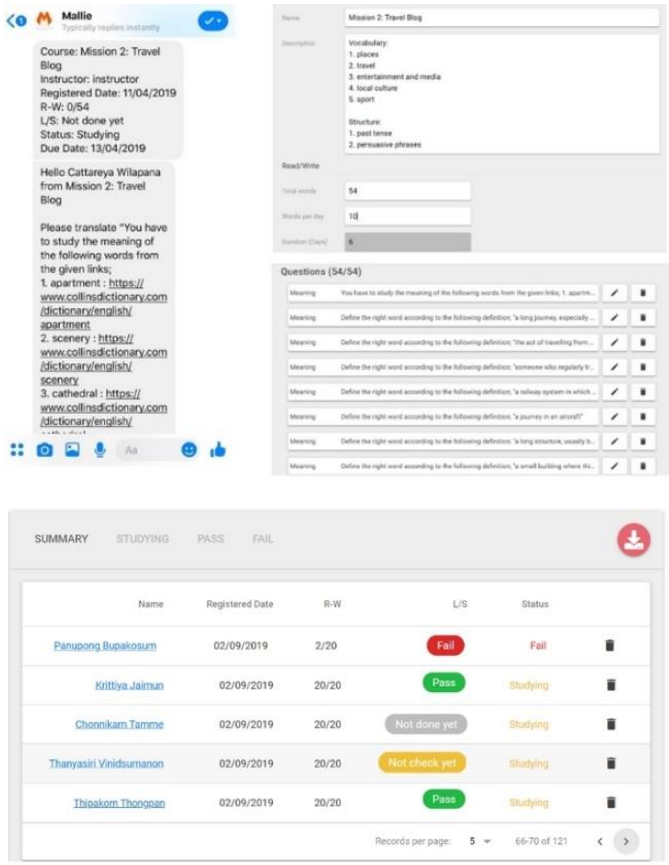

Figure 10: Back-office setup for vocabulary details, showing (above) exercises and (below) student progress

5.2 Research question 2

Table 3 presents the EFA results for the factors that contributed to the design and development of the MALLIE application for supporting ELCS in higher education learners, which incorporated the quantitative EFA and qualitative interview data. The system was designed in accordance with the analysis results.

Table 3: Factor analysis results for the MALLIE design and development

Factor	Eigen value	Variable (Number)	Factor loading	Variance (%)	Cumulative variance (%)
1	42.06	37	0.55 - 0.81	60.09	60.09
2	4.99	17	0.63 - 0.76	7.13	67.22
3	2.17	11	0.62 - 0.76	3.10	70.32
4	1.45	5	0.61 - 0.65	2.08	72.39

Note: Mobile assistant learning language (MALL)[1], virtual learning environment (VLE)[2], collaboration & communication skills for 21st Century Leaners (4Cs)[3], and English language communication skill (ELCS)[4].

The means for the 70 items extracted through EFA were between 3.62 and 4.11, with standard deviations between 0.76 and 0.97. Factors were then extracted using PCA and orthogonal varimax rotation. The 70 extracted variables loaded under four distinct factors that weighed more than 0.30 ($p < .05$), aligning with the research objective. Figure 11 presents the scree plot of the factor eigenvalues.

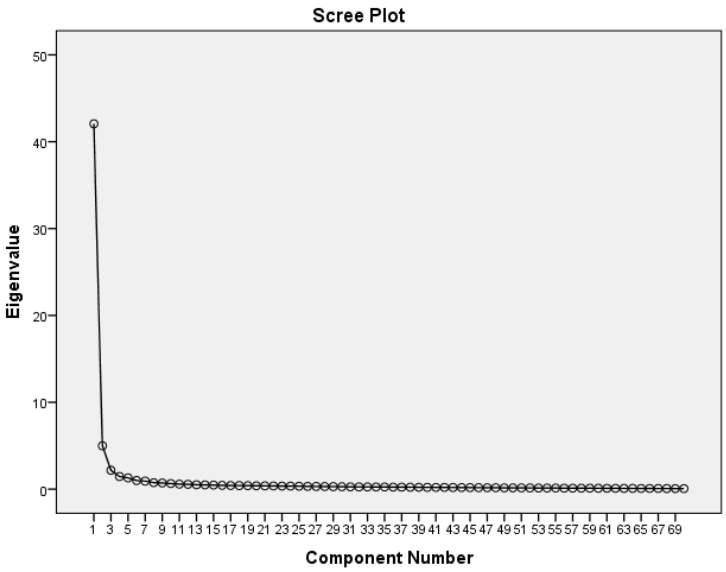

Figure 11: Scree of the EFA factor eigenvalues

In terms of the four factors, Factor 1 had 37 variables with factor weights between 0.55 and 0.81 and an eigenvalue of 42.06. It consisted of variables related to the instructor, the learner, the suitability of the content, the learning environment, and assessments, and therefore, this factor was named MALL. It comprised variables 1–35. Factor 2 had 17 variables with factor weights between 0.63 and 0.76 and an eigenvalue of 4.99. It consisted of variables related to access to mobile learning devices and the suitability of the MALLIE content, learning activities, and testing. Factor 2 comprised variable numbers 43–59 and was named VLE. Factor 3 encompassed 11 variables with factor weights between 0.62 and 0.76 and an eigenvalue of 2.17. It consisted of basic reading, writing, understanding, and speaking skills as well as 21st-century skills in collaboration and communication. The factor was composed of variable numbers 60–70 and was named the 4Cs for the four main language learning skills. Factor 4 had five variables with factor weights between 0.61 and 0.65 and an eigenvalue of 1.45. These variables related to enhancing English vocabulary, speaking, listening, reading, and writing skills and were therefore named ELCS. It comprised variable numbers 38–42.

