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Contextualizing Social Media Ecology and Its Pedagogical Affordances: The Perspective of High School Teachers

Wilson O. Otchie, Margus Pedaste, Emanuele Bardone and Irene-Angelica Chounta
Institute of Education, University of Tartu, Estonia
otchie@ut.ee
margus.pedaste@ut.ee
emanuele.bardone@ut.ee
angeliki.eirini.chounta@ut.ee

Abstract: The potential of social media technology has made its use a daily habit among individuals, institutions, and communities. However, several studies on technology adoption, especially social media use in education, focus more on its impact on the student than the teacher, who is generally perceived as a key stakeholder. This study used purposive sampling to select teachers who taught grades 7–10 and had used social media in their teaching activities. In-depth interviews were carried out with participating teachers to get their opinions and perspectives about how they used social media in their teaching activities (N=11). Inductive and deductive coding were used for the latent content analysis and four categories emerged: (1) SM technology in the classroom, (2) positive perceived contextual affordances, (3) negative perceived contextual affordances, and (4) support for social media. Results of the study show that, besides the schools' learning management systems, YouTube was the major SM app that was regularly used by participants in their lessons. Also, all participating teachers expressed their interest in teaching with social media. However, they cited some challenges as weaknesses towards social media use in teaching.

Keywords: social media; ecology; affordances; contextual use; operational use; formal learning; informal learning

1. Background

In recent years, social media, social media technology or social media tools (hereafter SM), has seen an enormous growth in terms of the number of users. In 2019, Facebook had 2.3 billion monthly users whilst Twitter had more than 321 million active users (Statista.com, 2019). Historically, Kaplan and Haenlein (2010) defined SM as "a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, which allows the creation and exchange of user-generated content". However, the continued evolution of SM comes with different user definitions, concepts, and implications (Greenhow and Chapman, 2020; Fox and McEwan, 2017). In the context of this study, we define SM as Web 2.0 internet-based applications that feature user-generated content, profiles for the site or app created by users, and the development of online social networks by connecting a user's profile with those of other individuals or groups within the system Greenhow and Chapman, 2020; Obar and Wildman, 2015). Facebook, WhatsApp, Twitter, Instagram, LinkedIn, Skype, Google Classroom and YouTube are a few examples of popular SM applications (Calvert, 2015). Given the definition of SM, many other tools also fall into this category. Some other technology tools, however, are not so straightforwardly categorized as SM: e.g., activities such as editing a Word file, performing a web search, filling in an assessment, watching a video on one's computer, etc.

Our paper refers to SM as an ecology. The term *SM ecology* emerged from Postman's (1970) definition of media ecology as "the study of media as environments" (Scolari, 2012, p. 205). Essentially, SM applications are never used in isolation; hence, it is worth referring to them as an ecology rather than a collection of separate applications. Thus, this environment comprises all SM networks or applications (Zhao, Lampe and Ellison 2016). For instance, Facebook, which is an application in the ecology, occupies a specific niche but interrelates with other applications within the ecology. Consequently, these applications and services have implications that could be political, social, educational, or economic.

SM has the potential to be used in different contexts, and this attracts growing interest in diverse disciplines. Many corporate organizations, communities, individuals as well as some students and their teachers are already using it in their own contexts (Raut and Patil, 2016).

Essentially, SM has become a ubiquitous toolkit that is used daily among individuals, and largely with the young adult population (Al Alwan et al., 2017; Dwivedi et al., 2016; Kapoor and Dwivedi, 2015); but most importantly,

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it has an impact on where or how people learn (Greenhow, Robelia, and Hughes, 2009). Thus, SM facilitates social, active, and interactive learning, which supports the social constructivist theory of learning (Vygotsky, 1978).

For example, in many universities and colleges, SM is used for institutional programmes and activities (Sudha and Kavitha, 2016) as well as for social interaction (Alt, 2017). The drive and enthusiasm by educators and researchers towards accepting SM as a potential pedagogical resource has not come as a surprise. According to Silius, Kailanto, and Tervakari (2011), SM facilitates learning and makes it possible for students to actively participate in online communities by creating, communicating, sharing educational resources, and sharing opinions (Cronje, 2020; Karkar, Fatlawi and Al-Jobouri, 2020; Kibuku, Ochieng, and Wausi, 2020). It also empowers students to connect, thus facilitating the establishment of online discussion groups. Another advantage that could potentially be pedagogical is the ability to reach global audiences much faster. Also, one needs only a digital device (desktop, laptop, or smartphone) and internet service to access SM. Furthermore, SM is user-friendly and self-scaffolding; thus, one does not need to be highly skilled to use it. Additionally, it is very interactive and can be easily accessed anywhere and anytime, which removes the barriers of space and time (Cronje, 2020). These perspectives were also amplified in a study where Manca and Ranieri (2013) discovered that teachers use SM to engage students through online group discussion, interaction, and information dissemination. Also, in a related study, Ramstad and Swenson (2017) investigated how SM impacts students' classroom participation. Thus, many stakeholders in education and the research community have seen SM as a valuable option because of its potential pedagogical affordances (Sudha and Kavitha, 2016). In essence, SM has created a learning environment where there is a diversity of learning options, such as lifelong learning, formal learning, informal learning, etc. (Greenhow and Lewin, 2015; Peters and Romero, 2019)

It is very important to mention that originally most SM applications were not designed for pedagogical use; nonetheless, teachers are appropriating them in the context of teaching and learning. Although SM technology use in the classroom is potentially student-centred and constructivist-driven, teachers are yet to discover the best way technology tools can help them effectively achieve their pedagogical objectives (Kopcha et al., 2020). Incidentally, this has ignited interest in the study into SM use in education (Van Osch and Coursaris, 2015).

Literature shows a number of reviews on the generic use of SM in education (Fox and Bird, 2017; Rodríguez-Hoyos, Haya Salmón, and Fernández-Díaz, 2015), educational affordances of Facebook (Barrot, 2018; Chugh, 2018; Manca and Ranieri, 2016; Manca and Whitworth, 2018; Nui, 2017; Voivonta and Avraamidou, 2018), Twitter as a potential pedagogical tool (Gao, Luo, and Zhang, 2012; Tang and Hew, 2017), global outlook on SM literacy development (Manca, Bocconi, and Gleason, 2021), and professional development using SM (Bruguera, Guitert, and Romeu, 2019; Lantz-Andersson, Lundin and Selwyn, 2018; Macià and Garcia, 2016).

Other studies have tried to establish a connection between formal and informal use of SM in the context of learning ecologies (Greenhow and Lewin, 2015; Peters and Romero, 2019). According to Greenhow and Lewin, SM has the potential to bridge the gap between formal and informal digital literacies. This was supported by Peters and Romero, who argued that learning opportunities are accessible across learning ecologies (formal and informal) through digital resources. Essentially, digital literacies (e.g., skills and competencies) that teachers and students bring into the classroom are a result of informal learning. For instance, the skills of using smart digital devices and most applications including SM are most often acquired outside the classroom. However, these skills directly contribute to using SM technology in the context of formal learning. In this regard, informal learning, which is more experiential, practical and skill-driven, could potentially bridge the gap in articulating the contextual use of SM in education.

Indeed, a few studies have focused on secondary education use of SM in the context of K-12 education: for example, studies showing pedagogical use of SM in general and specifically Facebook in K-12 formal learning and their effectiveness at improving students' learning (Alias et al., 2013; Greenhow and Askari, 2017; Veira, Leacock, and Warrican, 2014) and SM features having more affordances for teachers to achieve their objectives in classroom teaching and their professional development within the formal and informal learning context (Greenhow et al., 2020). Also, a review has been done by Greenhow and Askari (2020) on high(secondary) school students' integration of the distinct and complex literacies they acquire from SM into the formal learning context.

However, regardless of the relatively small number of studies on SM educational use in high schools (or secondary schools) for learning, the general outlook of research on the educational use of SM concentrates more on university education and professional development. Similarly, these studies do not give us a straightforward answer as to the way to go, especially in teaching with SM in high schools (see Otchie and Pedaste, 2020).

In the literature, we also find a polarization between studies looking at SM as a potential pedagogical tool and those that see SM as a mere distraction (Otchie and Pedaste, 2020). In order to try to bridge the gap, the first step to make is to disambiguate the amorphous term *use of SM*. In other words, we claim that failing to disambiguate the term *use of SM* may lead to the aforementioned gap and consequently the impossibility to reach a better understanding as to how SM can be used for and in education.

To this end, the first step we make is to review the literature on the affordances of SM and then to present a theoretical framework based on the distinction between operational use and contextual use of SM, within which the concept of affordance is used to specify how teachers' meaningful use of SM comes about. Subsequently, we put this framework and related theories to use by looking at the way in which high(secondary) school teachers articulate the contextual use of SM in their own teaching practice.

Therefore, what we are focusing on is the experiences and perspectives of teachers' contextual use of SM in teaching across some selected high schools in Estonia.

Framing the narrative around teachers in Estonia is not a coincidence; rather, this was due to the perceived high degree of technology tools use and its appreciation in Estonia (OECD, 2014). Furthermore, since teaching and learning technically involve a teacher and a student, it is very important to closely look at how their roles in using SM contextually or otherwise affect the teaching and learning process. Therefore, the purpose of this study was to explore the way teachers articulate the use of SM in their own practice.

2. Literature review

Gibson's (1979) ecological meaning of affordances is reflected in our ability to use tools effectively. According to Gibson, affordances refer to the environment's "action possibilities" for the user. On the other hand, Norman (1988) considers affordances in terms of perception. Thus physical and perceived affordances respectively. According to him, physical affordances are what an object can genuinely do in terms of its physical properties. However, perceived affordances are the things we believe the object can be utilized for. As a result, Polanyi (1962) takes a distinct approach to this. Effective tool use, he believes, is a set of hidden abilities which he termed *tacit knowledge.* Relationship is the unifying thread that runs across all of their beliefs, regardless of their varied perspectives. Our ability to efficiently use any tool is largely dictated by our relationship with it. As a result, our repeated interactions with tools provide us with more experience, which may contribute to the formation of our perceptions about the tool.

So, the concept of affordance in terms of our relationship with tools is seen as very critical and equally important for developing teachers' understanding about meaningful technology use in teaching and learning (Angeli and Valanides, 2009; Krauskopf, Zahn and Hesse, 2015). The ease of use and interactive affordances of technology tools help teachers with some technical knowledge and skills to operate these tools to identify and familiarize themselves with its functionalities which Bernhard, Recker and Burton-Jones (2013) termed technical affordances or, to use our own terminology, operational affordances. However, previous studies have failed to give a clear account of how this could lead to learning (Oliver, 2013). Indeed, this unambiguously supports the fact that we do not really understand how teachers perceive and actualize these affordances in a tool (Angeli and Valanides, 2018). However, we do know that teachers can begin to meaningfully teach lessons with SM, and this is possible when teachers can integrate tacit knowledge to technological knowledge (operational skills), content knowledge, and pedagogical knowledge (Mishra and Koehler, 2006). Therefore, a better understanding of the concept of affordance and its relationship with teachers' knowledge development could help in training teachers to meaningfully and effectively use SM in their lessons (Haines, 2015). The differences between the operational and contextual levels are summarized in Table 1.

Meanwhile, other scholars perceive affordance in SM from the social constructivist perspective: As an active social learning platform that allows learners to construct knowledge and to make learning more interactive and student-centred (Manca and Ranieri, 2013; Siemens and Weller, 2011). As learning becomes more social,

pragmatic and interactive, social constructivism tries to advance social interactions between students where the focus is on construction and sharing of knowledge (Vygotsky, 1978). Digital technology, therefore, gives access and leverage to free online learning resources, which have largely boosted students' interest and capacities to construct and share knowledge regardless of social or geographical isolation (Greenhow and Chapman, 2020). This was highlighted by Jonassen, Carr, and Yueh (1998) in the statement "Technologies should not support learning by attempting to instruct the learners, but rather should be used as knowledge construction tools that students learn with, not from." (p. 24)

The value of SM also lies in its affordances as a tool that updates the entire community including students and their parents about activities in the classroom (Manca, Bocconi and Gleason, 2021). The pedagogical potential of SM lies in the fact that it supports collaborative and active learning, is relational and contributes to social and civic participation among others (Galvin and Greenhow, 2020; Greenhow and Chapman, 2020; Manca, Bocconi and Gleason., 2021). Here, Gibson, Norman and Polanyi hold the same views on the importance of relationships when it comes to active learning or constructing knowledge.

In looking at this study through the ecological learning concepts, we then situate SM as a tool that has the affordance for diverse options of learning. A learning ecology comprises a set of contexts and interaction processes used in physical or virtual spaces that provides learning opportunities (Barron, 2004). It also gives students diverse experiences outside real life (Mar and Oatley, 2008; Merkt, 2014). Learning ecology is a new approach to learning which uses technology to scaffold learning. For example, informal learning, formal learning, lifelong learning and professional development are all options that could potentially be conducted through virtual spaces using digital tools.

This learning approach has a very important and interesting link to this study. On the one hand, it allows learners to freely access active and interactive learning through informal means. Thus, connecting the concepts of relationships to the construction of knowledge in understanding one's environment. In this whole process the learner (user) is directly and actively immersed in the knowledge construction process. On the other hand, it promotes skills development, experiential learning, critical thinking, and other tacit knowledge dimensions. Thus, it becomes imperative for teachers to build relationships with technologies to understand using them in the context of teaching and learning (Oliver, 2016; Stevenson et al., 2019). This could potentially bridge the gap between formal learning and other dimensions of learning. So, we find all these concepts more or less interrelated and directly playing out in the context of articulating SM technology in any form of learning.

Ultimately, the challenges of inadequate technological support and access in schools cannot be underestimated (Rasheed, Kamsin and Abdullah, 2020; Taghizadeh, and Hasani Yourdshahi, 2020). According to Kerckaert, Vanderlinde, and van Braak (2015), teachers' interactions with technology, their understanding of technology, and their pedagogical knowledge can all affect how they use technology in their classrooms. Essentially, teachers must be trained to consider the relationship between operational use and using technology in different contexts as part of their professional development programs in technology. As a result, it is very important that stakeholders provide all educational institutions with technology resources and adequate funding (Dillenbourg, 2008; Taghizadeh, and Hasani Yourdshahi, 2020). Aside from all of SM's potentials, stakeholders' views on it as a pedagogical resource are mixed. Thus, regardless of its pedagogical potentials, some stakeholders still regard SM as a learning distraction (Otchie and Pedaste, 2020).

Table 1: Differences between operational and contextual levels

Operational level	**Contextual level**
Functionalities are operated	Affordances are perceived in the context
Technology as designed	Technology as in use
The use is identified prior to use	The use is defined by the users
Technology is separate from us	Technology is put to use and thus becomes part of one's cognition
Operational functions predefined	Polysemy of use (the use is open)

Proficiency use can be defined and thus assessed objectively	Building relationship with the tool is key to exploring pedagogical affordances

3. Theoretical Framework

Several scholars have approached SM use in education from diverse theoretical models (Manca, Bocconi, and Gleason, 2021; Peters and Romero, 2019; Stevenson et al., 2019; Stewart, 2015). However, this study uses Gibson's ecological model, Polanyi's indwelling concepts, and constructivist and learning ecological concepts as a lens to have a worldview of SM use in education.

Theoretically, *affordance* is key to understanding the distinction between the operational and contextual use of tools, and it holds a fundamental place in this paper. The term was coined by Gibson (1986) to refer to what the environment provides the agent inhabiting it in terms of "action possibilities". Gibson's ecological concept of affordances therefore gives us an idea about how relationships facilitate our understanding of our environment. According to him, our ability to discover these affordances depends on our relationship with the environment.

Norman (1988), the first to incorporate affordances into design research and human-computer interfaces (HCI), takes a different approach. According to Norman, the term affordance refers to an object's perceived and actual features, particularly those that define how the object is utilized. A chair, for example, provides ("is for") support and hence allows for sitting. A chair can be carried as well (Davis & Chouinard, 2016, p. 243; Norman, 1988, p. 9). Real affordances, according to Norman, are the functions of an object, or the potentials that the object provides. For example, a chair is used for sitting. Perceived affordances, on the other hand, are those aspects of the item that the user is aware of. For example, a chair could be used not only for sitting but also like a ladder for climbing to pick something on very high shelves. Regardless of the many points of view, the concept of affordances is applicable across disciplines, is widespread in many research, and is based on relationships.

So, in order to understand how to support and promote the use of SM in teaching and learning along with its drawbacks, we posit that it is of fundamental importance to introduce a distinction, which helps us disambiguate the term *technology use in education*. This can be achieved when we theorize the use of technology in teaching and learning (Oliver, 2013), that is, when we conceptually articulate the way in which we establish a relationship with our tools.

Generally speaking, when we describe technology use in teaching and learning, we tend to conflate two meanings that the term *use* may come to acquire, which might be an obstacle to fully understand the potentials that SM has for teaching.

In this paper, we introduce the distinction between *operational use* and *contextual use*, which we derive from Michael Polanyi's seminal work. In his *The Tacit Knowledge* Polanyi argued that at the phenomenological level we can identify two distinct ways in which we can interact with a tool. Firstly, we propose the term *operational use* – this is the situation in which the tool confronts us as an object, entirely separate from us since it has not yet been put to use. The example that Polanyi brings is that of a person who, while grabbing a stick, can only feel "its impact against his fingers and palm" (Polanyi, 1962). Secondly, what we propose to call *contextual use* refers to the experience in which the tool is no longer separate from us but has now been put to use, thus becoming part of ourselves. This means, to resort to the same example, that the stick is now used as a probe to reach objects that could not be reached otherwise. In Polanyi's own words, "our awareness of its impact on our hand is transformed into a sense of its point touching the objects we are exploring" (Polanyi, 1962). This implies that the relationship established with the tool is such that the tool itself has become part of our cognition. Polanyi described this process as "dwelling in the tool", and it is at the basis of any process in which our ability to act in the world is distributed across tools, thus extending our cognition (Clark, 2003).

Since a tool is defined by its functionalities, which can be determined prior to its use, it follows that proficiency of use can be objectively assessed by looking at the degree of control that the user exhibits over the functionalities of the tool that is being used.

As mentioned above, when moving from the operational use of a tool to its contextual use, the term *use* comes to refer to a different type of relationship with the tool – the one in which it becomes a sort of extension of

oneself and therefore of one's cognition, adding new capabilities to one's own cognitive repertoire (Bardone, 2011).

The first consequence that we can draw from this is that the tool is re-described depending on the context of its application. Such re-description, albeit not free from constraints, is driven by perceived affordances, which hold the key to understanding the distinction between operational and contextual use of technology tools. So, a chair affords sitting and stairs afford climbing (Gibson, 1979). It is worth stressing that an affordance should not be mistaken for the functionality of the tool at hand. That is because the very nature of an affordance is ecological, which means that an affordance points both ways, to the environment, and to the agent (Gibson, 1979).

It follows that, to a certain extent, the tools at hand are not merely used but appropriated and re-appropriated (e.g., Bardone and Shmorgun, 2013; Derboven, Geerts and De Grooff, 2016; Salovaara, 2012). This means that the teacher will situate the tool at hand in his/her own context. Besides, the use of the tool cannot be determined prior to its use (Aagaard, 2017; Hamilton and Friesen, 2013). This means that contextual use is characterized by a certain degree of openness. The use of the tool is, in other words, polysemic or open.

The same tool can serve different purposes, and this depends chiefly on the context in which the tool is situated. As Melvin Kranzberg (1986) once put it, "Technology is neither good nor bad: nor is it neutral."

4. Aims

In terms of operational use, SM is defined by its functionalities as built by the designer (e.g., functionalities for typing and editing texts, creating graphic images, videos, etc.) to facilitate its use in a virtual environment. However, when it comes to using it in a context, then affordances are perceived only by the user and the specific purpose of use. So, in the case of pedagogical affordance, a teacher adapts, for example, a YouTube video on the Solar System to teach a physics lesson about how the Earth and other planets revolve around the Sun. Here, the teacher ensures that the video is relevant to the lesson and it is not too long in order to stimulate interest among students. Also, it has some practical implications. Therefore, it is important that we involve teachers because at the contextual level (in a pedagogical context), the affordances are rooted in teachers' perception. Hence, the aim of the study is not to have a large sample of teachers but to show the evidence of the existence of two different types of educational use of SM and this could be done using only few teachers. So, in our interview with teachers, we wanted to find out how their relationships evolve around SM pedagogically.

4.1 Research Questions

The following research questions were outlined to meet the aims of the study:

1. How do teachers articulate their use of SM in education operationally and contextually?
2. What makes SM a pedagogical tool for teaching and learning?
3. What does not constitute pedagogical use of SM in the classroom?
4. What kind of support do institutions provide towards SM use in education?

5. The Methodology of the Research

5.1 Sampling and Participants

Purposive sampling was used to identify and select teachers who have the skills and knowledge about SM and have used it in their teaching activities (Aguinis and Lawal, 2012; Creswell, 2013; Teddlie and Yu, 2007). The selection process involved teachers who taught high(secondary) school grades 7–10 (children aged 13–16) across Estonia and who had at least one year of teaching experience with SM. Emails with cover letters and consent forms were sent to participants requesting their consent and explaining their rights as participants in the study. After obtaining written consent from participants, a pseudonym was assigned to each of them to maintain their anonymity (Creswell, 2013). One limitation in sampling was teachers' readiness to have the interview in English (most teachers teach in Estonian, but the researcher conducting the interviews did not speak Estonian).

In any qualitative study, there is a possibility that a researcher's background, interest, role as well as his/her experience will affect the whole study, in particular the data collection and analysis (Creswell, 1998; Sword, 1999). While such influence is inevitable, it is important to situate the study explicating the roles played by the different authors of the paper so as to increase their reflexivity (Horsburgh, 2003). The first author conducted the data collection and led both the design of the study and the data analysis. The first author is an experienced

high school teacher with over 20 years of experience. The other authors were involved in the design of the study and data analysis. Thus, the mention of a researcher's reflexivity in terms of interest, role, biases, and philosophy might give the reader some ideas about their expertise and how these could indirectly impact the study

5.2 Data collection and analysis

A semi-structured interview protocol by LeCompte and Schensul (1999) for the qualitative study was modified and reviewed by experts before it was used for the interview (see Appendix I). Semi-structured interviews allow teachers to be heard (Flick, 2006) and are also suitable for studying teacher cognition (Adamson, 2004). The interviews were carried out in a period of four months (May–September) in 2019 and were aimed at getting a close-up on teachers' experience and perspectives about teaching with SM in their respective schools. The purposive criterion sampling helped to obtain and record evidence-based practices of teaching with SM. Hence, participants were selected according to the following criteria: nature of the participant's work, experience of teaching with SM (at least one year of teaching with SM was required), and the consequences of teaching with SM. Finally, eleven teachers were selected. All eleven participating teachers were selected from the public and private high schools in Estonia. The sample consisted of eleven teachers teaching biology, mathematics, physics, English, English literature, and arts in grades 7-9. Ten (90%) participants were female teachers while one (10%) was male. In terms of teaching experience, seven participants (64%) had 10–35 years of experience and four (36%) had 2–9 years of experience (see Appendix II). Participants were given the option to select their interview setup preferences from a list of interview categories. While two participants opted for face-to-face interviews, the rest settled for an online video interview mediated by Zoom (https://www.zoom.us/). All interviews were video-recorded and notes were taken in some instances. Participants were asked open-ended questions to elicit an explicit perspective on their experiences in teaching with SM (see Appendix I).

We used latent content analysis. It is a systematic process of coding large amounts of textual information. The latent content analysis seeks to establish trends and patterns in the words used, their frequency, their relationships, and discourses in communication (Creswell, 2013). It is also a tool for research analysis because it aids in the reporting of common data issues (Vaismoradi et al., 2013). We adopted latent content analysis because we wanted to examine the document's content and explain its characteristics.

So, we gave an overview of the data by inductive and deductive coding. Subsequently, we highlighted all meaningful sentences, words, extracts (from sentences) that contain some relevant and critical information on a participant's experience with SM. These codes were later organized into categories. Then we combined the highlighted statements and organized them into sub-categories, hence creating a collection of meaning and eventually became the topics. Based on the research objectives, four main categories (topics) emerged from teachers' teaching experience with SM (see tables 2–5).

6. Findings

All the participants (teachers) whom we interviewed gave a lot of positive and encouraging perspectives about using SM in teaching. In sharing their thoughts and perspectives, participants presented the professional use of SM from the classroom context. Again, they highlighted the advantages and constraints they encountered in using these tools during their line of duty. The following are the thoughts and views presented which constituted the categories that emerged from our analysis.

6.1 SM Technology in the classroom

Here, teachers integrating technology into the classroom were observed from two conceptual levels: the operational and the contextual level (see Table 2). Generally, teachers use SM technology in many ways (operational and contextual) to enhance their teaching and learning activities. Through SM teachers can seamlessly pass on information to students, store and access learning resources and make the learning process more collaborative and interactive.

Specifically, at the operational level, we noticed that teachers' focus was on using the operational affordances in the tool for sharing, managing, and accessing learning resources. Thus, SM provides students with the opportunity to safely keep their lesson materials in electronic folders for easy access, sharing, and retrieval. This is possible through links to learning resources and multiple learning platforms, which students frequently use since it gives them a diverse range of experiences. Essentially, SM technology allows students to access their

saved lesson files anytime and anywhere, thus enabling those students absent from school to follow the lessons remotely (see Table 2).

However, at the operational level, all these activities are not pedagogical, but they are part of the affordances as designed and not context-specific.
Meanwhile, at the contextual level, we have noticed that teachers have gone beyond the operational affordances. Here, they make meaningful use of the SM technology in the context of their teaching and learning, thus making learning more interactive and informative (see Table 2).

Consequently, using SM technology in this context is perceived as pedagogical because the teacher was able to apply his/her pedagogical and content knowledge to bear on the selection of the video. This means that he/she did not just share any video on the lesson but critically assessed its relevance in terms of content, volume and impact it would have on the learning process. Besides, the teacher was able to ask the students some questions as a task to elicit their feedback as well as help with his/her own reflection.

Table 2: SM technology in the classroom

Sub-Category	Result	Extracts
Operational level	Storage, sharing and retrieval of materials	*any activity with Facebook can be easily saved, downloaded or shared, and it is visible to the members of the group … and it is all in the same place.* (Jane)
	Information	*students can search for information with YouTube so quickly to do their assignments.* (Triin)
		I also use Google Classroom to give links and other resources to my students to use in their work. (Evelin)
	Access	*one good thing about SM is that the student always has access to lessons materials later or if students forget something at home, they can use the links and download it from the Google Classroom.* (Gerli)
Contextual level	Interactive learning	*My students watch a YouTube video to see how the bonds in the double helical structure of DNA are formed …very interactive, interesting, and revealing.* (Kaja) *I select, for example, a short YouTube video on the Solar System during a physics lesson which the students observe how the planets revolve around the Sun...and then they answer some questions in their workbooks.* (Kristjan)
		the students watch YouTube video during a lesson to hear how some scientific words in biology are correctly pronounced. (Triin)
		I like to use more of SM apps, e.g., Twitter as a class account so that we can learn as a class of how we can convey information, who we make it visible to and how we make sure it's credible. (Zara)
	Information	*My students take pictures of frogs with Instagram to show all the observable characteristic features on frogs during a biology lesson. (*Zara)

6.2 Positive perceived pedagogical affordances

Positive perceived pedagogical affordances of teaching using SM are divided into sub-categories such as management of resources, flexibility to learn, participation in learning, and availability of resources (see Table 3).

These are affordances that are purposefully and directly linked to ensuring a positive perceived pedagogical outcome. The highlights include making learning less stressful and interesting through easy access to information and interactive learning resources. Also, the fact that students could remotely collaborate and communicate through interactive informal learning protocols outside the classroom format makes learning with SM innovative and diverse because it comes with multiple learning options and opportunities.

Table 3: Positively perceived pedagogical affordances

Sub-Category	Result	Extracts
Flexibility to learn	Availability of teaching notes	*when a student misses my lesson or cannot understand, he can go to check at home or read what others have done and do it later* (Kristjan)
Communication	Online discussion	*some students use SM to contact me and ask more questions to understand a concept or share idea on a topic* (Katarina)
Interaction	More student activity	*the fact that more students contribute in the lesson.* (Triin)
Availability of resources	Access and variety of learning materials	*There are many good YouTube videos on math and English.* (Evelin)
Sharing of T/L resources	Current learning resources	*you can use the latest materials. So today instead of a textbook, I would look at the Notre Dame fire because it happened yesterday.* (Aivi)

6.3 Negatively perceived pedagogical affordances

This is the category for using SM for anything other than for learning or teaching (see Table 4). These are affordances that may be beneficial to the user but are ineffective in the sense of pedagogical context. They are regarded as negative pedagogical affordances because they produce no positive pedagogical outcomes. Some texts or websites that students access in a class, for example, are distracting and divert their attention away from the lesson. While these benefits may temporarily satisfy a student's curiosity, they are viewed negatively in the pedagogical sense, that is, not relevant to lesson being taught in class.

Teachers are not immune to the negative effects of these pedagogical affordances. They're also worried because they're still having trouble with knowledge and time management: for example, teachers must be able to pick appropriate videos and other multimedia resources for a lesson within a certain amount of time. To put it another way, they are entangled in a web of choice and time.

Table 4: Negatively perceived pedagogical affordances

Sub-Category	Result	Extracts
Students' concentration	Distraction by adverts and messages	*So, if you set them a task, they wander off to some other page or get this practice by a message coming from somebody else.* (Katarina)
		Sometimes students get carried away when using SM... they sometimes look at the pages they're not supposed to. (Gerli)
Time management	Time overlap	*Using FB class group, it looks like my work time and free time is mixed.* (Mirjam)
	Information choice	*Sometimes I get carried away when preparing the lesson because I have difficulty in managing a lot of information.* (Evelin)
Students' conduct	Cyber-bullying	*One negative thing is internet bullying... what is going on I cannot see if I sit in the classroom.* (Kristjan)

6.4 Support for social media

This study looks at how educational institutions contribute to using SM technology and other interactive digital environments in teaching and learning. Institutional support for SM use in schools comes with infrastructural development and staff training (see Table 5).

In terms of infrastructural development, all our participants had all the required technological infrastructure in their schools. According to them, they had very good and fast internet with strong Wi-Fi, availability of tablets for both teachers and students, modern computer labs, and other digital tools such as whiteboards and overhead projectors. Some of them had educational technologists in their schools who helped with issues in the context of digital teaching resources. They also had periodic training workshops in ICT and most importantly, all

teachers were given the freedom to use any digital tool they found good and relevant to their lessons. In addition, we know that 97% of students in that age group had already in 2016 the possibility to use their smart phones for learning (see Pedaste et al., 2017). This gives teachers the leverage in terms of competence and confidence in using technology to teach.

Table 5: Support for social media

Sub-Category		Extracts
Infrastructural development	Provided resources	*Every teacher has access to a separate computer, and we have tablets and laptops for students.* (Kristjan) *Management is very fond of people (teachers) bringing in technology to classes so they're encouraging any use of it (social media).* (Kaja) *All students have computers... and assigned laptops in class. The school also supports BYOD*.* (Mirjam)
Staff development	Provided training	*A regular training on how to teach with technology is provided and we find it very useful.* (Kristjan)
	ICT workshops	*The school supports teachers to participate in ICT workshops in Estonia.* (Evelin)

*BYOD: Bring your own device

7. Discussion

This study was meant to illustrate concretely the distinction between the use of SM in teaching in terms of operational and contextual use with some practical examples. So, we explored how teachers articulate their teaching experiences with SM in terms of its perceived pedagogical use within the context of teaching in high schools. Then, we carried out in-depth interviews with participating teachers in order for them to describe how they operate SM ecology, how they use it pedagogically, as well as their perspectives and challenges, if any. Subsequently, we have four categories to help address the research questions in the study.

First, in trying to address the ambiguity surrounding the use of SM in education, we theorize about teachers' relationship with technology by resorting to the distinction between operational use and contextual use, which is chiefly rooted in Polanyi's and Gibson's contribution.

For instance, at the operational level, SM has been predefined and therefore a teacher could determine what to do with it based on its functionalities and limitations. This was revealed in the findings where some teachers see SM as a tool that helps them to download and share learning resources to their students. This is what Norman (1988) calls perceived affordances. However, at the contextual level, the use is open and subject to the user's relationship with the technology(tool) and the contexts. Hence, the user is responsible for deciding the contexts in which to use the technology, and this goes beyond its operational limitations. So, in order for a teacher to contextualize SM pedagogically, he/she needs to dwell in the technology as Polanyi describes it, to be able to perceive these pedagogical affordances.

Affordances are grounded in perceptions (Gibson, 1986), and as Barsalou (2015) explains, perceptions could be likened to a force that detects and picks useful hints from the environment to help one's actions. In our quest to integrate technology into teaching, it is important to acknowledge the role of our perceptions in this context. Perceptions are dynamic processes that afford, for instance, teachers to try new things, experience emerging technologies, test new concepts, and develop new strategies and ways to solve emerging problems (Hamilton, Rosenberg, and Akcaogluet, 2016; McKenney and Roblin, 2018). Hence the decisions we make are reflections of our experiences in the environment (Kopcha et al., 2020). This supports Gibson's affordance concept, which is of the view that, the way we think and react is a reflection of our experiences with people and objects in our surroundings.

In essence, perceptions could be influenced by a teacher's experience with technology (Kopcha et al., 2020). Meanwhile, experiences could have direct links to a relationship with technology and regular interactions with the technology. This means relationships produce experience. For instance, a negative experience with technology constrains one's perceptions about possibilities in the technology, while a positive experience with technology boosts one's perception about the potential and possibilities offered by the technology. This means a teacher's positive encounter with technology could result in a positive experience and positive perceptions

which could potentially lead to meaningful use of technology in the context of teaching. A teacher must establish a relationship with technology in order to gain experience. In so doing, the technology becomes part of their cognition and potentially enables them to perceive most of the pedagogical affordances to be able to contextualize its use. This will potentially help to maximize SM use in teaching and perhaps minimize the perceived risks.

So, at the operational level, SM use was basically as it was designed by the software developers and therefore the operational affordances (functionalities) already exist with the application (Angeli and Valanides, 2018). Here, teachers try to gain control of its functions and to establish a basic relationship with its operations. As has been revealed in the findings, at the operational level teachers use SM to basically communicate, share information, post or review contents, make friends, or watch trending news, among others. More so, it affords teachers to add or delete text, share photos, videos, blogs, etc. As we have seen, the teachers' focus is more on how to acquire the operational skills and competencies to enable them to use the tool as designed, which is undoubtedly very important and necessary (Bernhard, Recker, and Burton-Jones, 2013; Norman, 1988).

That is why a few teachers' responses indicate that SM is basically a tool for connecting students and sharing learning resources in a more conveniently seamless manner. Nonetheless, most of the teachers regard SM as a tool that has the affordances to teach from a student-centred perspective, where they deliver lessons using interactive YouTube videos through a collaborative and active learning approach. This supports studies that view SM as an interactive and student-centred platform (Manca and Ranieri, 2013; Siemens and Weller, 2011; Vygotsky, 1978).

However, unlike operational use, there is no clarity on how a teacher transitions into acquiring contextual skills and competencies in a tool. Following Polanyi (1962), we may argue that the process of acquiring such skills and competence is rooted in the development of tacit knowledge, which is personal and experiential. So, contextual affordance is characterised by a degree of openness and it allows the users to determine the context; thus making the contextual use more uncertain, unstructured, and tacit, because it can go either way, either for good or ill (Gibson, 1978)

Angeli and Valanides (2018) observe in their study that affordances concern the process of thinking creatively about how one can transform the operational affordances of a tool into pedagogical (contextual) affordances to bring about goals. Operational affordances alone cannot do that. So, the need to innovatively integrate operational skills with experience to achieve a pedagogical impact. Our introduction of the terms "operational and contextual affordances" is a step to understanding the nuances in effectively using technology.

For example, teaching a lesson on the solar system using YouTube video. The teacher's creativity and experience, as well as the video content, its suitability for that class, the skills and confidence in the presentation, and the level of interactivity of the video and the spatial visualization, are all factors in making it pedagogical. This shows that knowledge in technology, content, and pedagogy (Mishra and Koehler, 2006) is not sufficient to make teachers use technology effectively. They need more experience and skills which are rooted in tacit knowledge. This was also disclosed in our interviews where teachers described how their experiential and operational skills in SM contributed to the effective preparation and presentation of lessons with the SM tools. As a result of their regular dialogue with the tools, the participating teachers' pedagogical use of SM eventually demonstrated a degree of control and confidence with tools. This supports Polanyi and Gibson's assertions about the importance of relationships with tools.

Indeed, contextualizing a tool for educational use has revealed some flaws in the TPACK paradigm (Mishra and Koehler, 2006). According to the TPACK concept, teachers cannot be effective with technology unless they have knowledge of technology, content, and pedagogy. Rather, the concept seeks to improve their operational skills in employing technology in the way that it was intended. As a result, it is critical that we focus on teachers' experienced capabilities, which Polanyi refers to as tacit knowledge, in order for them to contextualize technology in their teaching activities. We realize meaning and purpose in using technology (SM) appropriately at the contextual level.

The categorical areas of negative and positive perceived pedagogical affordances of teaching with SM directly hinge on the level of relationship with the tool, as we have just pointed out. According to one participant, her

students sometimes get distracted when using SM for learning in class They sometimes turn to different sites to watch movies, play games, or chat with friends.

Here, the technology becomes a distraction to the teaching and learning process because it takes the student's attention from the lesson. The reason teachers and stakeholders have divided opinions about technology integration in the school curriculum (Otchie and Pedaste, 2020).

On the other hand, technology is used in ways beneficial to the learner because of the context of use. In terms of the benefits of SM technology in education, another participant perceived technology as a tool that facilitates students learning because all learning materials are readily available and accessible even for those absent from school.

These two contexts demonstrate two diverse uses of the same tool within the context of teaching and learning. On one hand, even though the use was beneficial to the learner, it was perceived as a distraction because of the context. Indeed, the student could have used it in the context that is purposeful and pedagogically relevant. Also, it is important to mention that this perceived abuse which we termed "negative affordances" of the tool by the student was a result of his/her relationship with technology. Alternatively, using technology to access online learning resources is beneficial to the user within the context. Hence, we describe it as positive affordances. This clearly demonstrates that in contextualizing technology, the onus rests on the user because he/she determines the context of use.

The institutional support for teachers using SM in their teaching activities was one of the categories that emerged from our research. In contrast to previous studies, that schools lacked technological infrastructure and support (Dillenbourg, 2008; Taghizadeh, and Hasani Yourdshahi, 2020), all participants expressed satisfaction with the technological infrastructure and support provided by their schools.

Besides technological support, funds, and other necessities, management must also motivate teachers to give their best. Our findings revealed that access to ICT resources, such as computers, laptops, tablets, and other relevant digital devices, was not a problem for participating teachers and their students. However, there were a small number of students who did not have regular internet access or personal computers at home, confirming the findings of Rasheed and colleagues (2020), who found that there is inequality in technical support and access among students.

According to participants of the current study, the teachers undergo periodic training in computer technology in their schools and attend workshops organized in Estonia. However, we noticed from the interviews that most training courses were centred more on the operational level than the pedagogical level, thus making the teachers inclined towards using technology more operationally than pedagogically.

8. Conclusion and limitations

Essentially, the findings of the study underpin the assertion that SM is a potential pedagogical resource for teaching and learning. This was demonstrated by the participants' ability, interest, and willingness to teach with SM because it made their lessons more interactive, interesting, and innovative. Also, many teachers are teaching with SM tools because it affords them the opportunity to connect remotely to their students anytime and anywhere, especially those who were absent from school, allowing the students to follow the lessons from any location. Furthermore, it is important to mention that these technologies also allow teachers to remotely access the learning resources of their colleagues from different schools. Likewise, students' interest in learning has increased, as they find learning more flexible and get quick feedback and easy access to teaching and learning resources.

Regardless of the benefits of teaching and learning with SM, both teachers and students also encounter some significant challenges, which could potentially become a setback to the integration of these technologies into the classroom. Bringing this to the attention of teachers and other stakeholders can potentially help them have updates on these issues in order to be aware of and identify the potential constraints and limitations ahead of its possible integration.

For instance, teachers' negative perceived pedagogical uses such as spending too much time on lesson preparation and the overlap of working time and social time could be researched further. Also, the distractions some students encounter with SM during lessons could be addressed when both teachers and students acquire more knowledge about SM and, most importantly, appreciate the perceived pedagogical affordances it provides. This also confirms the importance of using technology in education generally and specifically in pedagogy. Thus, going forward, it is necessary that teachers establish stronger relationships with technology tools in order to understand the technology tools they use for pedagogy. Finally, and most importantly, the study proposes that teachers and students must be given unrestricted access to these technologies so that they can have regular dialogue with these technology tools in order for them to develop skills and confidence, gain control of using them, and discover more affordances for pedagogy.

However, the study also encountered some limitations which need to be considered going forward. The first and major limitation was the time it took to have the small number of teachers involved in the study. The fundamental issue was potentially their low level of the English language skills – the mother tongue of the respondents was usually Estonian, but the data was collected in English, as the data collectors did not speak Estonian. There was a general reluctance among teachers to participate in the interview which we could attribute to their challenge with English; they might have preferred Estonian, which is widely spoken in Estonia and serve as language of instruction in the schools. Thus, unfortunately, several teachers who might have been interested could not speak English and were unable to participate. Furthermore, most teachers were unable to participate in the interviews because May and June are among the busiest months for teachers, particularly those in high (secondary) schools who are preparing their pupils for a major summative evaluation. Despite these limits, we were able to accomplish our goals during the interviews.

Indeed, the goal of this study was to define the term "usage of SM." So, the terms "operational and contextual affordances" were coined as a result. Despite their differences, these two concepts work together to make effective classroom technology use possible. When it comes to leveraging technology, we also established the importance of relationships. As a result, a greater knowledge of these principles could make technology training for pre-service teachers easier.

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Zoom.us. https://www.zoom.us/

Appendix I

Interview Protocol

Questions
To explore participant's profile
Tell me briefly about the class you teach. *What subject do you teach?* *How long have you been a teacher?* *What makes you use social media in general?* *Describe what you use social media for in general.*
To explore broad experiences and perspectives of participants on social media in teaching
What is your opinion about teaching with social media? *How does social media influence your teaching?* *Probe: Any example.... can you tell me more about that?* *Tell me how time impacts on your social media use in class.* *Probe: What about your students?* *Describe a typical lesson with social media.* *Tell me about your students' attitudes to social media.* *Probe? How, why? Some examples…?*
To explore and generate specific experiences of participant's use of social media
What kind of social media do you teach with? *Probe: Why...tell me more about that.* *How often do you teach with social media?* *How long have you been teaching with social media?* *Probe: Any highlights? Regrets?* *Are you the only teacher using social media?* *Does your school management support social media use in teaching?* *Probe: How? What exact support? Can you give me some examples?*
To explore specific consequences of social media use in participant's work
Tell me about any challenges you encounter in teaching using social media. *Probe: Only that.... can you give some instances?* *Any benefits or advantages you derive from teaching with social media?* *Probe? Can you cite some more instances?* *Do parents raise any concern about using social media in class?* *How will you rate teaching with social media when given a scale* of 1–5?*

*1= poor, 2 = satisfactory, 3 = good, 4 = very good, 5 = excellent

The interview addressed the following topics:

- Background of the participants (subjects, class, and years of teaching with social media)
- How participants use social media in general
- Type of social media mostly used by participants to teach
- Frequency of teaching with social media
- How participants use social media in a typical class lesson
- Impact of social media on teaching
- The attitude of participant toward social media in education
- The attitude of parents to social media in teaching
- Schools support toward technology integration

Appendix II

Profile of participants

Pseudo-nym (*N=11*)	**Years of Teaching**	**Years of Teaching with SM**	**Type of SM**	**Subject**	**Grade**
Jane	8	7	YouTube, Facebook	Biology	7
Kaja	10	8	YouTube, Facebook	Biology	8,9,10
Kristjan	35	8	YouTube	Physics, Maths	8,9
Evilin	20	7	YouTube	Arts, English	7,8
Aivi	25	10	YouTube, Google Classroom	English	9,10
Mirjam	16	5	YouTube	Maths	9
Kristina	2	2	YouTube, Facebook	Biology	7,8,9
Zara	4	4	YouTube, Facebook, Google Classroom, Instagram	English, English Literature	7,8,9
Triin	6	6	YouTube, Google Classroom	Biology	8,9,10
Katarina	11	7	YouTube, Instagram	Arts	7,8,9
Gerli	15	8	YouTube, Google Classroom	Maths	9,10

Investigating the Influence of Quality Factors on User Satisfaction with Summative Computer-based Assessment

Hassan Bello and Nor Athiyah Abdullah
School of Computer Sciences, Universiti Sains Malaysia, Penang, Malaysia
hassbell72@gmail.com
athiyah@usm.my

Abstract: Computer-based assessment or e-assessment system is an e-learning system where information communication technology is utilized for examination activity, grading, and recording of responses of the examinees. It includes the entire assessment process from the examinees, teachers, institutions, examination agencies, and the public. E-assessment systems have been used extensively in educational and non-educational settings worldwide because of their significant impact on assessment to both the institutions and students. Electronic assessment systems have many significant advantages over conventional paper-pencil-based approaches, like reducing production cost, automatic marking, and fair grading. Other benefits include the ability to conduct adaptive testing, an increase in the frequency of assessment, a large number of people could be examined, low staff requirements during the assessment, and the ability to improve the quality of the evaluation. Text, images, audio, video, and interactive virtual environments in an e-assessment system are all feasible. Nevertheless, given all these advantages, some examinees expressed negative views about electronic assessment in our study due to fear or lack of familiarity with assessment technology and lack of information on e-assessment methods. Despite the increased adoption of e-assessment in higher education and organizations, the examinees' attitudes and opinions need to be studied to implement the system successfully. In an e-assessment environment, several factors account for the evaluation of the system quality. These factors can be categorized into three dimensions: technical, educational, and economical. However, based on literature reviewed, limited studies attempted to map these quality factors to determine user satisfaction with an e-assessment system. This scarcity of e-assessment satisfaction studies is the gap the study intends to fill. Furthermore, this study's findings would help provide practical and theoretical implications for educational institutions and organizations. This study is among the first application of the Delone and McLean information system success model to predict user satisfaction with computer-based assessment in a developing, African country.