5.3 Research Question 3

Research question 3 entailed examining how the study respondents accepted or conceived of acceptance and how they promoted using innovation in developing and accepting a mobile application to support ELCS among higher education learners. The survey topics included (1) perceived usefulness, (2) ease of use, (3) using behaviour, (4) peer influence, (5) attitude to use, and (6) intention to use.

Part 1: Basic information on the respondents

The questionnaire respondents consisted of 105 higher education students and the person interviews were collected from five students and five instructors, of whom seven respondents (70%) were female. All five students were in their second year, three studying humanities and social sciences and two studying science and technology. Each student had prior experience in mobile learning, with studying via mobile applications for more than 5 hours per week and two for 4.5 hours per week.

Part 2: Opinion survey on the acceptance and the possibility of using MALLIE

The opinion survey on the acceptance of and intention to use the MALLIE to support ELCS among higher education English language learners consisted of six main topics for assessment: (1) perceived usefulness of the MALLIE, (2) ease of use, (3) learners' use behaviour, (4) peer influence, (5) attitudes toward using, and (6) intention to use the MALLIE. The results are summarised in Figure 12.

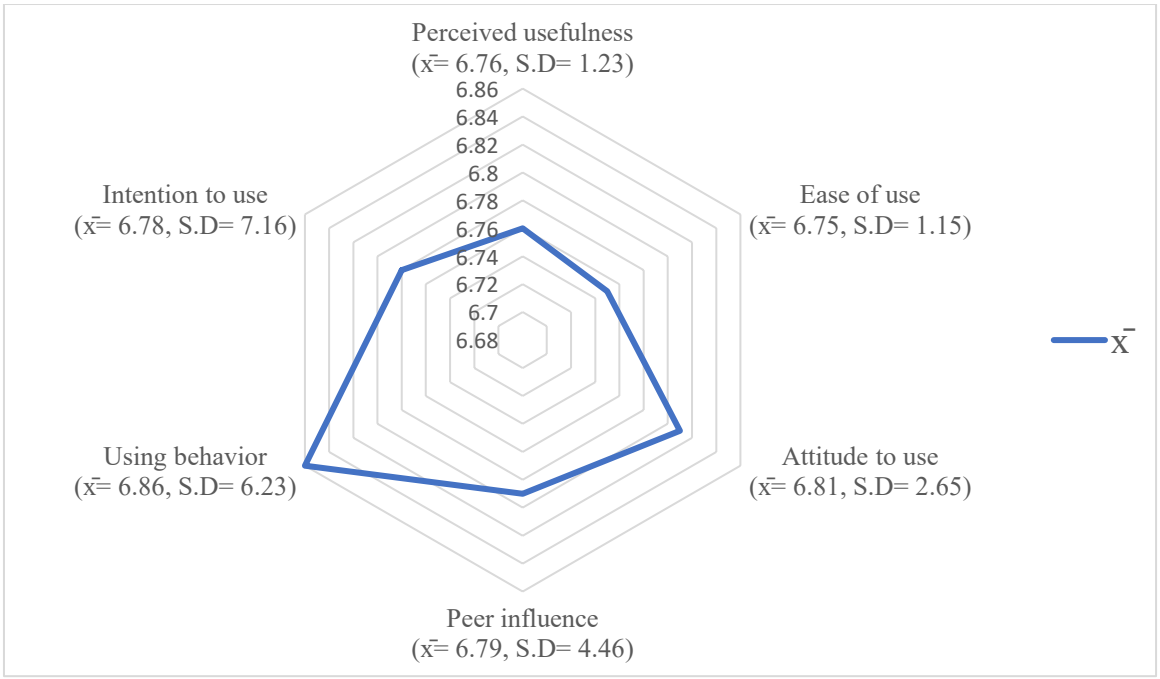

Figure 12: Trends in using innovation

The findings depicted in Figure 12 indicate that these 10 interviewees accepted the MALLIE for supporting ELCS development in all six dimensions and reported a high possibility that they would use this mobile application in the future. The perceived usefulness of the MALLIE received the highest score, 6.76 out of 7; it also helped learners achieve successful learning sooner than expected, and it was easy to use, with an average ease of use score of 6.89 out of a possible total 7 points. Additionally, 6.89 was the students' average rating for their use behaviour as well as for whether using the application was fun and enjoyable and whether they would use the application with a group of friends. The students rated their intention to recommend the MALLIE to other people with a score of 6.88. The interview results also indicated positive opinions of the MALLIE for English language learning ($p < .05$), aligning with the research objective.

6. Conclusion and Discussion

Today, the effective sustainability of English language skills must incorporate 21st-century technologies including mobile devices that are convenient to carry, easy to use, flexible, and always online for improving language knowledge and skills (Chen and deNoyelles, 2013; Gezgin et al., 2018; Wai et al., 2018). In this study conducted

among higher education learners, most had experienced learning through mobile devices, and their most popular device was a smartphone. The study results for the MALLIE development aligned with related literature from the following four perspectives. First, MALLIE is a ubiquitous technology that allows learning without limits, encouraging communication with other learners as well as encouraging tailored, personal learning (Kim and Kwon, 2012; Martin and Ertzberger, 2013). Second, MALLIEs are mobile applications and thus are available on any mobile device, enhancing their access (Ozdamli and Cavus, 2011). Third, MALLIEs are flexible and allow for learners' self-paced learning activities (Kumar and Jayachandran, 2019). Lastly, a MALLIE emphasises and encourages interactivity and knowledge sharing among users (Hwang et al., 2015). The results align with Ebadi and Raygan (2023) who studied the factors of facilitating conditions, perceived ease of use, and perceived usefulness of MALL in English language learning. They found that perceive usefulness influenced perception towards MALL while facilitating conditions influenced perceived ease of use. This is also true in another research that mentions that facilitating conditions, hedonic motivation, and social influence are significant indicators of the intention to use MALL among learners (Alhadiah, 2023).