Keywords: Computer-based assessment, E-assessment, E-assessment satisfaction, Summative assessment, Computer-based test

1. Introduction

In recent years, an increasing number of tertiary education and examination organizations have started using electronic tools to test and evaluate students through computer-based assessment (Nardi and Ranieri, 2019). This increase is due to educational institutions' growth and the enlargement of class sizes, which led many institutions and organizations to adopt electronic evaluation tools. Likewise, the development of user-friendly web-based applications for assessments and the availability of testing protocols that are secured over the internet both led to the common utilization of online assignments, quizzes, tests, and examinations (Cassady and Gridley, 2005). Furthermore, the Covid 19 pandemic has helped to encourage a wider use of e-assessment technology, a global e-assessment application for thousands of colleges as a social distance strategy (Wafaa, Mohamed and Hossameldin, 2021). Computer-based assessment (CBA) is an electronic assessment process in which information and communication technologies (ICTs) are used for assessment activities, performance grading, and response recording. This reflects the entire assessment process from examinees, teachers, schools, examination bodies, and the general public (Hettiarachchi and Huertas, 2011).

Previous studies categorized e-assessment into summative and formative assessment (Terzis and Economides, 2011). The purpose of summative assessment is to assess whether students/learners have achieved their objectives. On the other hand formative assessments provide corrective feedback to help students achieve their goals, mostly during their learning experience (Terzis and Economides, 2011). Furthermore, various assessment approaches are used to test student's different skills using computers, including multiple-choice questions (MCQ), multiple responses, hot spots, matching, ranking, drag and drop, multiple steps, and open-ended questions (Obeidallah et al., 2015). E-assessment can be carried out with different devices, like standard desktop computers or laptops, smartphones, iPads, or through the use of electronic gaming devices (Crisp, 2011). Technically, some e-assessment designs may overcome certain challenges of paper assessments such as external support to students (Wafaa, Mohamed and Hossameldin, 2021). However, computer-based assessment systems adoption in the modern education environment still met with some challenges despite their role in solving some

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traditional assessment problems (Al-Hakeem and Salim, 2017; Karimi, 2016). Some of the challenges include lower preference by students and exam dishonesty and misconduct (Elsalem et al., 2021), exam security and authentication (Pettit et al., 2021), digital competence lacking by the instructors (Garcia-Alberti et al., 2021) which became prominent particularly during the Covid-19 pandemic. Therefore, it is crucial to understand what overcomes user's challenges in using the system with ease and enjoyment.

The review of existing literature revealed a notable scarcity of studies, especially in a summative context, dealing with the identification of the impact of quality factors on examinees satisfaction with a computer-based assessment. Also, most of e-assessment research is concerned with finding out which factors affect student's acceptance and e-assessment adoption (Terzis and Economides, 2011; Liu, Chen, and Lu, 2015). Much research compares student's e-assessment performance with paper-based assessment (Nardi and Ranieri, 2019), while Acosta-Gonzaga and Gordillo-Mejia (2015) concentrated on the complexities of implementing the e-assessment. In the same vein, Nguyen et al (2017) deal with the e-assessment system design and security. Sanni and Mohammad (2015) studied the student's perception of e-assessment technology, while Economides (2005) concentrated on the quality requirement of the e-assessment systems. Despite these efforts, it seems that only a few studies assessed the satisfaction of students with e-assessment (Dobre, 2015; Vairamuthu and Anouncia, 2016;Bahati et al., 2019). Therefore, more studies are needed to clearly show how quality factors can be related to user satisfaction with a computer-based assessment.

In an e-assessment environment, several factors account for the system quality evaluation. Economides and Roupas (2007) categorized these factors into three dimensions: technical, educational, and economical. Economides and Roupas set out such criteria as the standard specifications for an e-assessment system. Nonetheless, minimal research maps these quality factors to determine user satisfaction with the e-assessment system. One research question guided this study: "What is the influence of quality factors on the satisfaction of the examinees with CBA?" This study identified three key quality factors in response to this question and investigated their influence on the examinee's satisfaction with CBA.

2. Literature Review

Three key dimensions of quality factors of computer-based testing were identified by past studies (Economides, 2005; Economides and Roupas, 2007), which include educational, economic, and technical quality dimensions. Based on these dimensions of Economides and Roupas (2007), the educational dimension comprises content, presentation, sequencing, and feedback. The technological aspect involves user interface, reliability, maintainability, performance, accessibility, networking, security, and adaptation. At the same time, cost, contract/ licensing, cost-effectiveness cover the economic aspect—basically, our study is concerned with factors that the examinees of the CBA could evaluate. Therefore, under the educational dimension, the study's criteria are the computer-based assessment contents and presentations (CBA). The cost-effectiveness of the test is our criteria under the economic factor to be determined by the examinees. Similarly, the examinee of a summative CBA could assess all the technical dimensions except maintainability, reflecting the organization's effort to maintain the CBA and make specific modifications (Economides, 2005).

Moreover, in e-assessment literature on satisfaction, few studies considered the impact of quality factors in e-assessment. For instance, Vairamuthu and Anouncia (2016) showed how computer-based assessment quality factors affect usability with an online assessment in an academic institution. Likewise, Dobre (2015) addressed student satisfaction over the use of an e-assessment method using natural language processing in an intelligent tutoring system (ITS) using 27 students who have used the system in a Romanian university as respondents to a questionnaire of satisfaction. In their attempt to determine the extent to which students at the University of Rwanda are satisfied with their engagement level and the quality of their feedback from formative e-assessment, Bahati et. al. (2019) conducted an online survey with 128 respondents. They found the students are satisfied with the quality of their interaction and the quality of the strategies for formative e-assessments. The impacts of different e-assessment design on students' satisfaction were studied by Nguyen et al. (2017) on 73,373 students in the UK that have experience with 74 different e-assessment modules. They employed correlational analysis and found no significant relationship between the e-assessment design activities and student satisfaction.

Despite the findings of these studies, little is known about how the factors of quality, particularly the educational and economic factors, may contribute to the experience of the examinees for enhanced satisfaction.

2.1 Theoretical Framework and Research Model

The theoretical framework of this study was based on the information system success model (ISSM) from Delone and McLean (2003) shown in Figure 1 to investigate the impact of the quality factors of e-assessment on user satisfaction. The DeLone and McLean (1992) model uses six important dimensions of IS success, namely (1) system quality, (2) information quality, (3) use, (4) user satisfaction, (5) individual impacts, and (6) organizational impact. The expanded model of Delone and McLean (2003) includes service quality as the third quality dimension, and the intention to use and net benefits as the other new dimensions. Therefore, as an adaptation of the extended model Delone and McLean (2003), this study only examines the impact of perceived quality on user satisfaction of the electronic assessment process of the Nigerian Unified Tertiary Matriculation Examination (UTME) by students from two Nigerian universities. Figure 2 shows the theoretical model for this study. The model demonstrates the relationship between perceived quality factors of e-assessment by Economides and Roupas's (2007) question content quality (educational dimension), cost-effectiveness (economic dimension), and system quality (technical dimension), and user satisfaction as the dependent variable.

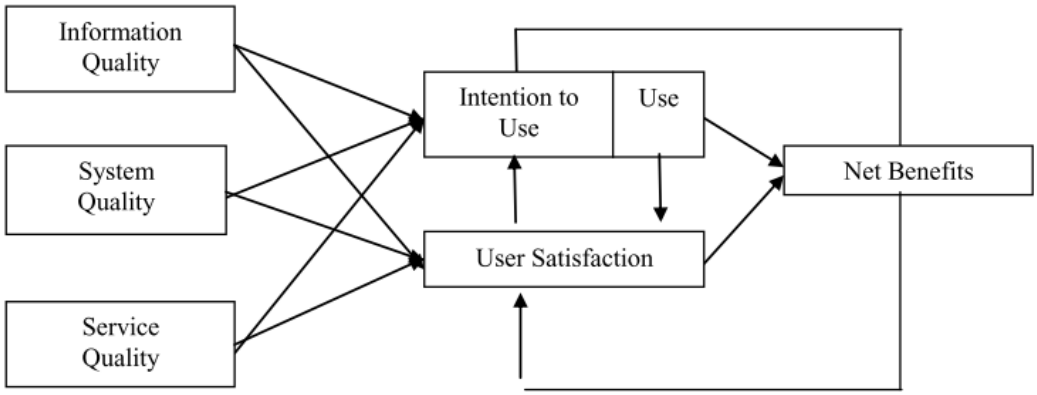

Figure 1: DeLone and McLean IS Success Model (Delone and McLean, 2003).

2.1.1 Educational Dimension: Questions Content Quality

The content domain is one of the educational quality dimensions proposed by Economides (2005) in evaluating the quality of e-assessment systems. The content refers to the quality and quantity of the questions in the e-assessment (Economides, 2005). In addition to the questions high-quality requirements, examinees expected the questions to be valid, trustworthy, useful, up-to-date, correct, and accurate (Economides, 2005). The relevance, suitability, and appropriateness of the question to the examinees' educational level are highly important, and they should be objectively presented without discrimination concerning age, gender, religion, and political inclination (Economides, 2005). Furthermore, it is also argued that the presentation and layout of the questions in e-assessment affect the quality of the assessment (Kuikka, Kitola and Laakso, 2014). Also, the wide acceptability of e-assessment due to Covid-19, Wafaa, Mohamed and Hossameldin (2021) established a significant difference between e-assessment questions content and paper assessment which was due to open-book nature of e-assessment.

In addition, the course content was identified in the e-learning system as a significant variable for determining the satisfaction of e-learners (Wang, 2003). In an exploratory study in Taiwan, Wang identified content as one of the dimensions in measuring e-learner satisfaction. Ideally, e-learning and e-assessment systems are supposed to be delivered with useful and sufficient content (Terzis, Moridis and Economides, 2013). Terzis and Economides (2011) defined two separate dimensions of the e-assessment content in their Computer-based Assessment Acceptance Model (CBAAM), namely: the course content and questions during e-assessment. Terzis and Economides (2011) analyzed the question content as a new construct with new items as to whether the questions were simple, clear, and comparable to the course content as measuring items and found that the question content variable also indirectly impacted the behavioral intention to use the e-assessment. Some scholars (such as Seta et al., 2018; Hassanzadeh, Kanaani, and Elahi, 2012; Mohammadi, 2015) analyzed the relationship between a specific IS quality of content and user satisfaction and found significant relationships. Seta et al. (2018), In a successful review of an e-learning system, the system information and content quality have had a significant effect on user perceived satisfaction with Indonesia's system. Similarly, Hassanzadeh,

Kanaani, and Elahi (2012) and Mohammadi (2015) found a significant influence of content quality on user satisfaction with the e-learning program in their separate studies to assess e-learning success in Iran.

However, in some studies, the content has had an insignificant impact on the satisfaction of users. In a work to evaluate the effectiveness of e-training in Malaysian multinationals, Ramayah, Ahmad, and Hong (2012) found the training contents have insignificant impacts on users' satisfaction. But, limited studies exist that associate questions content quality of e-assessment and examinee's satisfaction. Therefore, it is vital to test the relationship between questions content quality and user satisfaction. Thus, this study hypothesized the following:
H1: Questions content quality of an e-assessment positively influences examinee satisfaction with the e-assessment.

2.1.2 Economic Dimension: E-assessment Cost-effectiveness

In e-learning, cost-effectiveness is regarded as an advantage of e-learning for learners (Shee and Wang, 2008). Cost-effectiveness is one of the economic dimensions in evaluating e-assessment as proposed by Economides and Roupas (2007). The cost-effectiveness in this context is referring to whether e-assessment can provide a better quality of service (especially with the involvement of third parties in the provision of e-assessment services and facilities) than the paper-based exam, relative to the cost of using the e-assessment and paper-based; and how this will affect the overall satisfaction of the examination experience. Ideally, the examinees should be aware of the various costs, and the payments should be transparent at any time (Economides, 2005). The flexibility, duration, visibility, discounts (e.g., concerning the number of tests, examinees), and guarantees are also important parameters. Our study focuses on cost-effectiveness as an antecedent of user satisfaction rather than cost. Cost-effectiveness in computing refers to the degree to which a computer resource's benefit is worth the price invested (Saya, Pee, and Kankanhalli, 2010). In e-banking services, it was established that cost-effectiveness is one factor determining customer satisfaction in India (Kumbhar, 2011a).

The cost-effectiveness of this study is a key variable given the peculiarity of e-assessment fees in Nigeria. Since the introduction of e-assessment by *the Joint Admission and Matriculation Board (JAMB)* in 2013, there were many protests and calls on the examining body to reduce the price of the examination. As reported on 3rd March 2016 by one of the Nigerian dailies, AllAfrica, on a bill, the Senate passed, which is yet to be implemented

> *The Senate yesterday cut the registration fees for the Unified Tertiary Matriculation Examinations (UTME) to N2, 500 from the initial cost of N5, 560. The decision followed the adoption of the report of the Senate committee on tertiary institutions on the inquiry into the new admission policy of the Joint Admission and Matriculation Board* (JAMB)

In the same vein, there were calls to extend the expiration time of the examination to three years all because of the fees as also reported by the Premium Times a Nigerian newspaper on 3rd March 2016

> *The Senate has said the application fee payable to Joint Admissions and Matriculation Board, JAMB, the examination should not exceed N2, 500. While the Senate said the application fee should not exceed N2,500, it said course forms and all other incidental activities around the examination should be free. The legislative body also extended JAMB's entrance examination validity period to three years from one year*

There are few studies on the relationship between the cost-effectiveness of examination and user satisfaction. Therefore, these relationships need to be examined to ensure the relationship between exam cost-effectiveness and user satisfaction within the e-assessment experience. Hence we propose the following hypothesis:
H2: E-assessment cost-effectiveness positively influences examinee's satisfaction

2.1.3 Technical Dimension: System Quality

System quality or technical system quality is primarily concern with measuring performance characteristics of the information system in question. According to DeLone and McLean (1992), system quality of information systems is more oriented toward the technical performance of the system. Determining a sound quality system will create an easy-to-use environment in which users will skillfully discover practical IS groups and navigate efficiently the materials provided by the IS (Cheng, 2012). Gorla, Somers and Wong (2010) described system quality as the IS's processing power and its data components, which make the system technically sound. In their

view Freeze et al. (2010) referred to system quality as the individual perception of system output. In other words, the quality of the system is measured in terms of both the user's hardware and the particular software applications built for their intended use and needs.

For this study, system quality is defined as one of the e-assessment quality factors that primarily concern system-related and task-related features such as reliability, flexibility (Flexible to easily make changes), integration, response time, security, ease of use, ease of learning, user requirements, system features, system accuracy, sophistication, and customization (DeLone and McLean, 2003). Several researchers emphasized that system quality and user satisfaction were significantly related (e.g., Delone and McLean, 2003; Fang, Chiu, and Wang, 2011; Ramayah and Lee, 2012; Al-Mamary et al., 2015; Seta et al., 2018; Masrek and Gaskin, 2016; Al-Fraihat et al., 2020). Delone and McLean (2003) theorized the quality of the system as one of the fundamental determinants of an individual's satisfaction. In their efforts to model the repurchase intentions of customers in the context of online shopping, Fang, Chiu, and Wang (2011) confirmed that system quality has a major impact on customer satisfaction. Similarly, Ramayah and Lee (2012) noted that system quality has an important positive relationship to the e-learning system's user satisfaction. Also, this was supported by Almarashdeh (2016) in a study assessing teachers' satisfaction with the e-learning system inside a distance learning program. Similar findings were reported by Hadji and Degoulet (2016) with the clinical information system (CIS) and Mohammadi (2015), Hammouri and Abu-Shanab (2018), Hassanzadeh, Kanaani, and Elahi (2012), Navimipour and Zareie (2015) with e-learning systems.

Researchers (such as Chatzoglou, Fragidis, and Aggelidis, 2012) have however, found system quality to influence user satisfaction through information quality indirectly. System quality has also been found to have an insignificant effect on learning management system (LMS) user satisfaction in Nigeria (Yakubu and Dasuk, 2018). Therefore, it is important to test the relationship between the e-assessment system's quality and the examinee's satisfaction based on the literature discussed. The following hypothesis is based on that:
H3: System Quality will positively influence examinee satisfaction with e-assessment.

The constructs adopted from the Delone and McLean (2003) model are system quality and satisfaction. Also worthy of mentioning, our model does not include the "use" construct together with the remaining construct of "net benefits" due to the following reasons: (1) our scope is to measure user satisfaction with the system not to measure the outcomes of the user satisfaction (2) In a mandatory system setting, use does not make sense regarding the system evaluation (Petter, DeLone, and McLean, 2008; Sedera and Gable, 2004; Delone and McLean, 2003). (3) Some researchers argued regarding the consideration of use because many studies (such as Al-Fraihat et al., 2020) found the relation between quality factors and use not supportive. (4) researchers like Seddon (1997) argued that use is a behavior, not an effective measure. Similarly, Ramayah, Nejati, and Shafaei (2015) and Cheng (2012) replaced information quality dimension of Delone and McLean (2003) with content quality on the ground that in information system with personal content-oriented (like e-assessment, e-learning, web blogs) information quality can be replaced with content quality. Therefore, the information quality construct is replaced with questions content quality in our study. Similarly, in this study, the construct of service quality is not considered because it was not a quality dimension of Economides and Roupas (2007) e-assessment quality factors and also some studies like Hammouri and Abu-Shanab (2018) excluded it in their study of exploring factors affecting e-learner satisfaction with learning management system.

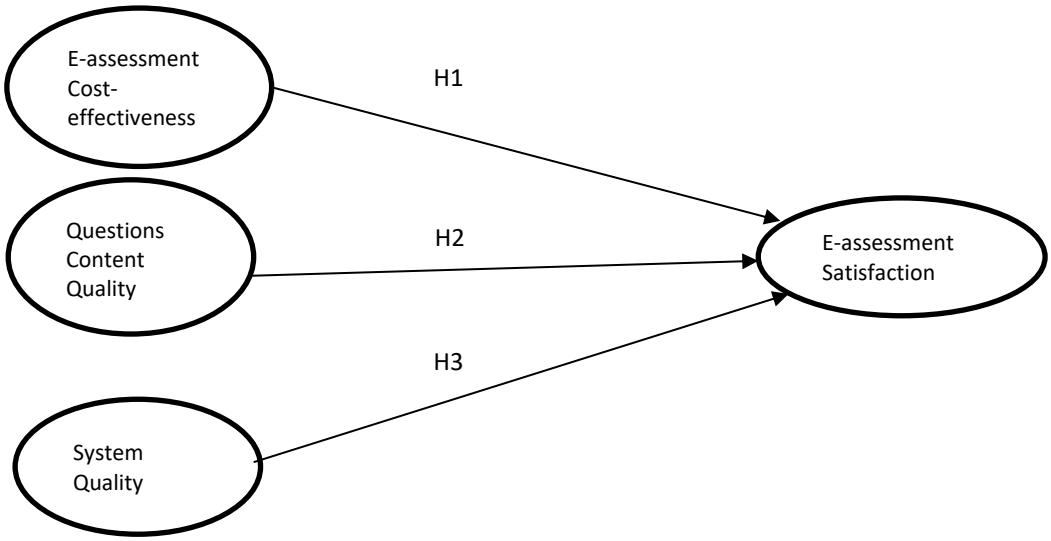

Figure 2: Research Model

3. Methodology

3.1 Research Participants and Data Collection

The selection of a quantitative approach to this study is based on the abundance of empirical studies rooted in the Delone and Mclean model, which is the theoretical framework of this study. This cross-sectional study maps quality factors measures of computer-based assessment to examinee's satisfaction. It tests the effect of these quality factors (exam cost-effectiveness, questions content quality, and system or technical quality) in determining examinee's satisfaction with CBA. According to the reviewed literature, the constructs and measures used in this study have rarely before been used to predict user satisfaction with CBA.

This study's population is students from Nigerian higher education institutions who used the computer-based unified tertiary matriculation exam (UTME) to gain admission between 2015-2019. However, the target sample for the study were undergraduates of two public universities in the state of Kano, Nigeria, that have used the unified tertiary matriculation examination (UTME) computer-based test to secure admission into the universities between the period 2015-2019. The reason for choosing undergraduates from these two universities was because of their familiarity and experience with the UTME e-assessment system, which can clarify their views of e-assessment in adequate detail. They also comprised the research convenience sample. Data were collected over a week, with the help of two research assistants, through a survey from these universities. A total of 300 potential respondents have been approached and asked to join the study. 229 replied by returning the questionnaire (a remarkable response rate of 76.3 percent), which is more than the minimum number of samples needed using the Gpower 3.1 software (Faul et al , 2009) setting of 119 samples.

A questionnaire was developed based on existing and relevant instruments from the literature. The questionnaire consisted of 23 objects, which were split into two parts. The first section consisted of six items which asked for demographic data (e.g., gender, age, school type, e-assessment experience, e-assessment training participation). The second part asked about quality assessment and satisfaction by the examinee and consist of seventeen items. Items for measuring the quality assessment and the examinee's satisfaction were adopted from the literature. Three items on exam cost-effectiveness were adopted from Kim, Yoon, and Han (2016) to assess the overall price, current price, and cost-effectiveness; three items on questions content quality were adopted from Nikou and Economides (2017) to measure question understandability, relevance, and usefulness; while five items adapted from Holsapple and Lee-Post (2006) on system quality were used to measure the e-assessment in terms of system's user-friendliness, stability, security, speed, and response; and six items were used to measure the satisfaction of the examinee with the e-assessment taken from Mohammadi (2015) to assess user's evaluation on his satisfaction in using the system.

The issues of common method bias (CMB) were addressed by adopting some procedural strategies to minimize them as follows: Firstly, a cover sheet and a set of instructions accompanied the questionnaire so that the respondents will be motivated by knowing how the information will be used or how it will benefit them or the

society at large. Secondly, we removed common scale property by adopting 5-point Likert and 7-point Likert scales, which, according to Jordan and Troth (2020), common scale property increases common method biases.

Table 1 details the respondents' demographics. Most respondents were students of science because one of the universities is a university of science and technology.

Table 1: Demographic information of the Respondents

	Frequency	Percentage
Age		
16-20 years	95	41.5%
21-25 years	89	38.9%
26-30 years	36	15.7%
31+ years	9	3.9%
Gender		
Male	148	64.6%
Female	81	35.4%
Type of Secondary School		
Public	109	47.6%
Private	120	52.4%
Course		
Science	158	69%
Art	47	20.5%
Others	24	10.5%

4. Data analysis and Results

For the model analysis, the structural equation modelling (SEM) approach was adopted. SmartPLS3 (Ringle, Wende, and Becker, 2015) software package was used to analyze the collected data as it is considered a complete statistical procedure that allows the research model to be evaluated and updated simultaneously, including the relationships between latent variables. The first step is to test the measurement model by examining the variable's reliability, convergent, and discriminant validities. The second stage is related to the structural model evaluation by exploring the structural model's paths and checking the significance of the relationships between the constructs.

4.1 Measurement Model

According to Hair et al. (2017), to assess the measurement model, a study needs to report the indicator loadings, average variance extracted (AVE), composite reliability (CR), and also the discriminant validity. Reliability or internal consistency reliability of a construct reflects the indicators consistency in measuring a given construct (Chen, Chen and Chen, 2009). According to Hair et al. (2017), if composite reliability (CR) is greater than 0.7, the scale can be regarded as being highly reliable. As can be seen in Table 2, reliability for all constructs exceeded 0.7, meeting the reliability criterion for research tools. Similarly, the reliability of indicators (outer loadings) indicates the degree to which an indicator or group of indicators is consistent with what it aims to measure (Urbach and Ahlemann, 2010). We adopted Byrne's (2016) suggestion, where loading values equal to and above 0.5 are acceptable when the summation of the loads results in high loading scores, the Average Variance Extracted (AVE) scores greater than 0.5 are acceptable. Similarly, a construct's convergent validity represents the degree to which different indicators are used to measure the same construct and strongly correlate the different indicator scores (Chen, Chen and Chen , 2009). We use the extracted average variance (AVE) to validate the convergent validity as suggested by Hair et al. (2017) appropriate value of AVE > 0.50 is recommended, indicating that the construct score includes more than half the indicator variance. The indicator loads, CR, and AVE for the reflectively measured constructs are shown in Table 2.

Table 2: Measurements Model

Constructs	Items	Loadings	CR	AVE
Exam cost-effectiveness	CEF1	0.786	0.845	0.646
	CEF2	0.885		
	CEF3	0.733		
Questions Content Quality	QCQ1	0.779	0.851	0.655
	QCQ2	0.838		

Constructs	Items	Loadings	CR	AVE
	QCQ3	0.811		
E-assessment Satisfaction	SAT1	0.633	0.908	0.625
	SAT2	0.741		
	SAT3	0.790		
	SAT4	0.859		
	SAT5	0.879		
	SAT6	0.815		
System Quality	SYQ1	0.801	0.861	0.557
	SYQ2	0.815		
	SYQ3	0.582		
	SYQ4	0.710		
	SYQ5	0.799		

Note: CR is Composite Reliability, and AVE is Average Variance Extracted

The next step of the measurement model evaluation is the discriminant validity (DV) assessment. Discriminant validity implies the degree to which a construct differs from other constructs within the model. This will be verified by comparing the square root of the Average Variance Extracted (AVE) with the correlations among constructs. If higher than the correlation values are the square roots of the AVE values in the respective row and column, it is verified that the measurements are discriminant. Table 3 shows the square roots of the AVEs greater than the row and column values. Therefore the Discriminant Validity is confirmed.

Table 3: Discriminant Validity

		1	2	3	4
1	E-assessment Satisfaction	0.791			
2	Exam cost-effectiveness	0.472	0.804		
3	Questions Content Quality	0.613	0.389	0.810	
4	System Quality	0.606	0.447	0.612	0.746

4.2 Structural Model

The structural model was used to test the relationships among variables adopted in this study's model. The path coefficients (β) were calculated in conjunction with their degree of significance for estimating construct effects. A bootstrapping method of 5,000 samples was used to determine the level of significance of the paths (t-value). So, we examine the model's paths to test the study's three hypotheses. Table 4 presents the results of analyzing the path.

Table 4: Hypothesis testing

	Relationship	Std. Beta	Std. Error	t-value	Decision
H1	Exam cost-effectiveness -> E-assessment Satisfaction	0.200	0.055	3.641***	Supported
H2	Questions Content Quality -> E-assessment Satisfaction	0.350	0.079	4.408***	Supported
H3	System Quality -> E-assessment Satisfaction	0.302	0.083	3.647***	Supported

***P<.01

The independent variables of exam cost-effectiveness (β= 0.200, p<0.01), questions content quality (β= 0.350, p<0.01), and system quality (β=0.302, p<0.01) were found to be positively related to the satisfaction of the examinee and collectively explained the variance of 49.2 % in satisfaction with the summative e-assessment. Therefore, support was provided for H1, H2, and H3, as shown in Figure 3.

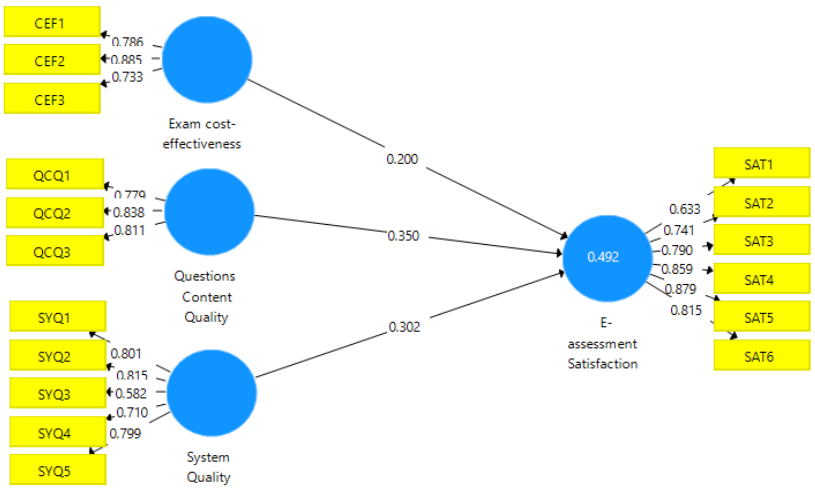

Figure 3: Hypotheses testing results

As suggested by Hair, Ringle and Sarstedt (2013), we also used a blindfolding procedure with a distance value of 10 to calculate the Q2 or predictive relevance. According to Hair, Ringle and Sarstedt (2013), blindfolding is a measure based on a sample reuse methodology, omits part of the data matrix, estimates the parameters of the model, and predicts the portion omitted using estimates (Hair, Ringle and Sarstedt, 2013). User satisfaction is greater than 0 with a Q2 value of 0.288 and only one endogenous construct (Fornell and Larcker, 1981), so we should recognize the model as having the modest predictive capacity (Hair et al., 2017).

5. Discussion and Conclusions

The success of an electronic assessment system in academic institutions can be attributed to the examinee experience and satisfaction. This study, therefore, examined the effect of e-assessment quality factors on the satisfaction of examinees for the matriculation examination. There is an increase in challenges faced by the examinees of electronic tests in Nigeria, particularly those of UTME CBT (Sanni and Mohammad, 2015), which have a potential threat to achieving the ultimate success of the system. Furthermore, there are few studies investigating examinees' objective and subjective assessment of the system by employing a well-established information system theory, particularly within the context of developing countries such as Nigeria. This study aims to fill these gaps using the updated information system success model from Delone and McLean (2003) to examine quality factors role in assessing user satisfaction with a computer-based assessment.

The study findings showed that the model dimensions explain 49% of examinee satisfaction with e-assessment in Nigeria, which is considered to have a moderate impact in IS studies (Knowles, Hyde and White, 2012). According to the Smart PLS parameters, all the determinants of user satisfaction proposed in the study model are significant. This result is in line with previous studies where a modified Delone and McLean (2003) model has been used to predict user satisfaction (e.g., Ramayah and Lee, 2012). Literature reviewed showed only one study in the field of computer-based assessment utilized Delone and McLean (2003) model to evaluate the usability of an online-based assessment system (Vairamuthu and Anouncia, 2016). The current study strengthens the predictive power of modified Delone and McLean (2003), which can be employed further to investigate examinee satisfaction.

The cost-effectiveness of the e-assessment system significantly influences the satisfaction of the examinees. This is in-line with previous studies (e.g., Kumbhar, 2011b) and has implications for Nigerian legislators who are striving to enact a bill (yet to be approved by the executives) mandating the JAMB to reduce the cost of the UTME examination or extend the expiration period of the examination result (the daily). For instance, the registration fee for the examination, the training fee, the mock exam fee should be harmonized and paid collectively during registration because some examinees were not aware of the other fees being charged during

training and mock examination. The cost-effectiveness is thus related to the examinee satisfaction with respect to the fees and costs.

The quality of the exam questions (content, presentation) was found to significantly predict the examinee satisfaction with the summative e-assessment. The result showed a moderately strong relationship between the two variables. They indicated the importance of the question content quality while predicting the determinants of summative e-assessment satisfaction in a Nigerian context. The questions should be accurate without errors and specific (relevant to the course chosen and the right combination chosen by the examinee), appropriate and fair considering the examinee age and educational background. The assessment (exam) questions should be comprehensive and complete, covering all the main ideas and key points. This result is consistent with the findings of Seta et al. (2018), Hassanzadeh, Kanaani an Elahi (2012), and Mohammadi (2015) that found a significant effect of content quality of e-learning on user satisfaction.

The system quality, which is technical quality dimensions, influences user satisfaction with summative e-assessment. The system quality element of system security was found to be the test taker's most significant concern, with an average of 4.02 on a scale of 5.0, followed by the system speed due to the value of time in an assessment process. The examinees are mostly concerned about how secure the system is in securing their information and results. These findings support the conclusion made by Ramayah and Lee (2012), and Al-Mamary et al. (2015) and other previous ones (e.g., Seta et al., 2018; Al-Fraihat et al., 2020) on how the quality of the system shows strong effects on the user satisfaction.

6. Implications

This study found some quality factors to be more satisfying for e-assessment systems. The findings have several implications for educational institutions and exam organizations operating in Nigeria and other developing countries. Some institutions and organizations are trying hard to establish a valid and trustworthy examination; many adopted an electronic assessment system. These institutions and organizations need to subsidize the rate of the examination fees so that the examinees should be aware of the various costs, and the payments should be transparent at any time.

The results revealed that the strongest predictor of satisfaction with e-assessment was the quality of question content. The higher the quality of the e-assessment questions we expect, the more likely the examinees are satisfied with the assessment process. The quality of the questions should be understandable, sufficient, and covered all the intended topics. It should be balanced in terms of difficulty levels, skills, and ability to be tested. The questions should be easy, timely, and cost-efficient (to the institutions and organizations) to develop, manage, validate, and update. The authors of the question items (instructors, lecturers, and examiners) should possess the required credentials and reputes in their respective subjects and courses. The questions should be based on a range of media (like text, image, video, audio) of higher quality, and the experience with the system should be enjoyable (Economides, 2005).

Technically, the result also revealed the importance of system quality for predicting examinee satisfaction. Therefore, this calls for a serious implication for the system designers, developers, technical staff, examination center managers to provide a highly secured system, a very fast, user-friendly, and stable system, mainly through the provision of a steady power supply during the examination (Sanni and Mohammad, 2015).

7. Limitations and Recommendations for Future Research

Although this study is quantitative, it may still affect some limitations on the overall generalization of the research findings. Since this survey captured targeted respondent responses (i.e., through non-random sampling) in the study context, the results may not be generalized to other e-assessment systems. Additional research is required to confirm the findings in various e-assessment systems in the country. While this study employed some strategies to overcome CMB, applying this model in other e-assessment systems can further establish the hypothesized direct relationships. Also, the quality of service was not taken into account in this study, although some examination services, personnel, and facilities are provided by third parties involved in conducting the assessment, like examination centres, technical staff, computer systems, and other infrastructures.

Furthermore, the cross-sectional nature of data collection is another limitation of this analysis, thereby restricting the possibility of detecting particular examinee changes over a certain period. In addition, instead of collecting data from students from different universities across the country, this study only covered students enrolled in just two universities. This, therefore, calls for more cross-regional studies to investigate the satisfaction of the examinees with UTME e-assessment.

Based on these limitations, future studies should consider other quality factors such as service quality, especially when conducting e-assessment involving third parties. Subsequent studies may also suggest a longitudinal study approach to increase the likelihood of causal inferences regarding e-assessment satisfaction among the examinees. The relationships among the construct in this model represent a linear relationship. Although the study's aim is attained in the country context of Nigeria, future studies are required to integrate the mediating or moderating effects of other relevant variables. For example, technology readiness is an essential variable in influencing user satisfaction (Wang, So and Sparks, 2017). We recommend using other techniques and methods to evaluate user satisfaction with CBA since the analysis used a data collection survey method.

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Appendix 1

Construct	**Items**	
E_assessment cost-effectiveness	CEF1	I find the overall price of UTME CBT inexpensive.
	CEF2	UTME CBT deserves the current price.
	CEF3	I find UTME CBT cost-effective.
Questions Content Quality	QCQ1	UTME CBT's questions were clear and understandable.
	QCQ2	UTME CBT's questions were relative to the subjects' syllabus.
	QCQ3	UTME CBT's questions were useful for my course
E-assessment Satisfaction	SAT1	UTME CBT is enjoyable.
	SAT2	I am pleased enough with the UTME CBT system.
	SAT3	The UTME CBT system satisfies my examination needs.
	SAT4	I am satisfied with the performance of the UTME CBT system.
	SAT5	UTME CBT was pleasant to me.
	SAT6	UTME CBT gives me self-confidence.
System Quality	SYQ1	The UTME CBT system is easy to use.
	SYQ2	The UTME CBT system is stable.

Construct	Items	
	SYQ3	The UTME CBT system protects my information from unauthorized access by logging only with my account and password.
	SYQ4	UTME CBT system runs very fast
	SYQ5	The UTME CBT system responds quickly to my request.

The Influence of Convenience on the Usage of Learning Management System

Lubna A. Hussein and Mohd Faiz Hilmi
School of Distance Education,
Universiti Sains Malaysia, Malaysia
lubnafatlawi@gmail.com
faiz@usm.my

Abstract: The advancement in internet-based learning technologies together with the national agenda towards globalized online education in Malaysia have prompted the learning management system (LMS) to become an important channel for institutions of higher education to effectively deliver education to students. Since user resistance has been known to be a stumbling block in the implementation of the LMS, it is crucial for the institutions to acknowledge that comprehensive adoption by users relies heavily on user acceptance. Moreover, since some institutions may have even made it compulsory for students to use the LMS, user acceptance of the LMS should be studied in the sense that using LMS is likable and pleasurable. Although the features of the technical capability of the LMS are important, it has been asserted that having the feeling of personal convenience when using the LMS is even more important to the users. With the amount of financial effort and manpower involved in implementing the LMS by institutions in Malaysia towards fulfilling the online learning agenda of the nation, it is important to study whether the convenience factor as an individual impact can play the partial role of influencing Malaysian students' satisfaction of the LMS which would in turn influence them to use the LMS. Based on the Information System Success Model by DeLone and McLean, this study establishes vital process factors regarding the LMS usage among university students in Malaysia. Hence, in this study, LMS usage by students is measured by the degree of students' acceptance of the LMS. An online survey has been done to collect data from 212 students of two large public universities in Malaysia. Structural equation modeling has been used to test the relationships in the conceptual model. The results of data analysis using the PLS-SEM technique employed in the study have indicated that student satisfaction is positively influenced by factors of information quality, system quality, service quality and convenience. LMS usage has been found to be positively impacted by student satisfaction while student satisfaction has been found to have significant mediation effect. The findings from this study can be utilized by institutions committed towards having successful implementation of the LMS. In enhancing LMS usage by the students, the institutions of higher education can consider focusing on the necessary steps towards increasing student satisfaction. Meanwhile, to increase student satisfaction, apart from improving the information quality, system quality and service quality, institutions should also seriously consider promoting the LMS to the students by highlighting the individual impact of the LMS in terms of convenience.

Keywords: DeLone and McLean Information System Success Model, learning management system (LMS), student satisfaction, convenience, individual impact

1. Introduction

The advancement of the internet has propelled the e-learning explosion where it brings about various ways for e-learning including the learning management system (LMS). LMS can be defined as a form of online system that enables organization of learning content and provides accessibility to online communication for learners and instructors (Aldiab et al., 2019). LMS has been implemented in many universities and colleges worldwide (Dorobat, Corbea and Muntean, 2019; Nawaz, 2019; Mtebe and Raphael, 2018). In South East Asia, among others, LMS has been utilized in several countries, including Singapore (Chaw and Tang, 2018), Thailand (Thongsri, Shen and Bao, 2019) and Malaysia (Dulkaman and Ali, 2016).

User satisfaction is an important topic in view of the rapid growth in the number of institutions using the LMS, where the LMS has been used popularly in the learning process. Student satisfaction is considered to be one of the central components in identifying the attributes of online learning (Soffer and Nachmias, 2018). For this purpose, universities need to continually gather information about student satisfaction (Gee, 2018), which is not only a significant determinant of programme and learner-related outcomes, but also a positive demonstrator of learners' perceived learning skills. It is important to consider student satisfaction because of its contribution to academic performance (Rahman, Uddin and Dey, 2021). Moreover, student satisfaction will remain an important contributing factor to affect LMS usage, even if the LMS is made compulsory for students to use.

Also, the availability of study materials and the ease of keeping track of on-going activities provides the feeling of convenience to the LMS use. In addition to that, the sense of convenience may also be contributed to the easy interaction and swift collaboration with the lecturers as well as among students through the LMS.

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Convenience is considered an important factor that influences the use of LMS (Mokhtar, Katan and Hidayat-ur-Rehman, 2018).

Malaysia has formalized the national agenda towards globalized online education. A blueprint for the period of 2015-2025 towards evolving into a higher education scenario, which includes focusing on the shift towards globalized online education, has been developed by the Ministry of Higher Education of Malaysia (Ministry of Education Malaysia, 2015). To embrace this shift, the learning management system (LMS) has been prompted more than ever to be utilized by institutions in Malaysia. Therefore, it is relevant to consider LMS usage by students as the organizational impact of the institutions. Meanwhile, since the sense of convenience may serve as an impact to LMS users in terms of instilling positive emotions and enabling cognitive possibilities, convenience can be considered as individual impact.

Therefore, the objective of this paper is to determine significant factors contributing to LMS use among university students in Malaysia using the framework of the DeLone and McLean model (D&M model) with convenience as an individual impact and LMS usage as an organizational impact. The organization of this paper is as follows. The first section lays out the background and motivation of the research. Section 2 provides the theoretical background of the D&M model used in this study. The description of the proposed research model is given in Section 3. Sections 4 and 5 elaborate on the methods and the results of the study while Sections 6 and 7 consist of the discussion, conclusion as well as the suggestions for future studies.

2. Theoretical Background

In the past 30 years, several models have been postulated in a bid to understand the factors that influence an individual's use of technology. Models such as the unified theory of acceptance and use of technology (UTAUT) by (Venkatesh et al., 2003), the technology acceptance model (Davis, 1989), and the DeLone and McLean Information System Success Model (DeLone and McLean, 2003). In terms of Information System (IS) dimensions that are independently considered, two IS dimensions, namely system usage and user satisfaction, have been extensively used as dependent variables in prior research (Jeyaraj, 2020). System usage has been used as the dependent variable in many studies with different models. Studies in the technology acceptance domain employing various models such as the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) their variants have also extensively examined system usage. However, the TAM model, for example, has only two important factors of perceived usefulness and perceived ease of use contributing to the intention to use or the system's use (Davis, 1989) and this model is simple, but it is rather limited in the sense that researchers may need to add other factors or constructs.

The DeLone and McLean IS model is more comprehensive and versatile compared to other acceptance models. To examine the success of a technological system such as the LMS, DeLone and McLean (2003) have proposed a process model where six factors of information quality, system quality, service quality, user satisfaction, individual impact and organizational impact constitute the major characteristics. Information quality, system quality and service quality refer to the characteristics of the system itself as well as of the provider. This model is also versatile because other different factors, which may be represented, for example, as organizational impact and individual impact, can be used together to make the model more sufficient in describing different types of technologies. As a process model, the D&M model has also been extended to include the detailing of the major characteristics or to include other characteristics relevant to the nature of the system of technology being studied. The D&M model is generally recognized and commonly utilized in studies, including e-commerce, cloud computing and internet banking (Angelina, Hermawan and Suroso, 2019; Lian, 2017; Jagannathan, Balasubramanian and Natarajan, 2018). In Malaysia, the D&M model has been used in the study of accounting information systems (Urus et al., 2020).

The D&M model has been used to study e-learning, mobile-learning and LMS in several countries. For instance, a study on mobile LMS has been done in Korea (Lee and Jeon, 2020) while a study on mobile-learning apps has been carried out in Taiwan (Wang et al., 2019). Motivated by the challenge faced by Romanian universities in the implementation of LMS towards the aim of having blended learning environment, a study on the LMS has been done in Romania (Dorobat, Corbea and Muntean, 2019). Findings in a study on LMS in Singapore showed that system quality and service quality had a significant relationship with LMS usage (Chaw and Tang, 2018). Results from a study on students in Sri Lanka have indicated that information quality, system quality, services quality have significant impact on student satisfaction of the LMS (Nawaz, 2019). In a study on e-learning in

Malaysia, the study has used the characteristics of information quality, system quality and service quality (Taat and Francis, 2020).

For the LMS, to a great extent, its success in terms of usage depends on user satisfaction. Convenience has been found to influence students' satisfaction with e-learning (Cole, Shelley and Swartz, 2014). A study on determinants of digital content adoption has confirmed that convenience has a significant indirect effect on user satisfaction with digital content (Hidayat-ur-Rehman et al., 2020). User satisfaction subsequently leads to the continuance of use. These results imply that if users find digital content convenient to use, then they are more likely to continue using the technology. By referring to convenience as the necessary time or effort required for using a technology, a study has incorporated convenience among the factors affecting user satisfaction with commercial e-book stores (Huang, Shiau and Lin, 2017).