The learning protocol in the MALLIE consisted of four steps: active reading, listening to vocabulary, review, and interactive writing and speaking. The chatbot facilitated interactive activities among learners for developing their writing and reading skills, and iReview encouraged the development of more effective and productive listening and speaking skills. Our findings supported those of Abdi and Makiabadi (2019) and Nejati et al. (2018) that organised learning using a MALL with a language application develops students' listening and speaking skills; learners studying with the MALL had greater skills than the control groups in those authors' studies. In addition, learning with MALL can support cooperative, collaborative, active, constructive, creative, and social learning (Kim and Kwon, 2012; Bii, 2013; Iftene and Vanderdonckt, 2016), which can increase students' motivation to learn well beyond the limitations of learning in normal classrooms (Lan, 2015; Gafni et al., 2017; Hsiao et al., 2017; Lin and Hwang, 2018).

The MALLIE proposed in this study helped develop ELCS in a group of Thai higher education English language learners by delivering tailored learning experiences via their mobile devices, nearly entirely smartphones. A Facebook Messenger chatbot developed the 4Cs (for communication skills) of ELCS: listening, speaking, reading, and writing. A separate application, iReview, integrated students learned English language skills to expand their 21st-century communication and collaboration skills. Notably, however, some students in this study did not have previous experience in learning through MALL or in VLEs. Instructors need to incorporate the potential knowledge deficits among such populations and develop learning materials that offer new learners in-depth information on how to navigate online learning systems.

This study highlights the innovation's feature to benefit learners in terms of convenience of time and space as well as the appropriate individual learning rate. This attends to and supports personalized learning. Nonetheless, for future research, a Delphi method might be used to examine the effectiveness of the application from the perspectives of MALL experts. Moreover, more information can be acquired as qualitative data from interviews or inquiring the learners to gain more insights. This may contribute to understanding the needs for design and development in English language instruction, as highly efficient innovation development can benefit from considering both quantitative and qualitative data.

Disclosure statement

The research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Acknowledgement

Fundings Sources: This work was supported by Thailand Science Research and Innovation (TSRI) (RDG61H0024)

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EJEL Editorial 2023: Trends and Research Gaps in e-Learning

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1. Introduction

The Electronic Journal of e-Learning (EJEL) is an online open-access journal that aims to publish articles and papers that contribute to the development of theory and practice in the field of e-Learning. The journal provides a multidisciplinary forum for research on education and learning that informs theories and practices regarding how people learn and the design of e-Learning environments in various contexts. From 2021 to 2022, a total of 92 papers were published in EJEL (47 papers in 2021 and 45 papers in 2022) from 43 different countries. Out of the 282 submissions received in 2022, 12(4%) were accepted. In 2021, EJEL was ranked in Q1 in the Education category and in Q2 in the Computer Science Applications and E-Learning categories (Scimago Journal & Country Rank).

Compared to previous editorials, for this year's editorial, we have decided to adopt a new approach. By examining and presenting our published papers on e-Learning from authors worldwide, we aim to highlight trends and research gaps in the field of e-Learning from 2021 to 2022. Additionally, we will compare our findings with the most recent papers on trends and gaps published in other journals to provide a broader context. Through this approach, we hope to contribute to answering questions about which topics have been of high relevance for researchers in the field of e-Learning over the past two years and to identify areas for future research.

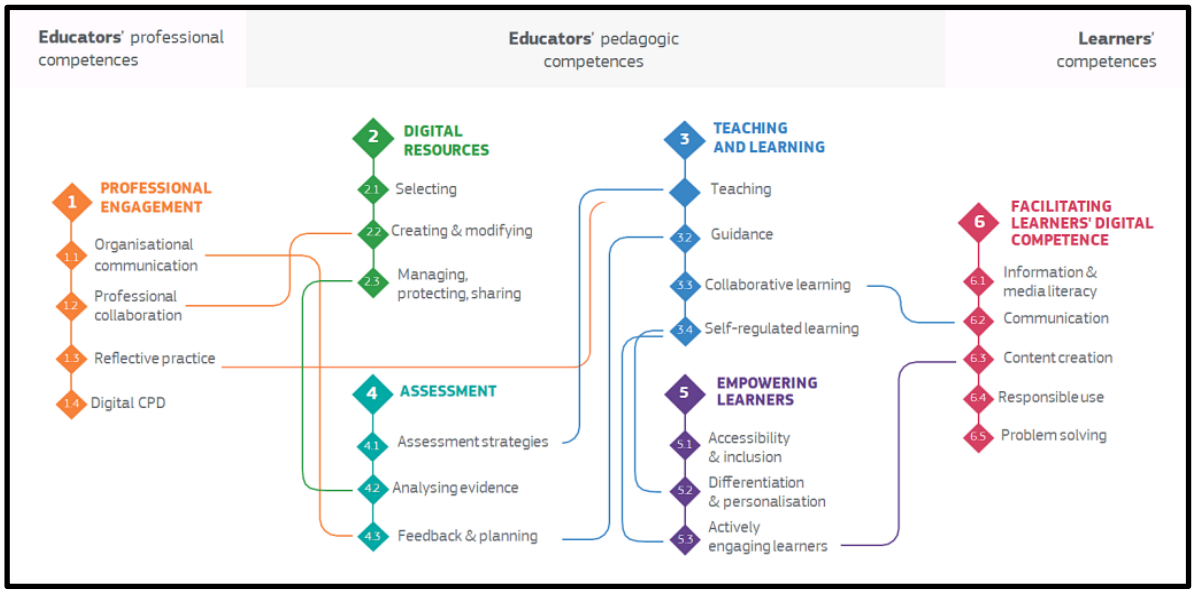
2. Methods

In the first step, we used the Open Journal Systems (OJS) software to identify the 30 most frequently read articles from January 1, 2021, to December 2, 2022 in EJEL. For each article, we considered the total number of abstract reads, full text (PDF) reads as well as the citation data obtained via Google Scholar as of January 11, 2022. Out of these, we focused on the ten most cited papers for our analysis because we emphasize that citations are a legitimate measure for portraying the scientific influence of a given work. The findings from these papers were mapped to the European Framework for Digital Competences of Educators (Figure 1) and to the EDUCAUSE macro trends (Figure 2), as well as trends in key technologies and practices. While macro trends focus on dimensions such as social, technological, economic, environmental and political, the key technologies and practices listed below are believed to have a significant impact on the future of post-secondary learning and teaching (Pelletier et al., 2022, p.4):