3. Proposed Research Model

In this research, the updated D&M model has been modified by including convenience as a novel factor relevant to the LMS usage being studied where LMS usage and convenience are considered as the organizational impact and the individual impact, respectively. The modified proposed model consists of six factors: system quality, information quality, service quality, convenience, student satisfaction and LMS usage. The proposed research model is displayed in Figure 1, followed by the description of each factor and the formulation of hypotheses.

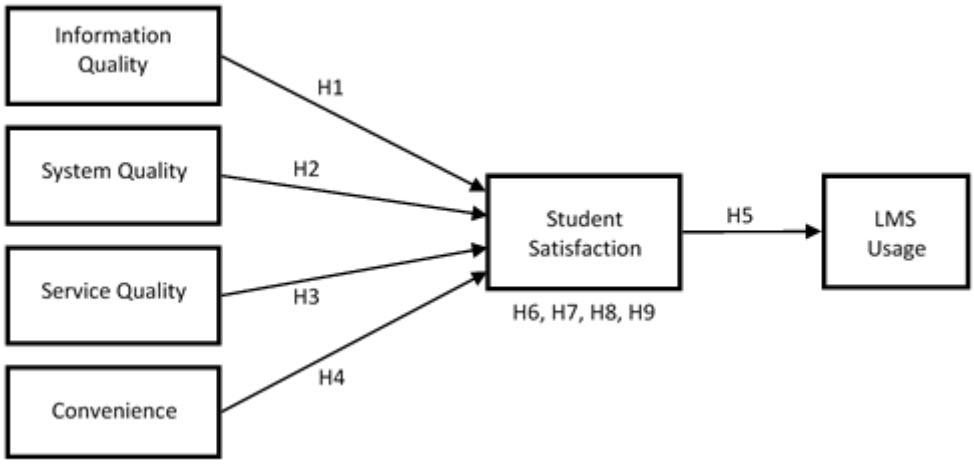

Figure 1: Proposed Research Model

3.1 LMS Usage (LM)

LMS usage may refer to actual usage by measuring the students' actions in using the LMS (Yakubu and Dasuki, 2018). LMS actual usage can be measured by usage frequency, time duration and nature of use (Aldholay et al., 2018). Both frequent and efficient use of the LMS would likely improve students' learning performance (Abdekhoda et al., 2016). A meta-review study on D&M models of information system success yields several measures of actual usage through extent of use other than frequency, such as deep structure use and breadth of use (Jevaraj, 2020). However, since user resistance is one of the main obstacles to the adoption and implementation of LMS, comprehensive adoption by users would depend heavily on user acceptance (Abdekhoda et al., 2016).

Therefore, in this study, LMS usage is defined as the extent to which a student finds using LMS to be acceptable in the sense that it is a good idea and that it is likable as well as pleasurable. This definition is applicable even in the case where institutions have made it compulsory for students to use LMS.

3.2 Student Satisfaction (SS) and LMS Usage (LM)

Student satisfaction refers to the students' evaluation of their overall experience of using the LMS (Wang et al., 2019). Students judge and decide on their continuance decisions regarding LMS usage based on their level of satisfaction. The feeling of satisfaction with the e-learning systems determines students' desire to use them (Ghazal et al., 2018). If the LMS is perceived as satisfactory by students, then the student satisfaction level would

be evaluated as satisfactory (Mtebe and Raphael, 2018). In this study, student satisfaction refers to the student's evaluation of the LMS application with respect to the LMS's quality and their own expectations.

3.3 Information Quality (IQ) and Student Satisfaction (SS)

Information quality is defined as the output characteristics offered by the system including relevancy, accuracy and consistency (DeLone and McLean, 2003). As stated by prior works of research, user satisfaction in regard to e-learning technology including LMS is positively influenced by information quality (Ghazal et al., 2018; Chaw and Tang, 2018; Abdallah, Ahlan and Abdullah, 2019; Ohliati and Abbas, 2019).

In this study, the definition of information quality refers to the students' evaluation of the quality of uploaded educational resources in the LMS in terms of accuracy, sufficiency, preciseness and timeliness. The corresponding hypothesis of this factor is formed as follows:
H1: Information quality has a positive impact on student satisfaction.

3.4 System Quality (SQ) and Student Satisfaction (SS)

System quality refers to the characteristics of the system including ease of use and ease of understanding (Mtebe and Raphael, 2018). Moreover, since system quality is well considered as one of the essential factors impacting user satisfaction of a technology such as the LMS, various studies have called attention to the impact of system quality on user satisfaction with regard to the technology being studied (DeLone and McLean, 2003; Abdallah, Ahlan and Abdullah, 2019).

In this study, system quality is defined as the student's perception of the efficiency of the LMS in terms of user friendliness, ease of access as well as time and location flexibility of access. It is hypothesized that students' satisfaction with the LMS can be determined partly by the quality of the features of such a system. The corresponding hypothesis of this factor is formed as follows:
H2: System quality has a positive impact on student satisfaction.

3.5 Service Quality (SEQ) and Student Satisfaction (SS)

Service quality is defined as the support or assistance that can be provided by the service provider of the information system (Abdallah, Ahlan and Abdullah, 2019). Furthermore, it refers not only to the provision of such support, but also to the timely availability of different communication channels to help users solve arising problems related to the LMS. The provision of system support services for users is considered as one of the most important responsibilities of an institution, since system support can have the greatest impact on the successful usage of the system (Raphael, 2016; Mtebe and Raphael, 2018).

Therefore, it is important to include service quality as one of the factors that can have an impact on student satisfaction. In this study, service quality is defined as the quantity and quality of support or assistance available and provided by the service provider with respect to the system use of the LMS. The corresponding hypothesis of this factor is formed as follows:
H3: Service quality has a positive impact on student satisfaction.

3.6 Convenience (C) and Student Satisfaction (SS)

In an online technology study involving mobile hotel bookings, it was discovered that convenience has a positive effect on user loyalty to technology (Ozturk et al., 2016). For LMS usage, convenience refers to a student's perception of convenience with respect to freedom in terms of time, place and execution that is being felt as a result of using the LMS. The student perceives convenience due to the capability of technology, including in making study information available and in enabling easy and swift contact with the lecturers and with other students (Mokhtar, Katan and Hidayat-ur-Rehman, 2018).

In this study, convenience is defined as a student's perception of convenience in terms of the freedom of study time, the ease of effort to study, the accessibility of study materials and activities as well as the perceived potential study benefit with respect to the use of the LMS. The following corresponding hypothesis is formed:
H4: Convenience has a positive impact on student satisfaction.

3.7 Further Formulation of Hypotheses

The formulation of hypothesis for the relationship between student satisfaction and LMS usage is as follows:

H5: Student satisfaction has a positive impact on LMS usage.

Student satisfaction is considered as a mediation factor between LMS usage and each of the four factors of information quality, system quality, service quality and convenience. Hence, the following hypotheses are formulated:
H6: Student satisfaction mediates the relationship between information quality and LMS usage.
H7: Student satisfaction mediates the relationship between system quality and LMS usage.
H8: Student satisfaction mediates the relationship between service quality and LMS usage.
H9: Student satisfaction mediates the relationship between convenience and LMS usage.

4. Methodology

In this study, the target population are undergraduate and postgraduate students in Malaysian public universities. The sample consists of students from two universities in Malaysia: Universiti Sains Malaysia and Universiti Utara Malaysia. The universities have been utilizing Moodle as the LMS platform. The research has used a quantitative approach using online survey conducted through GOOGLE form. The links to the form have been shared with the students through the WhatsApp group of lecturers as well as through emails of students. Using a convenient sampling technique, this study has employed a cross-sectional survey method. 212 students participated in the data collection. With respect to the selection of sample size, a minimum sample size in a range of 150-400 has been suggested for the analysis using a structural equation model (Hair et al., 2006).

This research utilizes questionnaire items where the research questionnaire is divided into two sections. The first section contains questions regarding the participants' demographic profiles, consisting of students' age, gender, level of education, and years of using the LMS, as well as the type of primary device they use to access the LMS. The descriptive information obtained by SPSS version 22 pertaining to the profile of the respondents is presented in Table 1.

Table 1: Profile of the respondents

Variable	Description	Number of Respondents	%
Gender	Female	140	66
	Male	72	34
Age	18-20	124	58.5
	21-24	25	11.8
	Above 24	63	29.7
Student Level	Undergraduate	194	91.5
	Postgraduate	18	8.5
Years of using LMS	Less than 1 year	124	58.5
	1-3 years	44	20.8
	Over 3 years	44	20.8
Primary device used to access the LMS	Laptop	125	59
	Tablet	2	0.9
	Smartphone	76	35.8
	Desktop	9	4.2

The second section of the questionnaire focuses on responses with regard to the key constructs of the research framework, namely information quality, system quality, service quality, convenience, student satisfaction and LMS usage.

This section consists of 22 items capturing responses on a seven-point Likert scale ranging from (1) "Strongly disagree" to (7) "Strongly agree". The items for the constructs have been adopted from previous studies related to this research. In this regard, the items for information quality (IQ), system quality(SQ) and service quality (SEQ) have been adopted from Abdallah, Ahlan and Abdullah (2019). Meanwhile, convenience (C), student satisfaction (SS) and LMS usage (LM) have been adopted from Mokhtar, Katan and Hidayat-ur-Rehman (2018), Wang et al. (2019) and Abdekhoda, et al. (2016) respectively. The questionnaire items for each construct are given in Table 2.

Table 2: Measurement Constructs

Construct	Code	Questionnaire item
Information Quality	IQ1	LMS can provide me accurate information.
	IQ2	LMS can provide me with sufficient information to do my tasks.
	IQ3	LMS can provide the precise information I need.
	IQ4	LMS can provide updated information regarding my tasks.
System Quality	SQ1	LMS has a well-designed user interface.
	SQ2	LMS offers flexibility as to time and place of use.
	SQ3	LMS language and means of communication are effective.
	SQ4	I can easily access LMS anytime I need to use it.
Service Quality	SEQ1	Training on the operation of LMS is sufficient.
	SEQ2	I can communicate with the technicians through multiple channels.
	SEQ3	The training provided can enhance my ability to use LMS.
	SEQ4	In general, the university provides enough support to help using LMS.
Convenience	C1	Using LMS enables me to search for the information/content for my study, without time constraints.
	C2	Using LMS saves my effort in performing my study and assignments activities.
	C3	Using LMS allows me to improve learning outcomes.
	C4	I can conveniently access and use LMS quickly
Student Satisfaction	SS1	I am satisfied with the LMS applications.
	SS2	The LMS application is of high quality.
	SS3	The LMS application has met my expectations
LMS Usage	LM1	Using LMS is good idea.
	LM2	Working with LMS is a pleasure.
	LM3	I like working with LMS.

4.1 Construct Reliability

A pilot study, consisting of 20 participants, has been carried out using a Google form to assess the reliability of the constructs. The scale reliability test has been performed to obtain the Cronbach's alpha reliability coefficient. For each of the constructs used in this research, the Cronbach alpha values observed are over 0.8 as shown in Table 3. The Cronbach's alpha values within the range of 0.8 and 0.9 are considered very good while Cronbach's alpha values more than 0.9 are considered excellent (Nawi et al., 2020). Thus, the internal reliability of the constructs used in this study has been established.

Table 3: Reliability of Constructs

Latent Construct	No. of items	Cronbach's Alpha
IQ	4	0.911
SQ	4	0.858
SEQ	4	0.910
C	4	0.902
SS	3	0.912
LM	3	0.912

5. Results and Analysis

Data analysis of Partial Least Squares Structural Equation Modeling (PLS-SEM) has been done with SmartPLS 3.2.8. The comprehensive two-step statistical approach of PLS-SEM consists of the establishment of a measurement model and a structural model.

5.1 Measurement Model

The two-step statistical approach towards modelling a PLS-SEM model begins with the establishment of the measurement model. To accomplish this establishment, the data of 212 participants have been analyzed using PLS-SEM where corresponding required values, including composite reliability (CR) and average variance extracted (AVE) are obtained. The measurement model with respect to PLS-SEM, examines the constructs' reliability and validity with respect to the calculated main loading values acceptable for each item of the construct used in this study.

Table 4 tabulates the acceptable main loading values for each item of the construct used this study as well as values of CR and AVE. The questionnaire item C3 has been found to be unsuitable for the measurement model due to the low main loading value and has been deleted. Thus, it can be observed from Table 4 that each of the remaining items has main loading value of more than 0.708. The value of 0.708 has been suggested as a rule of thumb for the lower value of acceptable main loading value (Hair et al., 2019).

In examining the reliability of the constructs with respect to the remaining items, it has been found that the CR value for each of the constructs has been found to be above 0.70, gratifying the rule of thumb presented by Hair et al. (2019). For example, the construct C has a CR value of 0.939 as can be observed in Table 4.

The AVE values given in Table 4 indicates the validity of the constructs used in this study. A construct with AVE value of above 0.5 is considered satisfactory in terms of convergence validity (Hair et al., 2019). Therefore, all values of AVE in this study are of satisfactory degree of convergence validity.

Table 4: Measurement Model

Latent Construct	Items	Main Loading	CR	AVE
C	C1	0.902	0.939	0.836
	C2	0.928		
	C4	0.913		
IQ	IQ1	0.893	0.937	0.789
	IQ2	0.907		
	IQ3	0.870		
	IQ4	0.883		
SEQ	SEQ1	0.895	0.937	0.787
	SEQ2	0.846		
	SEQ3	0.907		
	SEQ4	0.899		
SQ	SQ1	0.777	0.904	0.703
	SQ2	0.860		
	SQ3	0.851		
	SQ4	0.863		
SS	SS1	0.928	0.945	0.851
	SS2	0.910		
	SS3	0.928		
LM	LM1	0.912	0.945	0.851
	LM2	0.954		
	LM3	0.928		

5.2 Validation of the measurement model

Discriminant validity of Heterotrait-Monotrait (HTMT) ratio is used to validate the measurement model. The value of 0.90 has been used in prior studies for the construct maximum threshold of HTMT ratio (Gold, Malhotra and Segars, 2001; Hair et al., 2019). With respect to this threshold value, results given in Table 5 indicate the validation of the measurement model.

Table 5: Discriminant validity of Heterotrait-Monotrait Ratio (HTMT)

Construct	C	IQ	LM	SEQ	SQ	SS
C						
IQ	0.831					
LM	0.900	0.796				
SEQ	0.811	0.786	0.752			
SQ	0.869	0.886	0.863	0.866		
SS	0.886	0.846	0.878	0.842	0.887	

5.3 Structural Model

Having established the measurement model, the second step of the two-step statistical approach toward modelling a PLS-SEM model is to establish the structural model. Path coefficients as well as described variances are included in the structural model. Bootstrapping procedure has been used to sharpen the regression coefficients (or the beta values) by obtaining bootstrap standard errors where 5000 random subsamples have been extracted from one original sample with replacements. A constant repetition of such a process is required of which 5000 is the typical number (Hair et al., 2019). Subsequently, the PLS path model has been estimated using these subsamples.

The results pertaining to the significance of the paths corresponding to hypotheses H1, H2, H3, H4 and H5 are tabulated in Table 6. It can be observed the p-values obtained for the paths indicate that hypotheses H1, H2, H3, H4 and H5 are supported.

Table 6: Significance of direct effects - Path coefficients (n=212)

Hypothesis	Path	Beta value	SE	t-value	p-values	Result
H1	IQ -> SS	0.202	0.082	2.447*	0.007	Supported
H2	SQ -> SS	0.194	0.079	2.449*	0.007	Supported
H3	SEQ -> SS	0.224	0.058	3.840**	0.000	Supported
H4	C -> SS	0.342	0.086	3.991**	0.000	Supported
H5	SS -> LM	0.807	0.031	25.696**	0.000	Supported

Note: *p<0.05, t>1.645, **p<0.01, t>2.327, ***p<0.001, t>3.092 (one tailed); SE: Standard

An evaluation regarding the significance of the PLS structural model's indirect path, which is the mediating effect, has also been performed following the bootstrapping of 5000 random subsamples. Mediation is assumed to take place when there exists a statistical significance in the indirect relationship between the independent and the dependent variables (Hayes and Preacher, 2014). Using path analysis, the estimates are calculated and the results are given in Table 7. The corresponding four indirect relationships have been proven to have statistical significance where the p-values obtained for the indirect paths indicate that hypotheses H6, H7, H8 and H9 are supported.

Table 7: Significance of specific indirect effects - Path coefficients (n=212)

Hypothesis	Path	Beta value	SE	p-values	t-value	Result
H6	IQ -> SS -> LM	0.163	0.067	0.015	2.437	Supported
H7	SQ -> SS -> LM	0.156	0.064	0.014	2.446	Supported
H8	SEQ -> SS -> LM	0.181	0.048	0.000	3.775	Supported
H9	C -> SS -> LM	0.276	0.073	0.000	3.775	Supported

Note: *p<0.05, t>1.96, **p<0.01, t>2.58 (two tailed); SE: Standard Error

With regard to effect size, a few guidelines stated by Cohen (1988) have been followed in this study in terms of value assessment in the independent constructs or variables towards the prediction of the dependent constructs or variables. By evaluating the effect size related to the connecting path between each independent construct and its corresponding dependent construct, the model's fit can be decided. Moreover, each independent construct's impact power on its related dependent construct signifies the effect size (Cohen, 1988). Using 0.02, 0.15 and 0.35 to respectively be small, medium and large values for the effect size, the obtained values of 0.071 for the SEQ on SS, 0.053 for IQ on SS and 0.043 for SQ on SS are all considered to be of small effect sizes, whereas the value of 0.156 for the effect size of construct C on SS falls under the category of a medium effect size.

5.4 Validation of the structural model

In this study, both R-square value (R^2) and Stone-Geisser's Q^2 have been used to validate the structural model. Aside from taking the magnitude of the value of R^2 into consideration, the Stone-Geisser's Q^2 is a technique which can be employed as a criterion to determine predictive relevance. This technique has been used to evaluate the prediction capabilities of the research model (Henseler, Ringle and Sinkovics, 2009). Values of Q^2 exceeding zero specify the existence of predictive relevance in the independent constructs in regard to the dependent construct (Hair et al., 2019).

Figure 2 provides an illustrative display of the paths considered in the PLS model where it portrays some similar values that have been given in Table 6. For example, the value of 0.342 on the path of C to SS in Figure 2 refers to the same coefficient value as given in Table 6. With regard to the validation of the structural model, it can be observed in Figure 2 that the R^2 value obtained with respect to the direct effect of the four independent variables of IQ, SQ, SEQ and C on SS is 0.757, while the value corresponding to the impact of SS on LM is 0.652. These results indicate a strong fit of the model, as suggested by Cohen (1988), where R^2 values of .02, .13, and .26 are considered as weak, medium, and strong, respectively. In addition to that, the results from the validation of the model using Stone Geisser's Q^2 technique indicates outstanding predictive relevance for the research model where the obtained value for the variables of IQ, SQ, SEQ and C on SS is 0.601 while the value corresponding to the impact of SS on LM is 0.531.

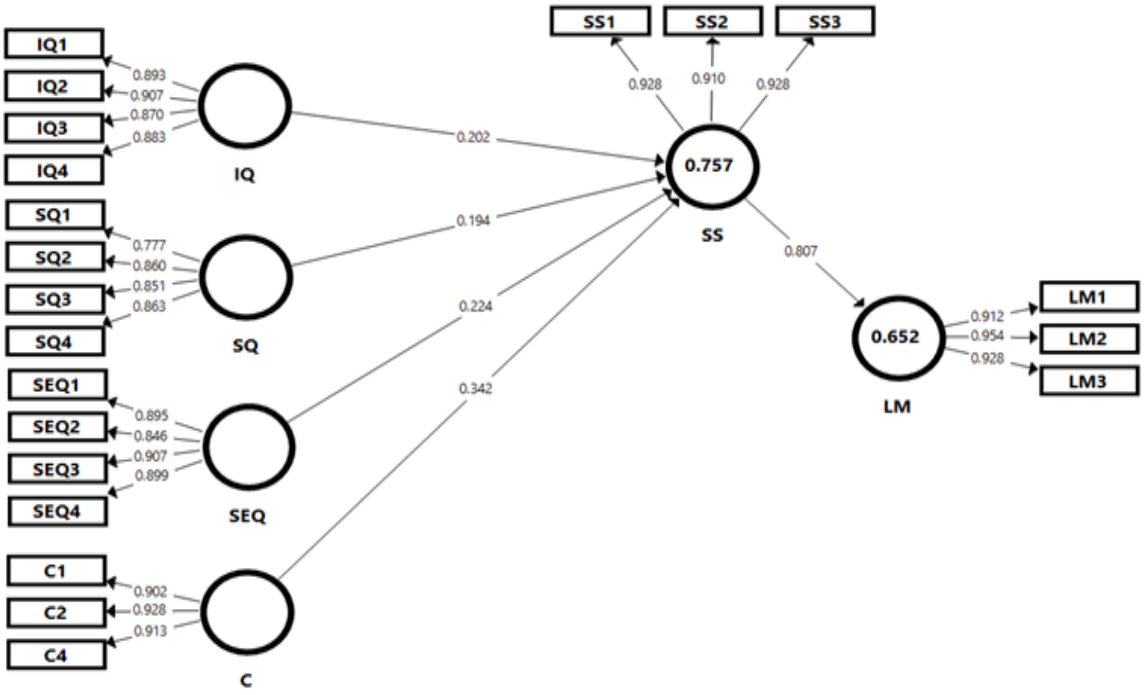

Figure 2: PLS path analysis with R^2 values

6. Discussion

In assessing the quality of the established measurement model with respect to PLS-SEM, the results of the reliability and validity tests of the model indicates that the formulated constructs are reliable and valid. Meanwhile, the validation of the structural model indicates that the obtained model not only has a strong fit but also outstanding predictive relevance.

Based on the results from the established structural model with respect to direct effects, hypotheses H1, H2 and H3 are supported. This implies that information quality, system quality and service quality have positive impact on student satisfaction, similar to the results of Lee and Jeon (2020). In a study by Ohliati and Abbas (2019) information quality and service quality been found to be a significant factor. However, studies by Ghazal et al.

(2018) and Abdallah, Ahlan and Abdullah, (2019) have yield significant results for information quality and system quality.

In this regard, results confirm that the quality of information provided in the LMS significantly affects student satisfaction. When students are able to ascertain reliability, readability, accuracy and effectively-structured course content as well as an updated LMS, they are more likely to be satisfied when using the corresponding system (Abdallah, Ahlan and Abdullah, 2019; Ghazal et al., 2018).

Results from the established structural model with respect to direct effects also indicate that hypothesis H4 is supported. This further implies that other than information quality, system quality and service quality, convenience also has positive impact on student satisfaction. In addition, with respect to effect size of the independent variables on student satisfaction, convenience has a larger effect size than information quality, system quality and service quality.