- AI for Learning Analytics
- AI for Learning Tools
- Hybrid Learning Spaces
- Mainstreaming Hybrid/Remote Learning Modes
- Micro-credentialing

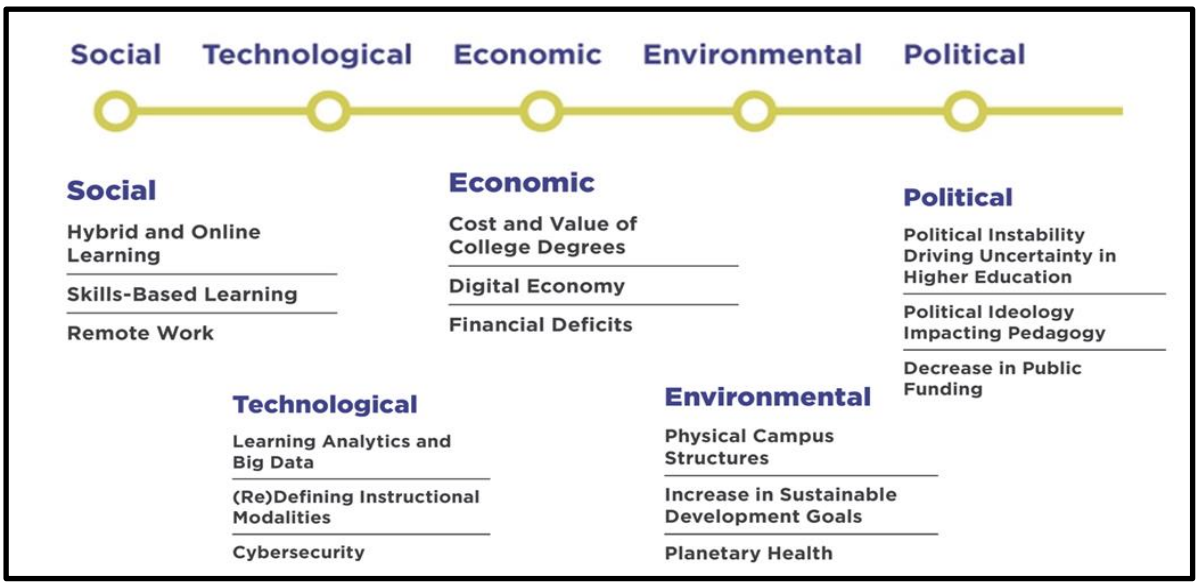
Reference this paper: Charbonneau-Gowdy, P. *et al.*, 2023. EJEL Editorial 2023 – Trends and Research Gaps in e-Learning, *The Electronic Journal of e-Learning, 21(3)*, pp 248-257, available online at www.ejel.org

- Professional Development for Hybrid/Remote Teaching.



Source: First published, in 2017, as "European Framework for the Digital Competence of Educators: DigCompEdu" by the European Commission's Joint Research Centre, EUR 28775 EN, ISBN 978-92-79-73494-6, doi:10.2760/159770, JRC107466, http://europa.eu/!gt63ch.

Figure 1: The European Framework for the Digital Competency of Educators (Redecker, C., 2017)



Source: First published, in 2022, in EDUCAUSE Horizon Report Teaching and Learning by Pelletier et al. (2022) under the Creative Commons licence CC BY-NC-ND 4.0 .

Figure 2: EDUCAUSE Horizon Report: Macro Trends in Postsecondary Teaching and Learning (Pelletier et al., 2022)

3. Results

We start with a brief overview of the 10 most cited EJEL papers (2021-22) listed in Table 1 in alphabetical order.

Table 1: Summary of 10 Most Cited EJEL Papers (2021-2022)

Citation	Population	Phenomenon of Interest	Context
Adzima, 2021	NA (systematic review)	Online cheating	HE
Al Rawashdeh et al., 2021	Students in UAE	Students' attitudes towards online learning	HE
Alsalhi et al. 2021	Dentistry students in UAE	Impact of blended learning on students' achievement	HE
Bumblauskas and Vyas, 2021	Students in Missouri	Application of Problem-Based Learning in an online learning environment	HE
Fauzi et al., 2021	Students in West Sumatra	Factors influencing students' acceptance of e-Learning platforms (Google classroom)	HE & Covid-19
Jdaitawi, 2020	Science students in SA	Links between emotions and learning in a flipped learning classroom	HE
Karasneh et al. 2021	Lecturers in Jordan	Diffusion of innovation/ challenges to online L&T	HE
Li, 2022	1st and 2nd year students in China	Perceived benefits and challenges of online classes	HE & Covid-19
Lin and Nguyen, 2021	International students in Australia	Education equality, accessibility, and inclusion	HE
Metruk, 2021	EFL students in Slovakia	Perceived benefits and challenges in use of smartphones for learning	HE

Adzima (2021) explores academic dishonesty, specifically online cheating, in higher education. It discusses the factors contributing to online cheating, perceptions of cheating among students and faculty, prevalence comparisons between online and classroom settings, and differences in cheating behavior in proctored and non-proctored environments. The paper includes a clear definition of academic cheating and highlights the challenges of monitoring online cheating due to the absence of physical proctoring. The methodology employed a systematic literature review, resulting in 63 relevant articles out of an initial pool of 242. The findings indicate that some students view cheating as a means of maintaining fairness, while others cite time constraints as a justification. The absence of face-to-face contact is identified as a significant factor contributing to online cheating. The author recognizes situational factors and perceptions as influential in dishonest behavior and highlights the need for tailored approaches to address online cheating.

Al Rawashdeh et al. (2021) examine the advantages, disadvantages, and barriers to effective e-Learning in higher education in the United Arab Emirates (UAE). Conducted with a random sample of 100 students from Ajman University in 2018/2019, the survey captures students' experiences and attitudes towards e-Learning. Key findings indicate positive aspects such as increased engagement with course material (81% of participants) and enhanced interactions with peers and teachers (80% of participants). However, students also identified disadvantages, including social isolation (73% of participants) and challenges related to digital illiteracy. The authors emphasize the importance of understanding student experiences to inform educational practices. Practical implications include offering preparatory courses for prospective e-learners and improving resources and infrastructure to support successful e-Learning.

Alsalhi et al. (2021) conducted a study to examine the impact of blended learning on students' achievement. The research employed a quasi-experimental design and involved 116 dentistry students from Ajman University (UAE), who were divided into traditional and blended learning groups. The study's findings provided valuable empirical evidence, indicating that blended learning had a positive effect, especially for female students. These findings contribute to our understanding of the benefits of blended learning in a different context, namely the UAE.

The paper by **Bumblauskas and Vyas (2021)** showcases an example of the application of Problem-Based Learning (PBL) in an online learning environment at the University of Missouri. The authors provide a narrative review of

PBL's motivation, outcomes, and its significance for students' experience and for graduate marketing programs. They describe the collaboration between faculty members and graduate students from business and education fields to develop a web-based simulation, immersing students in a factory environment and addressing a challenging learning topic. The simulation proved to be more useful and productive than the original design team anticipated and has since been scaled for use by other university and industry students. The paper presents a compelling argument for hybrid online PBL learning design, a popular topic in e-Learning.

Fauzi et al. (2021) discuss the utilization of e-Learning platforms, specifically Google Classroom, among university students in West Sumatera during the Covid-19 pandemic. The study aims to identify key factors such as internet facilities, device usage, and knowledge as determinants of online learning. The paper addresses the gap between platform utilization and user acceptance, utilizing theoretical models like the Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB), and the Technology Acceptance Model (TAM) to understand levels of technology acceptance. The paper employs a questionnaire distributed to 383 students, utilizing Likert Scale questions for robust identification. Structural Equation Modelling was used for analysis, revealing that facilitating conditions significantly influenced perceived ease of use and usefulness of Google Classroom. The findings also highlight the importance of available facilities, assistance, and devices for a seamless learning experience.

Jdaitawi (2021) explores the interaction between emotions and learning in science students within a flipped learning classroom context. The quasi-experimental design involved 65 science students from a Saudi university. A comparative analysis was conducted, comparing traditional teaching methods to flipped learning approaches. The study aimed to determine if the flipped learning approach promotes positive learning emotions and which method facilitates higher positive learning emotion scores. The Learning Related Emotions (LRE) scale was used to measure student experiences at the beginning and end of the study. Results indicate a significant difference in LRE scores between students in the flipped learning group and those in traditional classrooms. The flipped learning group had higher LRE mean scores and demonstrated overall improvement. While further research is needed, these findings suggest the advantages of flipped learning in science education.

Karasneh et al. (2021) undertook a study examining the online learning experiences of university lecturers in Jordan during the pandemic, as well as the barriers to its wider adoption post-pandemic. The research involved surveying 508 educators and employing descriptive analysis of the collected data, drawing on insights from Rogers' theory of diffusion. The survey results revealed that despite many staff members considering themselves early adopters and innovators, numerous barriers still hinder the broader implementation of online learning after Covid-19. In addition to the barriers documented in the existing literature, such as limited internet access and disruptions at home, the study also identified gender differences i.e., female staff members reported facing more obstacles compared to others.

In a study investigating students' experiences of online classes during the Covid-19 lockdown, **Li (2022)** conducted an online survey with closed and open questions. The findings were categorized into four main areas: perceived benefits, challenges, student beliefs, and overall evaluation. Overall, students had a positive view of online classes, valuing the flexibility and connectedness they offered. However, challenges such as time management, distraction, assessment difficulty, and workload persisted. Notably, students did not see online classes as adequately preparing them for future careers that involve online interactions. The study emphasizes the importance of focusing on online classes specifically, acknowledging the differences between pre-lockdown and emergency e-Learning. Factors like the digital divide and the need for flexible technical environments, personalized approaches, and student involvement are highlighted. Additionally, the findings suggest a preference for a blended model combining online and face-to-face components in post-lockdown educational settings.

Lin & Nguyen (2021) present an autoethnographic study of an Asian student's experience in an Australian higher education institute during the Covid-19 pandemic. The focus is on the potential of online education to enhance educational equality, which is not supported by this international student's experience. The paper provides detailed insights into the e-Learning approaches adopted by the student. While acknowledging the limitations of studying one individual, the paper prompts researchers and policymakers to reflect on assumptions about online education and the actual experiences of international students. The student expresses dissatisfaction with the e-Learning provided, highlighting the anxiety of connecting online and the importance of the student-tutor relationship. Additionally, the paper emphasizes the need for online educational environments to consider the motivations of Asian students regarding employability benefits and parental expectations.