Results with respect to direct effects also indicate that hypothesis H5 is supported, indicating that student satisfaction has a positive impact on LMS. This implies that when students are satisfied with the system, the LMS is more highly used. Although this is a study of students in Malaysia, the implication may be important other developing countries towards understanding the importance of student satisfaction towards LMS usage in their universities.

For indirect effect or the mediating effect of student satisfaction on LMS usage, the hypothesis H6, H7, H8 and H9 are all supported. Therefore, student satisfaction has been found to significantly mediates the relationship between each of the four factors and LMS usage where the four independent factors in this study are information quality, system quality, service quality and convenience.

Based on the established structural model, all direct paths as well all indirect paths have been found to be significant. This also implies that all the hypotheses formulated in this study are supported. Therefore, information quality, system quality, service quality and convenience have positive effects on student satisfaction which, in turn, has a significant impact on LMS usage.

7. Conclusion

In this paper, a process model of the information system derived from the study of DeLone and McLean has been constructed for LMS. This study is aimed to present a model to evaluate LMS usage for students in higher education in Malaysian universities by adapting the D&M model, with LMS use as an organizational impact and convenience as an individual impact. In this research, a process model as well as its corresponding metrics have been presented and verified. Towards determining the structure of the model, all paths have been found to be significant. In other words, information quality, system quality, service quality and convenience have positive impacts on student satisfaction, which, in turn, has a significant impact on LMS usage.

In this research, the newly introduced factor convenience, which is considered as individual impact, has been discovered to be a significant factor in determining LMS user satisfaction among university students in Malaysia. Student satisfaction has been found to have the highest effect on LMS usage. This implies that when students are satisfied with the system, the system use increases. The results of the study may help the university's administration in the country understand the importance of student satisfaction of the LMS in their universities. Therefore, having made enormous effort in terms of the funding of infrastructure and manpower with the belief of the importance of the LMS towards enhancing education, the institutions are recommended to change the focus towards enhancing student satisfaction to achieve intended LMS use by the students. Furthermore, in line with the results of this study, to enhance student satisfaction, the institution is also recommended to focus improvements not only on information quality, system quality and service quality but also on convenience as the individual impact on students. Enhancing information quality, system quality and service quality would require training of the relevant providers such as lecturers, instructors, system personnel or coaches, and regular updates of LMS platform. As for enhancing the factor convenience which is considered as individual impact, it is crucial for the institutions to highlight the convenience of using LMS by regularly advertising and promoting the various dimensions of convenience of LMS to the students.

8. Suggestions for future research

The participants of this study on LMS are undergraduate and graduate students in universities in Malaysia. Therefore, it is our suggestion for future researchers to utilize cross-sectional surveys consisting of a larger population of students from a variety of developing countries. In addition, since different information would be uploaded by the providers in the LMS for different areas of study, it is also suggested to look into students of a specific study area where they can make responses while focusing on certain specific courses or area of study, for example, language, mathematics and agriculture.

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EdTech Culturation: Integrating A Culturally Relevant Pedagogy into Educational Technology

Jenny Eppard, Amir Kaviani, Michael Bowles and Jason Johnson
Zayed University, United Arab Emirate
jrk3r@virginia.edu
amir.kaviani@zu.ac.ae
michael.bowles@zu.ac.ae
jason.johnson@zu.ac.ae

Abstract: In recent years, the use of technology in educational contexts including e-learning has become increasing ubiquitous. While it is commonly believed that technology use can facilitate the process of teaching and learning, it is of paramount importance to adopt a Culturally Relevant Pedagogy (CRP) to address the needs of students who might experience difficulty because of cultural, linguistic and technological obstacles that might be inherent in the use of educational technology. With this consideration in mind, the present paper reports on the findings of a qualitative research involving three case studies based on structured interviews with three university professors who are experts in developing digital tools and applications for educational purposes. The participants recorded their responses to interview questions on Google Docs over a period of one month, and the data was analysed for significant themes. The data revealed that all participants believe that cultural, methodological and pedagogical barriers can significantly affect the use of educational technology in face-to-face and online classes and can consequently impact student learning. The emergent themes in the data indicate that a solid understanding of the local context in which the process of teaching and learning takes place, flexibility in terms of one's methodological approaches to teaching and embracing differences in students' knowledge and abilities can help ensure students succeed in their academic endeavours, they are uncritically accepted and treated in an equitable manner regardless of their competency level. All three participants in the study believe that while there are some cultural and linguistic barriers in e-learning contexts and in developing and using technological applications for students, through adopting the core principles of a culturally relevant pedagogy (CRP), they have been successful in achieving the course learning outcomes for their students. They argue that by adapting the language used in applications to the linguistic level of students, using familiar and culturally relevant themes, and adopting a blended approach in which technology complements face-to-face instruction, a better dialogue is established between the teacher and the students, and learning is thus facilitated. The findings of this study reveal that becoming familiar with the local culture, the relevant prescriptions and proscriptions can furnish the education technology developers with the requisite knowledge for creating applications that are relevant to students' lives and are thus more effectual. Similarly, the results show that educational applications should provide a suitable platform to create and maintain an ongoing intrapersonal and interpersonal dialogue for the students to help them engage in the process of learning in a regular and consistent manner. Implications for pedagogy and research will be discussed.

Keywords: Culturally Responsive Pedagogy, Educational Technology, EdTech Culturation, Equitableness, Inclusiveness

1. Introduction

The United Arab Emirates has a large expatriate population (88.52%) and a relatively small local citizenry (11.5%) (Population of the UAE, 2020). With such a large and diverse expatriate population, providing a space for Emiratis to engage in cultural practices specific to the local context is becoming increasingly difficult. The public education sector in the UAE tries to provide space and resources for students to feel culturally connected. For example, public universities enrol mostly local students. However, while the students are Emirati, most of the teaching faculty come from outside the country (Qs Top Universities, 2020). Many of the resources such as textbooks and educational technology are imported mainly from English-speaking countries. In such a context which resembles other educational settings that comprise a mostly western pedagogical framework with local students (Ladson Billings, 1995), there is a need to include elements of Emirati society in teaching and learning, such as content and learning strategies, in order to empower the local student population.

Like other parts of the world, the UAE is moving from an educational environment of traditional, rote learning to one that highlights the importance of 21st Century Skills such as critical thinking, creativity, collaboration and communication skills (UAE Ministry of Education: Quality Education, December 2020). In line with this, educational technology is central to integrating these aspects of learning and teaching practice (Bond et al., 2020). However,

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similar to the use of other resources, the challenge is to implement digital technologies that empower the local students, and that these technologies are not getting in the way of learning (O'Donnell, and Sharp, 2012; Kennedy and Dunn, 2018).

In this research paper, the researchers would like to recommend the term "EdTech culturation" as a pedagogical approach which requires a sound understanding of and adeptness in the use of technology in classroom and out-of-class teaching and learning, which is appropriate for the relevant sociocultural context. The present research thus focuses on EdTech culturation as a dynamic process as well as a valid ethnomethodological approach in the context of higher education. Such an approach represents a Culturally Responsive Pedagogy (CRP) in diverse sociocultural contexts and facilitates achieving learning outcomes. In light of this perspective, the researchers believe through the use of appropriate technology, digital educational tools will be more meaningful and relevant to the specific needs of the students and help to engage in learning in a consistent and effective manner.

In the present study, the researchers have endeavoured to use technological tools and teaching approaches that are culturally appropriate and relevant to the context. While almost all the students the faculty teach come from a homogenous background culturally and linguistically, the use of "imported" technology in such a context can sometimes lead to problems for students, as they might not be able to understand how to use digital tools effectively in accordance with the expectations of the faculty who often come from other cultures. Such problems for students from Arab countries have been highlighted by some researchers. For example, Al Hashlamoun (2021) in a study of Arab students studying in Western institutions, highlights that these students prefer to speak in their mother tongue, and they find it difficult to use eLearning tools and feel demotivated as they did not find the programme relevant to themselves and/or their sociocultural context. The participants in the current study have thus adopted and adapted a Culturally Relevant Pedagogy through providing their students with more equitably accessible educational resources with the aim to minimise technological apprehensions due to cultural and linguistic barriers. Hence, the purpose of this study is to highlight how adopting such a pedagogical approach can be instrumental in facilitating students' learning as they will, in all likelihood, be "enabled" to follow instructions and use educational technology in a more effective and efficient manner.

2. The Study

2.1 Literature Review

2.1.1 Ethnomethodology, Acculturation, Cultural Relative Pedagogy

In 1967 Garfinkel, the prominent American sociologist developed the theory of ethnomethodology which is principally based on phenomenology. Phenomenology is a school of philosophy concerned with the study of lived experiences as opposed to the actual phenomena and their properties in the real world. The concept of ethnomethodology is of distinct relevance to educational practices in different social contexts. This is because both the theory and the praxis of educational activity at all levels implicate situated linguistic and non-linguistic activity encompassing contextual, reactive and descriptive features (Keller, 2011; Meyer, 2019).

These unique qualities require a constant meaning-making and meaning-giving approach that helps translate the theoretical principles into relevant and practical activities. Therefore, it is important to understand the specific socio-cultural context in which the situated pedagogical activity takes place (Dunn, Sondel and Baggett, 2018). The nature of this activity is thus defined by the design of the lesson and the predictable as well as the unpredictable linguistic and non-linguistic behaviour of the participants (Wilson, 2019). In particular, the observation and description of both teachers and students' demeanor may lead to a unique understanding which helps develop the right ethnomethodological approach to pedagogy, one that allows for the specifics of the context, the social rules and expected norms (Scott, Hirn, and Cooper, 2017).

In such a scenario, the use of any type of methodological approach necessitates adaptation and acculturation. Lakey (2003) posits that "... the terms "assimilation," "cultural integration," "accommodation," "absorption," and "self-identification" are used, not necessarily equivalently, but to refer generally to the concept of "acculturation." (p.106). Similarly, Ng and Nagayama (2011) maintain that "Acculturation is a multidimensional process of how one

culture adopts aspects of another culture's values and behaviors such as attitudes, language, and beliefs. It is generally defined as a change in cultural attitudes, values, and behaviors due to contact of one culture with another...". Berry (2005) also defines acculturation as "… the process of cultural and psychological change that takes place as a result of contact between cultural groups and their individual members." Sam (2015) argues that acculturation results in "affective", "behavioral" and "cognitive" changes in the individual.

The process of education is without a doubt one with its own acculturation features for both the teachers and the learners especially when they come from different backgrounds and are accustomed to specific cultures of and beliefs about education. For example, Cilesiz (2015) in a study of undergraduate university students' experiences with recorded lectures, highlights four stages of "ignorance", "disillusionment", "crisis" and "coping" that students undergo before completely being acculturated into using recorded lectures as a viable substitute for face-to-face lectures (p.478). Correspondingly, Choney, Berryhill-Paapke and Robbins (1995) recommend a five-level model of acculturation which shows how individuals move from their "traditional orientations", "transitional orientation", "bicultural orientation", "assimilated orientation" and finally a "marginal orientation". The traditional orientation signifies attachment to one's own cultural norms and traditions, while the transitional stage is characterised by becoming familiar with the new culture. The bicultural orientation shows how the individual is accepting both cultures as viable ways of doing things. The assimilated orientations are mostly inclined towards the new culture with some remnants and familiarity with the first culture. Finally, a marginal orientation reveals being uncomfortable with both cultures. The movement from one stage to another is not always linear, but each stage has its own characteristics and features. Today's universities not only comprise people from different linguistic and cultural backgrounds, but also constitute plural cultures of education due to the fact that professors and students come from diverse social and institutional cultures.

Doubtless, the culture of higher education in the twenty-first century is an amalgamation of diverse social cultures and traditions as well as a variety of cultures of education, i.e. norms of teaching and learning. In such a context, teachers bring their own teaching styles and students bring to the university their expectations of what a culture of higher education should constitute and represent. The researchers believe that this complex system of cultures within cultures reveals transitions from one stage to another at every level. New methodologies including innovative educational technologies are no exception. Thus, moving from one stage to another is gradual, gradational and not necessarily straightforward, filled with obstacles in terms of acceptance from both the students and teachers.

2.1.2 Characteristics of Culturally Responsive/Relevant Pedagogy

Ladson-Billings (1995) believes that a culturally responsive pedagogy is a dynamic approach, one that focuses on and fosters students' academic success, promotes their cultural competence and inculcates in them critical cognisance as regards the social ramifications of their environs. She believes it is only through effective conceptualization of notions of "self","other" and "knowledge" that educators and researchers alike can develop a sound understanding of culturally relevant pedagogy and apply the principles in their teaching and/or research. (Ladson-Billings, 1995 and 2014).

Jabbar and Mirza (2019) believe a culturally responsive pedagogy in higher education is based on five major concepts of cultural consciousness, resources, moral responsibility, cultural bridging and curriculum. They believe an effective culture of higher education allows for capitalising on plurality of and interaction between cultures, strengthening moral and professional responsibility and responsiveness and enabling students to become successful through the use of resources and effective curricula. Similarly, Ladson-Billings (2014) argues that a culturally relevant or "sustaining" pedagogy is characterized by a flexible understanding of cultures and teaching methodologies that allow for equality and equitableness. Adopting such an approach in educational settings where teachers and students represent multiple ethnicities can in all likelihood be conducive to teachers becoming more reflective and aware of their role as educators to allow for differences (Samuels, 2018; Johnson, and Elliott, 2020). These studies indicate that an understanding of students' cultures, their competency levels and their learning styles, can help design teaching activities that are outcome-based and relevant to students' lives. The studies also show that through adopting a culturally responsive pedagogical approach, educators can develop more valid and meaningful assessments that help evaluate students' achievement in diverse ways.

Gay (2002) posits that a culturally relevant pedagogy should embrace and promote knowledge of diverse cultures, include curricula that are culturally relevant, foster caring cultures and communities, facilitate communication between cultures and create cultural affinity in teaching. Adopting a culturally relevant pedagogy is seemingly a more cumbersome and complex process when teachers and students do not speak the same language, and come from different countries and socio-educational backgrounds with specific cultures of education.

A number of studies explore the effectiveness of a culturally relevant pedagogical approach in different sociocultural contexts. For example, Hamdan Alghamdi (2014) in a study of expatriate teachers' pedagogical practices in Saudi Arabia, discovered that adopting a culturally relevant pedagogy was rather challenging for these teachers. This was mostly because of teachers and students' different beliefs about what constitutes teaching and learning, which in turn made adjusting teaching unwieldy for the teachers. In another study of two expatriate teachers working in China who had distinctly different teaching approaches, Shi (2017) considers being straitjacketed by stereotypes a big impediment in having a culturally relevant pedagogical approach and highlights the importance of establishing a dialogue between local students and foreign teachers in order to become familiar with their perspectives on best practices in the local context and proceed accordingly.

2.1.3 Acculturation of technology, "EdTech culturation"

Education around the world has diverse origins. In the Gulf region, for example, education started with religious schools or madrasas with mostly mimicry and memorisation drills and exercises (Alhebsi, Pettaway and Waller, 2015). In the Americas, first nations people used education as a way to pass on skills such as knowledge of the land and knowledge of native traditions (Urban, Wagoner, and Gaither, 2019). English education has its roots in an interplay between church, apprenticeship, family and community (Cremin, 1970). Indian education, one of the oldest in the world, focused on verbal and religious education for boys and practical skills for women (Jayapalan, 2005)

Regardless of the origins, while informal education was widespread, much of the early days of formal education was only available to a few individuals. However, the recent trend is for education to be available on a mass scale in order to provide an outlet for upward mobility. Ramirez and Boli (1987) claimed that mass schooling originated in Europe in the eighteenth and nineteenth century and has branched out to other parts of the world ever since. Spring (2008; 2015) argued that mass formal education is one of the main commonalities that all countries and cultures now share.

As a legacy of European education and because of the spread of American ideas throughout the world, many education systems mirror structures developed by and for these populations. For example, textbooks and other resources are often created by and for a population rooted in European cultures or a non-localized context (Ajibade and Elemi, 2012) Therefore, the content, imagery and context all reflect these origins. However, there is a need to create educational systems and resources that focus on reinforcing the needs of diverse populations (Quaye, Harper and Pendakur 2019).

Parallel to the emergence of this need, has been the importance of digital technologies as a central component to education and society at large. In order to support the needs of current and future learners, digital technologies have the potential to be a source for learner agency. However, in order to ensure that educational technology is integrated successfully in various contexts, there is a degree of EdTech culturation that needs to occur (Wu, 2017). Thus, professionals involved with creating educational technology resources should consider EdTech culturation that focuses on the following: (1) the way local community views learning activities; (2) the needs of localized communities within the larger world; (3) the involvement of individuals from the local culture in the design of materials; (4) an increase in learner autonomy (Dang, 2010). Clearly, the ultimate goal is to promote educational technology that forms a connection between the learner's identity and the materials, and for the digital technology tool to be both culturally and cognitively additive and not subtractive. In other words, individuals and local communities should be able to use technology as a means to explore their own learning needs and preferences based on their lived experiences in such a way that they could develop a good degree of educational autonomy.

These challenges hold true for educational technologists in the United Arab Emirates and the Arab world in general. Multiple studies describe the use of educational technology in the United Arab Emirates, which include flipped learning, blended learning, student perceptions and iPad integration (Hani, 2014). However, more research needs to be conducted to explore the best ways to utilise technology in the local context. Such research will aim to increase agency for Emirati students based on their individual social, and local needs, and help determine why these strategies are successful in this context or otherwise.

Previous studies indicate that Emirati students prefer to learn collaboratively and value personal relationships (Rapanta, 2014). Culturally, they place great importance on their community, their family and their religion (Engin and McKeown, 2012). Therefore, including all or some of these elements when designing digital tools could conceivably make learners feel more connected and supported culturally. This idea was highlighted by Rogoff (2003) who argued that curriculum and lesson designers should focus on the needs of the individual learners in a community as well as the culture needs of the cultural community as a whole. Similarly, Sulecio de Alvarez and Dickson-Deane (2018) state: "This allows for mindful incorporation of new perspectives to enrich learning experiences, by stimulating the strengths of local cultural processes, instead of alienating the communal perspective" (p. 346).

The authors further argue that educational technology has the potential to be transformative. It can provide learners with tools to create their own meaning that are easily disseminated and adapted to future needs. (Sulecio de Alvarez and Dickson-Deane, 2018).

In line with the main principles of a culturally responsive pedagogy and the relevant findings in the studies reviewed herein, the authors seek to investigate and shed light on the following areas:

- How can an educational technology project successfully implement culturally appropriate technology?
- What are some of the pedagogical barriers to using educational technology in a local context?
- What are some of the cultural barriers to using educational technology in the UAE?

The study was conducted in the United Arab Emirates where the researchers and the participants are currently living and working.

3. Methodology

3.1 Participants

This research is a qualitative case study of three participants, two of whom are from the United States and one is from the United Kingdom. All participants teach undergraduate courses at a university in the United Arab Emirates. In addition to teaching at university, the participants also develop pedagogical applications and digital teaching and learning tools for use within a university context. The three participants are western-educated professors who have lived and worked in the United Arab Emirates for more than a decade. Their teaching experiences are varied and include teaching English as a Second Language, Education Studies and Mathematics to the undergraduate students who are almost all from the United Arab Emirates. Due to the increasing need in their professions to develop and use technology in teaching at university, the participants in the study have been involved in creating educational technology tools to support teaching and learning in the local context. Learners used these applications on their digital devices as ancillary pedagogical facilities. The participants also created online classes open to the public to provide support for learners who are mostly Emiraties and needed to improve various academic skills including their knowledge of English. The participants also designed online classes for the professional development of preK-12 teachers using bilingual features as well as local imagery and concepts to make it easier for them to master teaching of the foundations of English Grammar. The selection of the participants in this study has been in line with "purposive sampling", as the three participants share an interest in Culturally Relevant Pedagogy (CRP).

3.2 Research Instrument

In order to collect data for the study, structured interviews were administered online with the use of Google Docs. Due to the current pandemic, for the purpose of minimising the possible health risks, the online platform was used

for data collection. In order to seek the insights and opinions of the participants in the study, they were asked to comment on the cultural relevance, cultural appropriateness and cultural barriers of the projects they had developed. They were also asked to reflect on how their projects have been able to support learning and reflect on their noticeable successes as well as inadequacies. The interview questions were informed by and developed based on the existing literature in the field, the researchers' personal observations of their students' difficulties in their classes, and their teaching strategies to help them master the relevant knowledge and skills. The use of Google Docs as a way of recording responses to interview questions proved to be practical and effective, as the researchers were able to ask follow-up questions based on the information already furnished by the participants, which enriched the data collected for the study. *(The list of questions appears in Appendix I).*

3.3 Research Design

Considering the nature of the study conducted, the researchers opted to adopt a case study approach to investigate the research problem. The choice of a case study was deemed advisable, as the participants teach different subjects in different departments at university, and this can enrich the study as each participant will bring discipline-specific teaching experiences and insights into the current research. Likewise, the participants' unique experiences in developing different educational technology tools can help see the problem of a Culturally Relevant Pedagogy from different angles, i.e., based on their own experiences of using these tools and how these tools can address the needs of their students. The fact that all participants teach in the same context can also highlight the similarities in terms of the problems they face in either developing or teaching their students in the same context.

3.4 Data Analysis

As stated earlier, the qualitative data collected in this study is in the form of case studies of three professors who are all educators and experts in developing educational applications as well as digital teaching and learning tools. The data was collected over a period of one month. Each participant's responses on Google Docs were analysed using the qualitative analysis method, and the salient themes were selected for presentation in this paper. Each researcher individually coded the data based on what they considered a "salient" theme. Salience of the themes was determined through considering the significance attached to a theme by any of the participants. In order to maintain the trustworthiness of the themes, (Lincoln and Guba, 1985) the emergent themes were collated, and the researchers re-visited the data over a period of three months and agreed on what constituted the main themes in the three case studies.

In the following sections, each case study will be presented using fictitious names to maintain confidentiality of the participants. Throughout the study, and in the revision process, they were sent every version of the draft. They gave their written consents to use the given names and the data used for the presentation in the study.

4. Findings

4.1 Case Study One: Jacob, A Mathematics Education Researcher and Digital Application Developer

Jacob has extensive experience of teaching mathematics in different countries and various sociocultural settings, and has been involved in developing educational tools for his students who come from different cultural and linguistic backgrounds. In the following section, the main themes in Jacob's responses to interview questions will be explored.

4.1.1 Linguistic barriers and student learning

Jacob believes that there are many western apps that help students strengthen their mathematics skills through games and manipulations of the relevant mathematical tasks and activities. However, he thinks that most of these apps do not consider students' culture and/or mother tongue.