Metruk (2021) discusses students' attitudes towards smartphones in their English as a Foreign Language (EFL) studies at a Slovakian University. A survey was conducted to gather insights on smartphone usage both inside and outside the classroom. Out of 77 student respondents, the results indicate a generally positive view of smartphones in EFL studies, primarily due to the flexibility they offer for studying anytime and anywhere, supporting student autonomy. However, the survey reveals that smartphones are not considered essential for their studies, with fewer than half using them to practice English outside class. The author highlights the potential benefits of smartphones in EFL, such as the wide range of language learning applications and the connectivity they provide for peer practice. The results suggest that students may not fully utilize their smartphones, possibly due to the overwhelming number of available applications. Therefore, teachers play a vital role in guiding students to maximize smartphone usage for both classroom-based and independent studies.

3.1 Gap Analysis of EJEL Papers: e-Learning Competencies and Trends

The 10 most cited papers in EJEL (Table 1) are addressing a variety of competencies identified in the European Framework (Punie and Redecker, 2017) such as:

- selection of digital resources (Jdaitawi, 2021; Karasneh, et al., 2021);
- teaching (Karasneh, et al., 2021) and collaborative learning (Bumblauskas & Vyas, 2021);
- empowering learners through accessibility, inclusion (Fauzi et al., 2021; Lin and Nguyen, 2021) and active engagement (Bumblauskas & Vyas, 2021; Fauzi et al., 2021; Jdaitawi, 2021, Li, 2022);
- facilitating learners' digital competencies through the development of information and media literacy (Al Rawashdeh et al., 2021; Alsalhi et al., 2021; Metruk, 2021; Fauzi et al., 2021), problem solving (Bumblauskas & Vyas, 2021) and responsible use of technologies (Adzima, 2021).

Notably missing competencies that these papers are not researching are related to:

- professional engagement, in particular more research involving teachers' perspectives;
- creation, modification, management and sharing of digital resources;
- online assessment;
- self-regulated learning;
- differentiation and personalization.

Regarding EDUCAUSE trends (Pelletier et al., 2022), the focus of the EJEL's most cited papers was on social and economic categories, such as:

- mainstreaming of hybrid/online/remote learning modes (e.g., Al Rawashdeh et al., 2021; Alsalhi et al., 2021; Adzima, 2021; Bumblauskas & Vyas, 2021; Jdaitawi, 2021; Karasneh, et al., 2021, Li, 2022; Lin et al., 2021; Fauzi et al., 2021), as well as skills-based learning (Adzima, 2021; Bumblauskas & Vyas, 2021; Metruk, 2021);
- comparing the cost and value of college degrees (Bumblauskas & Vyas).

Therefore, more research aligned with environmental and political issues is needed, including topics such as:

- physical campus structure supporting hybrid learners;
- links between online education, sustainability, and planetary health;
- the impact of decreased public funding and political instability on e-Learning.

Last but not least, additional research is sought on specific new technologies and their applications in education such as:

- AI for learning analytics;
- AI learning tools;
- Micro-credentialing.

3.2 Meta-Analysis Of Review Articles on Online Learning

In this section, we provide a brief review of the most recent and relevant reviews of academic literature on online and hybrid learning to identify clusters of themes in the e-Learning domain as well as areas for future research.

i) The paper by **Zhang et al. (2022)** provides a holistic overview of research that investigated online learning in higher education around the globe during Covid-19. The review article was chosen for its relevance in the current post pandemic era, its global scope, and the insights it offers into our shared realities in terms of research

interest in the field of e-Learning. The authors of the review used co-citation analysis and text mining to analyse the patterns and topics of peer-reviewed papers from 103 countries or regions from the Global North and Global South, published between January 2020 and August 2021. The term *online learning* is equated to *e-Learning*, *distance learning* and *remote learning* and in any cases where the internet is being used for enhancing learning activities – *synchronous* or *asynchronous*.

The focus of the review was on uncovering research and practice trends in online learning in higher education during this period. Their bibliometric analysis methodology involved employing descriptive publication data on authors, institutions, journals, keywords, disciplines, and citations. This data served to generate networking knowledge maps within a research field along with text mining techniques to uncover research themes and promising future research directions (Ziegler, 2009). Using the Web of Science as a data base, their research questions were aimed at revealing global information regarding 1) the geographic distribution of knowledge, the most cited research, and journals with the most publications and 2) the themes that emerged from investigations of pandemic-imposed online learning in higher education. From the 1,658 articles published between January 2020 and August 2021, 1,394 were reviewed (931 open-access, 216 early-access, 246 published in traditional journals and one conference proceeding).

Acknowledging that the prime focus of this EJEL editorial is reporting on themes and research topics, it may be of interest to note that in the interpretation of the results of the review, it was found that 61.96% of the articles emanated from the Global North and 38.04% from the Global South. Also, the review reveals that the US, India, China, Spain, and Saudi Arabia produced the most articles. Of the top 10 journals publishing articles on e-Learning, 7 were educational related. Medical education and chemistry education were the most-investigated disciplines.

Regarding topics and themes, it is important in the interpretation of the findings to keep in mind that the review was conducted on articles that were produced during the pandemic. Seven clusters of themes, sometimes intersecting, and key words associated with the themes, were uncovered. Following is a list of the clusters or themes and a synopsis of key words:

- Mental health – anxiety, digital divide, assessment, inequity, stress.
- Re-designed curriculum – student-centred instructional approaches, collaborative/co-operative learning, hands on learning (clickers, videos and YouTube), professional development and support of faculty in online platforms.
- Technology acceptance and adoption – attitudes and behaviours, ease of use, usefulness, gender-differences, quality, developing countries, self-regulation, mobile learning, motivation.
- Student satisfaction – motivation, self-regulation, social presence, resource-management strategies, well-being, academic performance.
- Multiple technologies and innovations – flipped classrooms, augmented and virtual realities, design and effectiveness, student performance.
- Gamification and digital tools – Zoom, Moodle.
- Community support and barriers - Community of learners, student support, building online communities, equity, digital divide, internet connectivity, access to suitable devices, external distraction, experienced-based strategies.