When asked to reflect on one of his educational technology research projects, Jacob distinctly highlights the importance of these factors in developing his project:

> *These two factors were taken into consideration when a research project was designed to create an IOS math app to allow grade six Emirati students an opportunity to explore mathematics, along with using Bayesian Networks to examine the educational implications. The learning app was developed using*

ethnomathematics modules, based on the Emirati culture. Students were required to navigate through several modules to explore various mathematical concepts from algebra and geometry. Some aspects of the app were translated to Arabic....

4.1.2 The importance of cultural relevance in developing educational technology:

When Jacob was asked to comment on how he made this project culturally relevant, he mentioned:

Our project is considered culturally relevant, since we aim to connect the students' culture to the curriculum. In other words, we allow students to have a meaningful experience with mathematics. For example, in our pilot study, each prospective Emirati early childhood teacher was required to create one ethnomathematics learning activity based on the Emirati culture that could be displayed on our mobile device. One prospective early childhood teacher created an activity using a Talli (حرفة التلي) - a type of embroidery that is used on Emirati women's clothes. To make a Talli a Cajoja (كجوجة) machine is used. The student explained that in the beginning, she was highly interested in exploring mathematics and the Emirati culture; and was unable to think of an idea. She further described the assignment to her grandmother; and her grandmother gave a wonderful example – Talli (حرفة التلي). The student was aware that her grandmother designed and created Talli but never knew the extent she went through to develop the Talli. In the end, she and her grandmother designed and created Talli (حرفة التلي) together.

In response to the question about ways of successfully developing culturally appropriate educational technology, Jacob further comments:

For example, one module for our second Math App will explore the use of a Gargoor (Arabic القرقور). A Gargoor is a traditional Emirati dome-shaped wire-netting cage that is used in fishing. A fish enters the Gargoor through the funnel entrance and is unable to leave the cage. In 2019, the UAE government banned the use of the Gargoor due to endangered fish entering the cages and abandoned cages. The module requires students to create an alternative to the Gargoor that could be used by an Emirati fisherman. The module supports innovative ideas such as the material used to create the Gargoor; otherwise, the Gargoor floats. Again, we want students to use their creative imagination to design an alternative structure to the Gargoor.

4.1.3 Institutional and gender-based perceptions of educational technology

When asked about barriers he faced in developing apps, Jacob responded:

The only pedagogical barrier we have experienced is the idea that a mobile device is typically considered a tool for entertainment, rather than a learning tool. This perception is mostly held by teachers and/or administrators.

We have experienced such cultural barriers as cultural perceptions and gender concerns… Our research findings convey a dramatic difference for girls and boys learning mathematics using a mobile device (Johnson and Cory, 2020). Based on our findings, girls prefer not to use a mobile device to learn mathematics. However, boys do prefer to use a mobile device to learn mathematics.

When Jacob was asked about the specific tools, ideas, processes that have been successful for students in the UAE, he observed:

For instance, the Emirati sixth-graders in our study, preferred to use a mobile device to explore ethnomathematics, have a deep connection to the Emirati cultural artifacts, and favored to learn mathematics using ethnomathematics based on the Emirati culture. The Emirati sixth-graders showed appreciation for the artifacts used (Henna, Prayer beads, and Bamboo Baskets) in our first Math App. For example, the students do not create Bamboo Baskets from gathering the materials from a Bambusoideae tree; however, the students were able to create a Bamboo Basket using the features of a mobile device.

Generally, Jacob believes educational technology can support student learning in the UAE, and asserts:

> *We believe the integration of STEM and/or STEAM with ethnomathematics could be common practice for classroom teachers. The 21st century student is synonymous with technology. We also believe that 3D (3-Dimensional technology) visuals with ethnomathematics could greatly enhance Emirati students' experience with mathematics… Many ethnomathematics experiences may not be accessible for students. However, using 3D technology would bring ethnomathematics to the classroom.*

Jacob's observations indicate that while there might be some barriers in implementing culturally appropriate educational technology in creating digital tools in contexts that are different from that of the educator's, adopting and adapting concepts and technologies that can facilitate student learning is a fruitful enterprise. He believes that through augmentation techniques, we can acclimatise and localise the educational applications to achieve success in teaching and assessing knowledge and improving learning at the same time. In general, Jacob's observations attest to the fact that EdTech culturation is a valid methodological approach as it embraces the cultural vicissitudes of the local context, allows for students' specific linguistic and non-linguistic needs and provides a solid foundation for them to engage in learning inside and outside the classroom.

Jacob's responses are in line with other researchers' findings with respect to the use of technology in the classroom. For example, Nye (2015) argues it is important to allow for language and cultural localisation when using technology in educational contexts. Similarly, Gogus *et al.* (2012) and Nistor, Göğüş. and Lerche .(2013) show that students' culture plays a significant role in their acceptance of the educational technology used in the classroom and can have a significant impact on students' success.

4.2 Case Study Two: Jackie, A Professor in Early Childhood Education and a Specialist in Literacy and Educational Technology

Jackie has 25 years of experience of working with Second Language Learners (SLL) and has worked in North America and the Middle East. Her rich background of developing and using educational technology has enabled her to observe her students' struggles and successes in the use of technology. Below are the salient themes that emerged in her responses to interview questions:

4.2.1 The importance of using simple language in educational applications

When asked about her educational technology projects, Jackie commented:

> *I have been involved in several projects aimed at developing online materials for Gulf Arabs. I assembled a team of individuals who have many years of experience working in the region. Many have educational technology backgrounds, K-12 backgrounds, bilingual and SLL teaching experience... The team helped develop online materials that embed local context such as images, history, concepts and experiences. Audio was made with the local population in mind. English was slowed down to teacher talk levels or content materials were translated into Arabic...*

When asked if her project was culturally relevant, she explained:

> *We used language that the learner could understand. We used the local context to include images, ideas and belief systems all the while keeping true to the globalized nature of the UAE.*

4.2.2 The importance of using culturally relevant educational technology in the classroom

Jackie believes in the successful implementation of culturally relevant educational technology, she contends:

> *It is important to make sure that the design connects with the students and is not offensive, and that students are not hindered by difficult language. Using local resources when available is a very significant criterion to allow for when developing educational technologies.*

When asked about possible barriers in implementing a culturally relevant pedagogy in the local context, Jackie mentioned:

> *It is of great importance to make sure that students know how to use the technology, so that the teacher can use the pedagogy correctly in the first place. It can't be too cumbersome. Also, students are often used to rote learning and PowerPoint delivered lessons. ... That shouldn't stop someone from using*

constructivist and situated pedagogy but just be aware that it takes some time for students to become acclimated to learning this way.

4.2.3 The significance of cultural and competency-based barriers

When Jackie was asked about the cultural barriers in using culturally appropriate pedagogy, she mentions that she finds students' lack of interest in taking the initiative in speaking or revealing their identity as the main cultural barrier:

Not showing faces or speaking for fear of someone taking pictures or recording. The same is true for using open forums.

Jackie believes that in general, tools and educational approaches should have certain features to be successful in the local context. She reflects:

In general, those applications and digital tools are successful that dovetail well with the students' level of knowledge, skills and abilities. The ones you can use in a variety of contexts such as videos, collaborative tools like kahoot, quizlet, etc. The applications should first and foremost have a variety of features that can accommodate a variety of students with different levels of knowledge and interest. It is important to employ the knowledge of an expert in the local culture making sure that what is being used is accessible and non-offensive in nature.

Jackie comments on how educational technology can support student learning and she asserts:

I think the best way to support student's learning is using a flipped or blended format. Even during COVID, students still needed a lot of teacher support. Technology should never be viewed as core.

Jackie argues that one way of determining the success of an educational technology project would be how students evaluate it in terms of interactivity, simplicity of use, student-friendliness, but more importantly how students can complete the relevant tasks and achieve the course learning outcomes.

Jackie's responses are particularly interesting because she focuses on the competency level of students and the fact that any educational technology tool should correspond with this competency level. This is an important pedagogical consideration as without knowing the students, their needs and their current knowledge and skill in a given area, the relevant applications cannot be developed or can be ineffective. Her emphasis on interactivity, accessibility and adaptability also speak of the important features of culturally relevant pedagogy. Her overall inclination towards technology that makes sense to the teacher and to the student, brings to the fore a much-neglected aspect of pedagogy and as such she also highlights the importance of EdTech culturation as an effective teaching approach that embodies students' current knowledge and skills level as well as their inhibitions in using technology.

Jackie's responses are in line with the research findings of Dodson, Sterling and Bennett (2013) who show that lack of adeptness in the use of language and technology presented serious problems for the female participants in their study. Ullah, Ali and Hussain (2021) also emphasise that it is important for teachers when using educational technology to use simple, jargon-free and thus accessible language so that students can follow instructions and complete relevant tasks. Likewise, Al-Maroof, et al. (2020) contend that students' motivation, how they perceive the use and usefulness of educational technology play a significant role in their learning behaviour and achieving the learning outcomes.

4.3 Case Study Three: Miles, A Language-Teaching and Educational Technology Specialist

Miles has 24 years of ELT teaching experience in Asia and the Middle East. Teaching general and academic English to all levels and ages ranging from 3 to 83 years old. Miles developed an application for developing students' academic vocabulary. This is how he describes his project:

AVA (Academic Vocabulary App) is a self-access, mobile vocabulary learning app that aims to help Arab learners develop their receptive knowledge and productive use of 600 general academic word families and their most frequent and useful collocations. ...

Below are the salient themes that emerged from Miles's responses to interview questions.

4.3.1 The importance of using culturally appropriate content and imagery in educational applications:

When Miles was asked if his project was culturally relevant, he stated:

> *...the English spellings of some Arabic words were included in the content (e.g. kandora, the United Arab Emirates). We also tried to use images that reflected the regional culture and avoided inappropriate images of alcohol or women showing shoulders.*

When asked about ways of developing culturally relevant educational technology in the UAE, Miles observed:

> *Obviously, the content can be made culturally appropriate just as any other materials. In terms of the actual technology, Emiratis seem to have taken to the use of mobile devices very quickly - one of the highest mobile penetration rates in the world 228% in 2017,(Arabian Business Industries, 2017)...My only suggestion is that students often lack device self-regulation for learning purposes… Maybe shorter and fun activities that students can complete quickly for their dopamine hits would also help.*

4.3.2 Over-dependence on and overuse of technology as an entertainment tool by students

Miles believes there are some pedagogical barriers in using digital tools in education:

> *Mobile apps and smartphones are often seen more as communication and entertainment devices, rather than serious learning devices. Students are also more easily distracted by social media and notifications on the phones and some suffer from nomophobia and digital addiction which impedes learning through ed tech.*

He also mentions that there are some cultural barriers in the use of educational technology in the local context:

> *There are few cultural barriers in using ed tech. Technology is very embedded in students' daily lives, so there are no barriers in terms of technology. Perhaps, using online groups/forums across organisations and countries is more difficult because UAE females want to maintain privacy more, so won't show their faces and even use their voices unless they know the other people.*

Miles comments on the tools and processes that have been successful in the UAE, and that they should enjoy certain features:

> *Seamless mobile learning that takes into account students' learning ecologies and links in-class with out-of-class learning can be successful. The teacher needs to show students the tools, sell the benefits and the reasons for using them and use them in class, before students…. Integration is key.*

4.3.3 The importance of adaptiveness of technological applications to students' knowledge and skills:

When asked about how educational technology can support student learning, Miles states:

> *I think if it's clearly linked to students' current level and fully adaptive to what they know and don't know, ed tech can be very effective for independent learning. Students need spaced repetition as well to aid long-term retention, so built-in reviewing and recycling with daily reminders can reduce the burden on students to remember to review. At the same time, online learning platforms should offer a range of communication tools that are easily accessible for students to contact each other and the instructor. Also, students need proper training in order to make the most of the technology. Yes, university students know how to navigate social technology, but they often don't know how to make the best use of technology for learning purposes and academic study.*

Miles believes that student feedback in a survey, student ad hoc comments in class can be very informative as regards the success of an educational technology project or digital tool.

Miles has a very unique approach to the use of educational technology which is characterised by students' understanding of the ways of using digital tools inside and outside the classroom in a way that they become an integral part of the students' lives. He highlights the importance of training in achieving this goal and believes feedback on students' work can help open a dialogue between the student(s) and the teacher, and as such, the use of technology can be an effective pedagogical tool. According to Miles, this can be conducive to developing

students' knowledge and more importantly the locus of control, i.e. they will own their own learning and they will learn to self-regulate more successfully. Mile's views also indicate that EdTech culturation as a methodological approach should be planned and implemented systematically in order to meet the students' educational needs. His observations reveal that through establishing a feedback cycle, the professor and the students engage in meaningful communication that can help iron out any inconsistencies or issues that get in the way of learning through the use of technology.

Miles' commentary highlight the importance of students' expectations and habits of technology use as highlighted by Aagaard (2015) findings which indicate that ~~students~~ because of their daily habits of using technology, students are often distracted when using educational technology in the classroom. Similarly, Seemiller (2017) argues that it is important to devise interventional practices that help students regulate their behaviour in terms of technology use in the classroom. Miles' observations as regards the importance of feedback on students' work are emphasised by Yengin (2017) who argues that students' learning behaviour can and should initiate appropriate feedback from the instructor and creates more effective communication between them.

4.4 EdTech culturation: Towards establishing a practical model

In light of the findings of the study, the researchers would like to propose the following model which encompasses the central themes as discussed earlier.

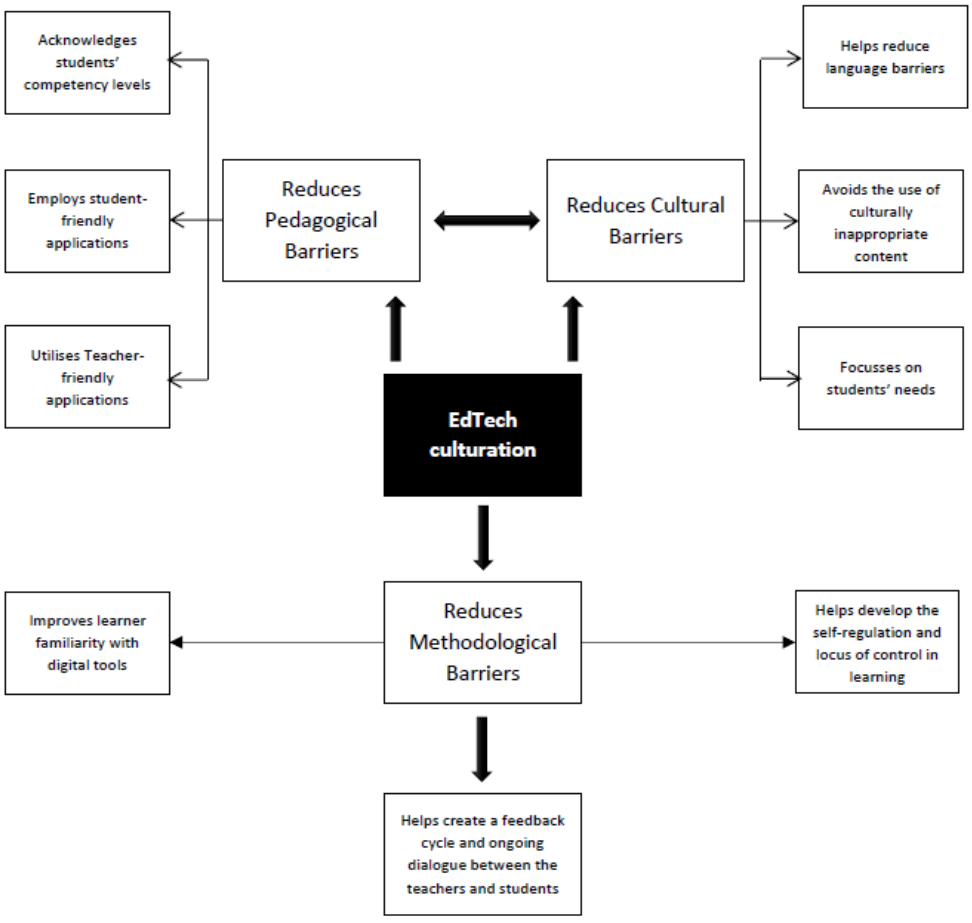

Figure 1: EdTech culturation Model based on the findings of the three case studies

As the model reveals, in general, reducing cultural, pedagogical and methodological barriers can help develop a Culturally Relevant Pedagogy (CRP) which focusses on the use of educational technology that dovetails well with the needs of the students in a local context. Such a pedagogical approach, doubtless, is relevant and of practical significance to online education, e-learning, and technology-rich educational methodologies that are mostly innovative and often imported into contexts such as the one where this study was conducted. Hence, it can be argued that EdTech culturation in today's educational scenery is a practical approach which is appropriate and becoming of educational settings that comprise students who come from either heterogenous or homogenous backgrounds. This is because in today's world of education, the concept of one-size-fits all especially with respect to technology use in education is anachronous and ineffective. Becoming familiar with the local context, the language(s) spoken by the locals, and their specific needs in developing educational technology applications should require proper planning, research based on students and teachers' surveys and implementation. This methodological approach helps students better achieve their academic goals through facilitating their engagement in the process of learning inside and outside the classroom and as such is conducive to the consistency in their learning. The participants in the study point up the fact that it is only through acclimatising educational technology tools to the local context that we can further students' learning. EdTech culturation is thus, both a process and a product: it is a process as it involves constant meaning-making and meaning-giving to the students' learning experiences. It is also a product as it is created, used and modified in accordance with the changing needs of the learners. Adopting such an approach, the researchers believe, should be the new norm in today's dynamic educational scenery, one that involves constant change and readiness for change, and as such warrants being receptive, adaptive and innovative in one's use of technology in education. This way, perhaps, we will be able to aid our students succeed in achieving their learning objectives and will help them keep up with our changing times in a better prepared and more confident manner.

5. Conclusion

This study reported on the views of three professors, who are also developers of educational technology tools, on how "EdTech culturation" as an approach which embraces a culturally relevant pedagogy can be an effective methodological approach. The term "EdTech culturation" was introduced by the researchers as a portmanteau word combining technology, acculturation and education meaning that when the use of technology is culturally relevant and appropriate for the students in a given context, teaching and learning will be more effective. The three participants in the study all observed that educational technology use can be meaningful to both the educators and the students, when it helps establish a dialogue between both parties. Such a dialogue can only be created, if the cultural prescriptions and proscription are taken into account when developing educational technology tools. Based on the participants' observations, some of the main features that should be considered are the linguistic features of the applications, and the accessibility of languages to students, the appropriateness of imagery and concepts presented, and the current competency level of students in terms of a given subject area.

While these factors can be of significance in most educational settings, they are especially paramount in contexts where technology is used to facilitate the process of teaching and learning, e-learning and online education as we have experienced in the current pandemic. It should be noted that many educational technologies are developed in Western countries and are imported into local contexts. Therefore, these technologies may be cumbersome to use by the local students due to the fact that they may not be user-friendly technology-wise and culturally appropriate and may pose linguistic barriers. Such barriers disrupt the process of teaching and learning and can impede students from achieving the envisaged course learning outcomes. Adopting an Ed-Tech Culturation Approach will furnish the educational policy makers and educators to make more informed decisions about the design and implementation of courses that incorporate educational technology. Other researchers such as Selinger (2004) show that local cultures have a direct effect on teachers and students' belief of what should constitute the process of learning and teaching and what are the so-called acceptable norms. McLoughlin (2006) also postulates that in online education, it is important to allow for cultural and pedagogical factors such as linguistic and cultural differences as well as different learning and thinking styles, as educational settings are as diverse as the cultures they are housed in. Gogus *et al*. (2012) have adopted a similar position and have argued that cross-cultural differences play a significant role in accepting the use of technology.

6. Implications

The current research can have several major implications for pedagogy and research. The EdTech Culturation Model, pedagogically, highlights the importance of knowing the linguistic and educational needs of the students, the teaching context, its cultural norms, prescriptions and proscriptions. Such knowledge, when delivering lessons using educational technology, or in online classes and/or on e-learning platforms can help establish a better connection with and understanding of the students and their culture(s) and can thus create a better teacher-student dialogue. It is believed that this dialogue which is essentially pedagogical paves the way for the mastery of course-related knowledge and skills. Another pedagogical implication of the current study is the role of acceptance and responsiveness to different linguistic and competency-based levels. The EdTech Culturation Model is characterised by a meaning-making and meaning-giving process in which the teacher becomes aware of and is sensitive to the needs of the students and provides the requisite assistance with language and educational technology accordingly. The study also has implications that can be of great significance for future research. While most research focusses on highlighting the importance of methodological factors influencing teaching and/or learning, more research is needed to show how technology-mediated education as a unique model can have its own unique affordances. More research is needed to show how students and teachers may be better "enabled" to utilise these affordances through adopting an EdTech Culturation approach. Another important ~~research~~ implication of the present research is to study how teacher orientation programmes based on a good understanding of the local culture, can be instrumental in developing the requisite skills for teachers who are new to teaching in an educational context and how to integrate educational technology effectively into their lessons. This information can provide more insight into more effective teaching and learning in local contexts.

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Appendix I

The questions that the participants were asked to answer to on Google Docs:

1. Briefly describe your professional/ academic background.
2. Briefly describe your research interests.
3. Describe your project.
4. How could your project be considered culturally relevant?
5. Based on your experience, provide your thoughts and reflections on the following:
    1. How can an educational technology project successfully implement culturally appropriate technology in the UAE
    2. What are some of the pedagogical barriers to using educational technology in the context of the UAE?
    3. What are some of the cultural barriers to using educational technology in the UAE?
    4. What are the specific tools, ideas, processes that have been successful for students in the UAE?
    5. How can educational technology potentially support student learning in the UAE?
6. How did you determine success?

Examining Flow Antecedents in Game-Based Learning to promote Self-Regulated Learning and Acceptance

Kelvin Wan[1], Vivian King[2] and Kevin Chan[3]
[1]Centre for Holistic Teaching and Learning, Hong Kong Baptist University, Kowloon, Hong Kong
[2]The University of Hong Kong, Hong Kong
[3]The Hong Kong Polytechnic University, Kowloon, Hong Kong
kelvinwan@hkbu.edu.hk
vking@connect.hku.hk
sskevin@polyu.edu.hk

Abstract: Game-Based Learning (GBL) has been recognized as an essential tool for motivating students to engage in active and constructive learning. While there is a link between GBL and learning outcomes, current research evidence tends to undermine the interrelationships of concepts and oversimplify flow experience in the context of GBL. This study adopted a conceptual framework of flow in computer-mediated environments to examine the roles of specific flow antecedents, such as concentration, feedback, immersion, and challenge affecting students' self-regulated learning (SRL) and acceptance of use in a higher education GBL context. Six simple board-game style educational games covering topics at the introductory level of psychology were built for learners to play asynchronously. When students entered the games, they were given an instruction page that explained the game rules as well as the topic area if appropriate. A simple pop-up window would emerge, informing the students whether they had answered the questions correctly or incorrectly. The participants were 275 students from an undergraduate level social science class in a research participation pool. Students' opinions on the GBL were measured by validated scales that emphasized their flow experience, acceptance of use and SRL. After fitting the data to the hypothesis model, a path model was generated. The model demonstrated an excellent fit of the data with interrelations among constructs about flow antecedents, acceptance of use, SRL (consist of motivation and metacognition). The findings revealed that learners place a higher value on GBL with flow antecedents like concentration and challenge, which is linked to their learning motivation and metacognitive outcomes. Aid by GBL on knowledge gain and immersive experience are considered as the underpinnings of performance expectancy before students consider adopting GBL for their learning. In contrast to what is typical of GBL, learners primarily use GBL to improve their academic performance rather than for its immersive experience. Future studies could use the current model to develop and examine a different learning artefact, depending on its nature and study goals.