In discussing their findings, the authors recognize that many of the articles come from less than high impact journals due to the lengthy timelines required for publication in these journals and the otherwise quick turn-around for others. According to the authors, the important implications of their research point to:

- A lack of studies related to *innovative pedagogical practices* and *strategies in online learning* and the *impact of online learning on students with disabilities;*
- *Advances in technology that are outpacing educational research* such as artificial intelligence, micro-credentialing, blockchain and open-education resources;
- An *imbalanced distribution of research between the Global North and Global South;*
- *A need for large-scale research* that explores country-, university-, faculty- and student-level factors that contributes to the effectiveness of different pedagogical practices for online learning.

ii) A review by **Lara, Aljawarneh, and Pamplona (2020)** traces the most recent trends in e-Learning assessment and provides a systematic review of recent topics and contributions within this area of Distance Education. The review highlights the state-of-the-art, frameworks and techniques that research projects of 10 papers report. The papers chosen through a rigorous, peer-review process demonstrate: i) *the implementation of software*

and/or hardware approaches, ii) *a focus on the implications for the improvement of learning assessment,* iii) *a strong grounding in learning theory* and/or rigorous *educational research design*.

Summarizing the top 10 papers chosen reveals the following areas of interest/themes in e-Learning research:

- *Student dropout in MOOC's*: developing an analytics framework for predicting students at risk through the development of a neural network used at various stages of a course and with 88.81% accuracy.
- *Psychological impact of e-Learning*: a positive correlation was found between attitudes towards e-Learning and satisfaction towards life.
- *Playfulness and anxiety in e-Learning systems*: reducing learners' anxiety in using a system is found to be far more important than playfulness in improving learning and students' system skills.
- *Ubiquitous innovative tool use*: current tool preferences – e.g., Moodle over Blackboard, the gains and risks of integrating Web 3.0 tools into 3.0 e-Learning for social learning.
- *Mining for students' self-regulation processes*: connecting students' self-regulation models to success or failure at passing a course.
- *E-learning assessment in other areas than education*: assessing education internalization (tourism) as a predictor of higher education development.
- *Blockchain technology*: the use of blockchain in managing transactions of content, teaching and competencies to close the gap between the academic and work worlds.
- *Web gamification*: games provide instant feedback and are dynamic, motivational and academically encouraging.
- *Connection between engagement and learning design*: using analytics-based interventions to inform designers about adapting learning activities to individual groups of learners' goals.
- *Analysis of prior knowledge*: the merits of analysing prior knowledge at entry levels to reveal gaps and increase competence in online courses.

The authors of the review provide several recommendations for future research in assessment in e-Learning. The recommendations include:

- increased importance given to e-Learning assessment especially in data science projects.
- expanding the horizon of e-Learning assessment beyond formal education to other areas like company learning and tourism learning.
- the ubiquity of calls in education for the need to involve new technologies, like Blockchain e-Learning assessment.
- E-Learning assessment can play a multidisciplinary role in for example Social Network analysis, Gamification strategies and Prior Knowledge evaluation.

The authors recognize the limitations of their review in falling short of reporting on all new advances regarding e-Learning assessment.

iii) Martin, Dennen, and Bonk's (2023) *review of the* Systematic Reviews of Research on Online Learning discusses the state of research in online learning and the need for systematic reviews to provide an overview of the current knowledge in the field. It highlights that tensions and controversies have existed in online education since its emergence in the 1980s and that research has focused on various topics such as Communities of Learning, motivation, interactivity, and assessment. The Covid-19 pandemic has further accelerated the development of online learning and provided new research opportunities. Yet, the article notes that much of the online learning during the pandemic was emergency remote learning and should be considered in context.

The special issue aims to provide a systematic overview of research in online teaching and learning. It features seven systematic reviews and two scoping reviews categorized into three focus areas: *systems* level, *pedagogical* level, and *people* level.

Systems Focus

Within this focus, two reviews are cited:

Doo, Zhu, and Bonk (2023) reviewed 191 articles published during the pandemic and found an increased global interest in online learning research in this period. The authors found a shift in studies from a heavy emphasis on learner engagement and their characteristics to also include *online course development*, the *technology tools and features utilized* in such courses, as well as *instructor training for online settings*.

Wright et al. (2023) reviewed articles to explore the components of high-quality online courses. The most common frameworks used to understand online course quality are cited as: Community of Inquiry (CoL) and more recently Universal Design for Learning (UDL) and Quality Matters (QM). They point out that the themes that arise in research on quality are: online course communication practices, discussion guidelines, appropriate feedback mechanisms, valuable organizational components, and a few assessment considerations for high-quality online courses. Flexibility in course design and delivery, more than one mode of communication between instructors and students, and multiple means of assessment are tied to ways to enhance quality. They call for further research in:

- the *professional development* and *training of instructors teaching via online delivery.*

Pedagogy Focus

The authors looked at 5 review articles within this area. Without citing each of the review articles, the themes covered by the reviews can be categorized into the following: *learner collaboration*, *help-seeking strategies*, *intersubjectivity, passive participation* and *assessment*. Based on the authors' findings, conclusions regarding further research included:

- more generalizable studies rather than case studies related to help-seeking;
- greater research in intersubjectivity as a means to improve practice;
- studies in passive participation to understand its connection to learning outcomes and pedagogical strategies used;
- research that studies various modes, formats, and types of assessment as well as opportunities offered by online assessment for learning, assessing collaboratively and feedback.

People Focus

Learners and instructors and their agency in online courses ultimately determine the outcomes of learning. Considering not only how each performs in class (i.e., outcomes) but also what they bring to, and need from, the online learning experience is critical. Two review articles in this area are cited:

Gardner and Leary's (2023) review of 42 articles focuses on the challenges first-generation and minoritized students face and the supports needed. They categorize the themes uncovered in three areas:

- *learner characteristics*
- *personal environment*
- *course environment*

Ahlf and McNeil's (2023) overview of 52 studies into the moderator's role in asynchronous online discussion provides a taxonomy of roles, underlines the long history of research in this area, the variety of types of research (single case studies, experimental, qualitative in that order), and the importance of the topic in terms of the implications of the roles that moderators assume for successful course designs and outcomes.

More research is deemed needed in the following area:

- *moderators' roles* to resolve and address ongoing discord.

4. Discussion

Tensions that exist in education are at the basis of all research, including in e-Learning research. By reviewing and analysing which research reports in EJEL are deemed of high interest, we gather valuable knowledge about the kinds of challenges that a majority of our readership consider are, or more precisely were, standing in the way of quality e-Learning during the period of 2020 to 2022. Further, if we map these areas of interest in research against frameworks that give a more global picture of trends, or of key interests, including those revealed by reviews in other journals, we can discover valuable information - information about existing gaps that should call for researchers' attention as they consider where to place their efforts in choosing relevant topics to pursue in e-Learning.

It is evident from our analysis that the main concern of e-Learning scholarship and its readership from 2020 to 2022 has been with the satisfaction of learners, based on their experiences in digital spaces. Satisfaction has been measured through researching levels of motivation on the part of learners, their engagement and importantly their feelings/attitudes vis à vis whether these experiences have prepared them in terms of their achieving the essential knowledge needed for the job markets that they will inhabit post formal education. Based

on our analysis also, Interest of scholars and readers around the *how* of learning - the tools used, levels of connectivity, the approaches adopted both in teaching and assessment and the expertise of educators, are viewed as key to learners' positive and inclusive experiences. Surprisingly, while many researchers in e-Learning might argue that the advantages of digital learning have been long ago established, an underlying theme from our analysis suggests that the need to prove technology-based learning's fundamental value to learning is still a trend in current e-Learning literature.

As in all research, and especially in terms of our analysis of interest and trends in certain areas, *context is everything*. It is important to point out that the trends that are revealed in this analysis are seen through the lens of the 43 countries that are represented in the body of literature that was examined. The majority involved studies conducted in the global south. While statistics are unavailable, one might assume that the readership of EJEL, and thus the interest we examined, is strongly represented by that area of the world as well. Another essential consideration is the fact that the period purposely chosen for the analysis lies during an unprecedented event affecting education, i.e., a global pandemic. Judging on the outpouring of research during this timeframe, the choice of and interest in topics of research were no doubt influenced by the fact that the numbers of willing adapters of e-Learning were far-outnumbered by those who were being *forced* by circumstances to pivot to digital learning for the first time. In other words, the results of our analysis must be read with these major contextual conditions in mind.

Comparing the results of our analysis of studies of prime interest in EJEL in the 2020-2022 timeframe with major European and North American frameworks and other leading journal reviews for the same period, can help mitigate these contextual conditions and widen the significance of our findings. Indeed, making these comparisons has led to insights into gaps that exist in current research that, as alluded to above, should be of interest to e-Learning scholars in the EJEL community and more broadly.

For example, mapping the topics of the leading articles from our EJEL analysis to the main categories and subcategories of the European FDCE framework, it is interesting to note that the lead EJEL articles fall under both the Educators' Pedagogical Competencies and Learners' Competencies but *not* Educators' Professional Engagement nor Assessment. In other words, both these latter important topics can be considered gaps in research being produced, or of less interest to the EJEL readership.

Also, performing the same mapping exercise to the North American-based EDUCAUSE framework reveals that the top EJEL articles of interest apply primarily to only one of the trends that, according to the predictions of EDUCAUSE's global committee of experts, will "shape the future of global education teaching and learning" (EDUCAUSE, 2023, n.p.). That trend is the *social* aspects of e-Learning. Yet, topics related to the *technological, economic*, *political,* and *environment*al areas of e-Learning have received much less focus or indeed lack interest in EJEL, especially the latter two areas. The same is true of the technologies and practices that EDUCAUSE cites (see Figure 3) that will have a significant impact on teaching and learning. How can we encourage researchers to diversify towards examining topics related to these important trends, technologies and practices? One response is to feature special issues on such topics.

5. Conclusions

Our analysis has indicated several gaps in the literature that will need to be attended to if stakeholders in e-Learning education are to be well informed and prepared for the evolving realities in this post pandemic period. In our comparison of e-Learning reviews in three other major journals we see similar trends identified. Interestingly, the same themes arise in these articles – the same focus on students' experiences and satisfaction and on the multiple *how* factors – the tools, connectivity, approaches to learning and assessment, expertise of educators, inclusivity issues, the same questions about the acceptance of the value of e-Learning. One review conveniently categorized these trends into *system*, *pedagogical* and *people* issues. At the same time, and not surprisingly, similar indications in these reviews indicate a recognition of the technologies and practices cited by EDUCAUSE as of key importance going forward - AI, blockchain, micro-credentialing, hybrid learning spaces and professional development for these tools and spaces. In addition, the issues related to the *economic*, *political* and *environment*al areas of e-Learning and competencies in the areas of *assessment and professional development* can be identified as gaps in the most cited EJEL publications (2021-2022). Researchers and the journals that support such research cannot fail to see the loud call for investigations in these critical areas. Journals like EJEL concerned with the development of quality e-Learning globally will need to take a leadership role in responding.

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