Keywords: flow, game-based learning, serious game, technology acceptance, self-regulated learning

1. Introduction

Gaming is a universally captivating phenomenon, whether as a form of entertainment or as a vehicle for learning among adolescents. Despite the lack of external rewards, people collectively spent three billion hours per week playing online games (McGonigal, 2011) and, according to a recent report, this tendency is expected to continue, with a 14% increase in gamers spending hours playing games between 2020 and 2021 (Limelight Networks, 2021).

As the popularity of this novel technique of learning grows, use of digital games in learning has been extensively researched and reviewed in this decade (Hamari, Koivisto and Sarsa, 2014) and it has been increasingly recognized as an effective mean for achieving constructive learning (Ranieri, Raffaghelli and Bruni, 2018; Alaswad and Nadolny, 2015; Sailer and Homner, 2019; Bakan and Bakan, 2018). Due to the COVID-19 pandemic, educators have been experimenting with new technologies and integrating them into various teaching methods in the context of online learning (Latorre-Cosculluela et al., 2021; Veldthuis et al., 2020). While use of digital games in learning is one of the most exciting fronts for bringing constructive learning to the learners (Koivisto and Hamari, 2019; Hung et al., 2018), educators are now interested in how it can arouse students' interest in the virtual classroom, whether synchronously or asynchronously.

It is no doubt that the use of digital games in learning belongs to the family of transformational teaching. The transformational teaching model focuses on positive engagement, collaborative learning, and student-centered learning, which inspires students' creativity to achieve active life-long learning (Slavich and Zimbardo, 2012). Although use of digital games in learning plays a necessary role in Challenge-based and scaffolding tools to help students learn (Hamari et al., 2016), it has not been distinguished independently from other constructs related

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to Game-based Learning (GBL), gamified learning in the past, such as having an overlap with the research on Serious Games (Landers, 2014). The majority of current digital games in learning research is based solely on the literature of different GBL constructs. Such a trend creates a space for more empirical research into modeling various learning constructs to develop a holistic understanding of the GBL phenomenon.

1.1 The conceptual framework in this study

There were no distinctions made between these constructs in this study, and any study that the authors classed as gamification or GBL was taken into account. As the context of this study was mostly related with the concepts of GBL, GBL would be utilized in this work to illustrate the learning with digital game. GBL in higher education is generally associated with benefits observed in learners in terms of improving their attitudes, enjoyment, motivation, and learning performance. Concerning the design of GBL, specific game elements such as points/badges, and leaderboards are recognized as integral elements in GBL for higher education (Subhash and Cudney, 2018). There are few evaluation frameworks of GBL in higher education, as current research in this area tends to undermine interrelations among concepts, such as motivation, behavioral intention, and learner's characteristics in models for predicting determinants of effective GBL. In this study, we adopted (Kiili, 2005)'s framework of flow in computer-mediated environments. This is a framework based on the person-artifact-task (PAT) model (Finneran and Zhang, 2003) contain factors in each stage of the flow. In this study, the authors modified it to fit the context of the current GBL regarding the game flow model (Sweetser and Wyeth, 2005). It aims to examine if flow antecedents and experience in GBL, such as a clear goal and a sense of control, can predict learners' knowledge acquisition, acceptance of use and learning motivation.

1.2 Purpose of the study

The current study aims to examine how flow antecedents and experience could lead to flow consequences in the context of GBL. By incorporating these constructs towards a holistic model, we wish to i) address the key flow antecedents in GBL among university students, and ii) delineate flow antecedents from the proposed framework that demonstrate direct and indirect effects on learners' attitudes toward flow consequences in GBL, particularly GBL acceptance and SRL in the higher education context.

1.3 Research Questions

1. Which flow antecedents explain and contribute to the direct and indirect effects on SRL in the context of GBL?
2. Which flow antecedents explain and contribute to the direct and indirect effects on acceptance of use in the context of GBL?

2. Theoretical and empirical background

2.1 Use of digital games in learning

As mentioned before, there is no consensus on how to define the use of games in learning, and researchers have come up with their own definitions of gamification, GBL and serious games in their research. There has been some conceptual ambiguity in the educational realm, as terminology such as gamification, game-based learning, and serious games are all regularly used to refer to the usage of games in educational situations (Landers et al., 2015; Koivisto and Hamari, 2019). Despite the ambiguity in educational field, use of digital games in learning generally shared the definition of "the use of game design elements in non-game contexts" (Deterding et al., 2011). From a service market perspective, it has been defined as "a process of enhancing services with (motivational) affordances in order to invoke gameful experiences and further behavioral outcomes" (Huotari and Hamari, 2012). The term, motivational affordances, could be found in association with information, communication technologies and gaming design as early as 2006 (Zang, 2008; Good and Robertson, 2006). In the present study, under the context of GBL, motivational affordance is a supportive component for enabling users toward the actual use of the system (Huotari and Hamari, 2012). Some popular characteristics of flow theory such as challenge, feedback, clear goal, and immersion, have been identified research on GBL in learning advantages (Koivisto and Hamari, 2019).

2.2 GBL and Flow

Affordances observed from GBL align well with the flow theory (Csikszentmihalyi, 2014). The original definition of flow described it as a state that is completely engaged in a sensation of energized attention, full involvement, and delight in the activity's process (Nakamura and Csikszentmihalyi, 2014). It comprises six dimensions including concentration, clear goal, feedback, challenge, autonomy, and immersion. The difficulty of the game

is expected to increase as the player learns the game and improves his or her skills. Flow theory is therefore applied in game studies to create concentration for the students in the lectures, according to these elements (Bakan and Bakan, 2018). Researchers constructed a game flow model for mapping elements from the original flow theory to evaluate player enjoyment of games (Sweetser and Wyeth, 2005; Kiili, 2005). Two new dimensions were added to the theory: social interaction and knowledge improvement. However, existing empirical research findings on flow were rare (Koivisto and Hamari, 2019), the definition, and measurement of flow are mixed. Some researchers defined the flow state as discrete constructs such as enjoyment (Koufaris, 2002; Zhou and Lu, 2011), concentration (Liu, Liao and Pratt, 2009; Zhou and Lu, 2011), playfulness (Lee, Yoon and Lee, 2009), or simply implemented the general term "flow experience" (Chen, Lu and Luor, 2018), within their research design and investigation. As a result, the constructs used in the 'flow' scales haven't always been consistent across studies.

2.3 SRL, learning motivation and learning Strategies of GBL

Findings on psychological and behavioral outcomes in GBL are often allied with the perception of the learning experience, academic achievement, and the mechanism of applying game elements to formal education. This mechanism has been shown to efficiently develop SRL in learners as a motivational affordance (Rutherford et al., 2018; Dichev, Dicheva and Irwin, 2020). According to the past studies, the concept of SRL was often perceived as the merge of self-motivational beliefs such as self-efficacy, task value and with self-regulatory strategies like metacognitive outcomes (Ng, Wang and Liu, 2017; Panadero, 2017; Liu et al., 2012). This combination of self-regulatory beliefs and strategies requires the application of a variety of cognitive and self-regulatory strategies, which takes more time and effort on the part of students and involves a high level of motivation on their part (Duncan and McKeachie, 2005). While learning motivation plays an important role in SRL, a GBL trends analysis revealed that it is part of a larger trend (Kasurinen and Knutas, 2018). A review also indicated that the major types of psychological theories in GBL are learning theories and motivational theories (Landers et al., 2015). The motivational theories could be further divided into expectancy-based theories, goal-setting theories, and self-determination theory (SDT). An empirical examination has proved that these theories are closely related to the theory of gamified instructional design (Landers and Landers, 2014). The theory of gamified instructional design emphasized how a game element from GBL could impact an individual's motivation in learning and produce metacognitive outcomes (Landers, 2014). It suggested that GBL played a role as a moderator in the relationship between learning content, learning motivation and meta-cognitive outcomes. Those psychological and behavioral outcomes are usually measured as motivation (Sung et al., 2017; Hanus and Fox, 2015), engagement (Hamari et al., 2016), autonomy (Zainuddin, 2018; Sheldon and Filak, 2008), social skills (Tan et al., 2016; Barr, 2017), and satisfaction (Hanus and Fox, 2015).

2.4 Technology acceptance of GBL

Learners are likely to benefit from GBL when they find its artefacts beneficial for learning. Grounded by the theory of planned behavior (Ajzen, 1985) and expectancy-based theories, technology acceptance is found on many forms of gaming platforms such as mobile games (Chen et al., 2011) and online games (Oh and Yoon, 2014). Gaming is generally considered as an information and communication technology (ICT) and the research findings on game acceptance models have been integrated with the technology acceptance model (TAM) and the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003). The UTAUT framework has been used to explore key determinants of technology adoption since 2003. Researchers reviewed eight existing models on information technology in the past and used their acceptance determinants to formulate new determinants and moderators on intention and usage. In the educational setting, the UTAUT model has been implemented for exploring key determinants of different educational technologies such as learning management systems (Marchewka and Kostiwa, 2007) and computer-based assessments (Terzis and Economides, 2011). Furthermore, the existing game acceptance models were mostly determined by the technology acceptance model (TAM) (Liu, Liao and Pratt, 2009; Koufaris, 2002; Lee, Yoon and Lee, 2009), which ignored the social environment and other determinants of acceptance in the educational game context. Although UTAUT has been one of the major updates to TAM in recent years, only a few of the GBL studies have adopted this model.

3. Methods

3.1 Study Design & Participants

A cross-sectional observation study design is employed. Participants are 275 undergraduate students, 48% of females with a mean age of 18.7 who had experienced playing the educational game platform in a Hong Kong

university. Recruited from an undergraduate level social science class, participants were students in a research participation pool towards class partial credits.

3.2 Intervention

This study adopted the Wisc-Online platform (https://www.wisc-online.com/) for developing and delivering GBL objects to participating learners. An open-source platform for all educational users since 2000. The Wisc-Online provides a vast and diverse collection of learning objects that learners and educators can create their interesting games for different subjects.

Six educational games covering topics at the introductory level of psychology were built for learners and release each game per week. These games cover a wide range types of game genres such as puzzle games, memory card games, win a million and shooting Games (Figure 1). A background description of the different indicators in flow tested in the study with the game design is provided below, along with a mapped process.

1. In games, students can only focus on one task at a time (concentration).
2. The student was shown how to start the game on a landing page (goal clarity).
3. A pop-up window would appear, informing students whether they had correctly or incorrectly answered the questions (feedback).
4. In the game, provide questions with varying levels of difficulty and, similar to a shooting game, allow the player to select the target moving speed (challenge).
5. Students are free to play at any time (autonomy).
6. Learners who participate in the shooting game may have a more immersive experience because shooting the correct target in a limited amount of time requires intense focus (e.g., 4 seconds) (immersion)
7. Because the games were MCQ-based, some of them, such as Win a Million, could be played by multiple students at the same time. The answers can be discussed among the students. (social interaction)
8. These games include the course content (knowledge improvement).

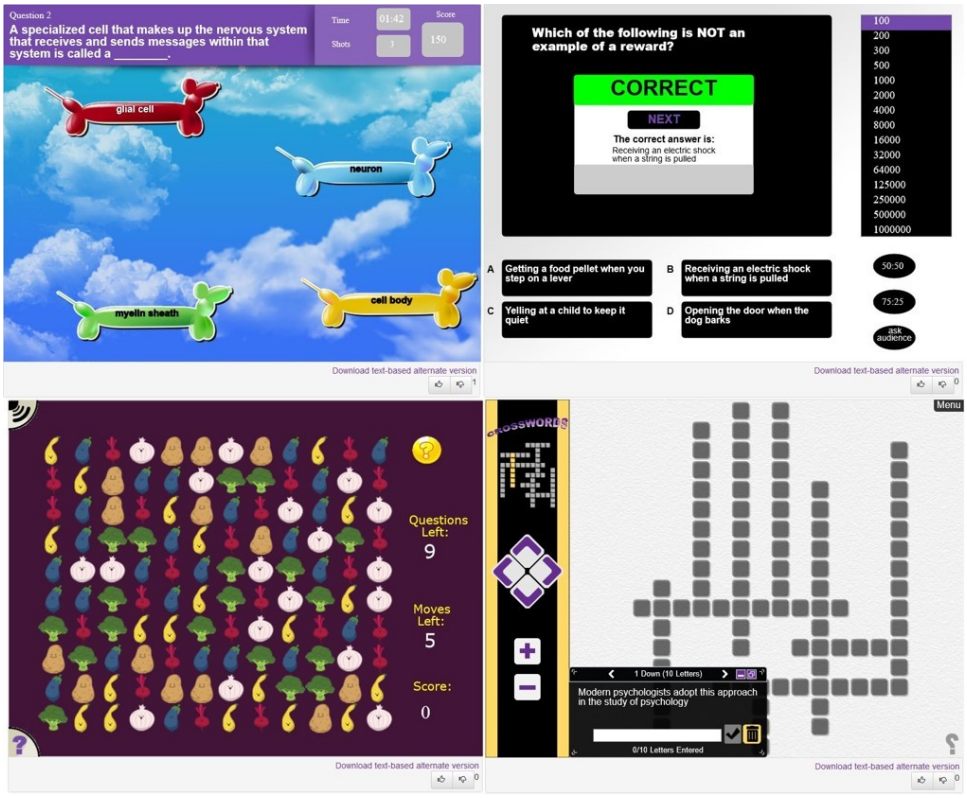

Figure 1: The Wisc-Online Games

3.3 Procedure

An online questionnaire was used to collect self-reported GBL artefact usage and ratings on constructs related to its use. Participants submitted the questionnaire through an online platform. Returns of the questionnaires were collected over four-weeks towards the end of the semester.

3.4 Measurements

There are four sets of questions included in the questionnaire (See Figure 2). Firstly, demographic information such as gender, year of study and discipline was solicited from the participants.

Instrument	Subscale	Example items
Your Personal Information (e.g., gender, age, year of study		
MSLQ (Liu et al., 2012)	Learning Strategies	When I am studying a topic, I try to make everything fit together.
	Self-efficacy	I think I will receive a good grade in this class.
	Intrinsic Value	I like what I am learning in this class.
	Anxiety	I have an uneasy, upset feeling when I take a test.
	Lack of Learning Strategies	When work is hard I either give up or study only the easy parts.
EGame Flow (Fu, Su and Yu, 2009)	Concentration	No distraction from the task is highlighted.
	Feedback	I am notified of new tasks immediately.
	Challenge	The difficulty of challenges increases as my skills improved.
	Autonomy	I know next step in the game.
	Goal Clarity	Overall game goals were presented clearly
	Immersion	I feel viscerally involved in the game
	Social Interaction	I feel cooperative toward other classmates
	Knowledge Improvement	The game increases my knowledge.
UTAUT (Venkatesh et al., 2003)	Performance expectancy	I would find the Educational Games Platform useful in my learning.
	Effort expectancy	I would find the Educational Games Platform easy to use.
	Social influence	People who influence my learning behavior think that I should use the Educational Games Platform.
	Facilitating conditions	A specific person or group is available for assistance with using the Educational Games Platform.
	Behavioral intention	All things considered, I think it is beneficial to keep using the Educational Games Platform in my class.

Figure 2: The structure and example items of the survey

3.4.1 Flow antecedents and experience

Secondly, flow antecedents and experience were measured by the EGameFlow scale (Fu, Su and Yu, 2009), a 42-item instrument with a 7-point Likert scale. It aims to explore the learner's enjoyment and the effectiveness of educational games based on a gaming model for evaluating player enjoyment (Sweetser and Wyeth, 2005) and the theory of flow (Csikszentmihalyi, 2014). The subscales correspond to the eight elements of flow experiences according to (Csikszentmihalyi, 2014)'s conceptualization of the flow theory (Table 1).

3.4.2 Flow Consequences (SRL)

Thirdly, SRLwas measured by the Revised Motivated Strategies for Learning Questionnaire (MSLQ for junior high). The MSLQ is a self-report questionnaire for measuring learning motivation and strategies (Pintrich et al., 1993). This study adopted a 28-item version, a 7-point Likert scale of MSLQ including learning motivation and learning strategies subscale (Liu et al., 2012). The motivation component measures an individual's value and belief in learning such as intrinsic motivation. The learning strategies components measures an individual's metacognitive abilities such as critical thinking and SRL. Under these two components, five subscales are named as learning strategy, intrinsic value, self-efficacy, lack of learning strategies and test anxiety.

Table 1: The EGameFlow Scale (Fu, Su and Yu, 2009)

Subscales in EGameFlow	**Definition**
Concentration	Games must provide activities that encourage the player's focus while minimizing stress from learning overload.
Goal clarity	Tasks in the game should be clearly explained at the beginning.
Feedback	Feedback allows a player to determine the gap between the current stage of knowledge and the knowledge required for the ultimate completion of the game's task.
Challenge	The game should offer challenges that fit the player's level of skills.
Autonomy	The learner should enjoy taking the initiative in game-playing and asserting total control over his or her choices in the game.
Immersion	The game should lead the player into a state of immersion.
Social interaction	Tasks in the game should become a means for players to interact socially.
Knowledge improvement	The game should increase the player's level of knowledge and skills while meeting the goal of the curriculum.

3.4.3 Flow consequences (acceptance of use)

Lastly, the acceptance of use was examined by UTAUT (Venkatesh et al., 2003). This scale includes five subscales with a 5-point Likert scale. This 20-item instrument proposes how users agree to adopt a technology tool in terms of their attitudes and behavioral intention. Those domains are performance expectancy: the perceived benefits of using the technology for a specific task; effort expectancy: the effort of implementing the technology; social influence: how peers influence the user's actual use of the technology; facilitating conditions: the technical support and surrounding environment for the users to adopt the technology; and behavioral intention: the strength of an individual's intention to perform a specified behavior.

3.5 Data Analysis

Data was analyzed with the IBM SPSS 23 software and the IBM SPSS Amos Graphics 23 software (Arbuckle, 2014). Cronbach's alpha and composite reliability (CR) were employed to measure the internal consistency of the scales. Only the α of scales >.70 were used for further structural equation modeling (SEM) (Lee, Yoon and Lee, 2009). Confirmatory factor analysis would be performed with each scale to compute the CR, average variance extracted (AVE) and maximum shared variance (MSV) for examining the discriminant and convergent validity. Descriptive statistics, correlation of existing variables and mean difference were also performed to guide the researcher to construct the present path model. A path analysis by the application would apply for modeling the inter-relations among the variables and examine the direct and indirect effects based on the following research hypothesis. The current study contained no missing data and adopted the Standard maximum likelihood estimations in the SEM.

3.6 Hypothesis

This study employed the framework of flow in computer-mediated environments (Kiili, 2005). A proposed conceptual framework was presented in Figure 3 to guide the authors in designing the research questions and the hypothesis path model.

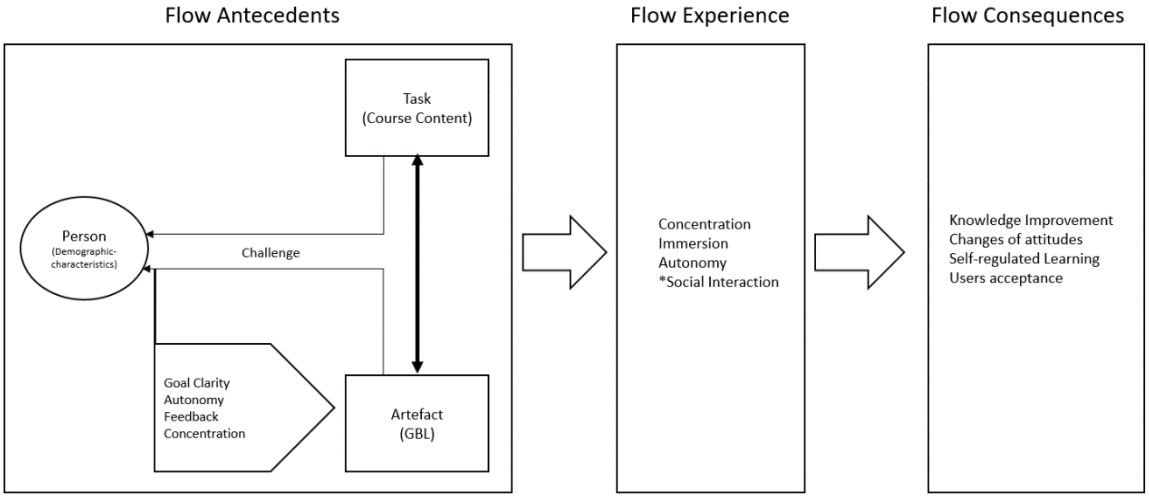

Figure 3: The proposed framework in this study. Adopted and modified from (Kiili, 2005)'s work – flow in computer-mediated environments and *item was not from the original framework

Based on the proposed conceptual framework, the following hypotheses were established to address the presented research purposes.

H_1: Flow Antecedents and experience such as concentration, feedback, challenge, knowledge improvement and immersion have direct and indirect effects on SRL (metacognitive and motivation) outcomes.

H_2: Flow antecedents and experience such as social interaction and knowledge improvement have direct and indirect effects users' acceptances.

It is hypothesized that the flow antecedents would have effects on both learning motivation and learning strategies (cognitive and metacognitive) domains. It would also examine whether those antecedents are moderators for behavioural intention. Based on the stated hypothesis, a hypothetical model is illustrated in Figure 4.

4. Results

4.1 Preliminary analysis for the path model

The correlation matrix suggested a significant moderate to strong positive association between all variables except test anxiety and lack of learning strategies (data not shown). All scales exhibited good to excellent internal consistency and are eligible for further CFA and path analysis (Table 2). Two items from facilitating conditions and behavioral intention were removed due to the poor correlation between the items and the corresponding subscales. CR from the CFA indicated satisfactory reliability. Testing results of convergent and divergent validity display acceptable CR and AVE which supported the occurrence of convergent validity in the study (Fornell and Larcker, 1981). Some of the constructs' AVE values were lower than the MSV such as immersion, which had raised the concerns on discriminant validity.

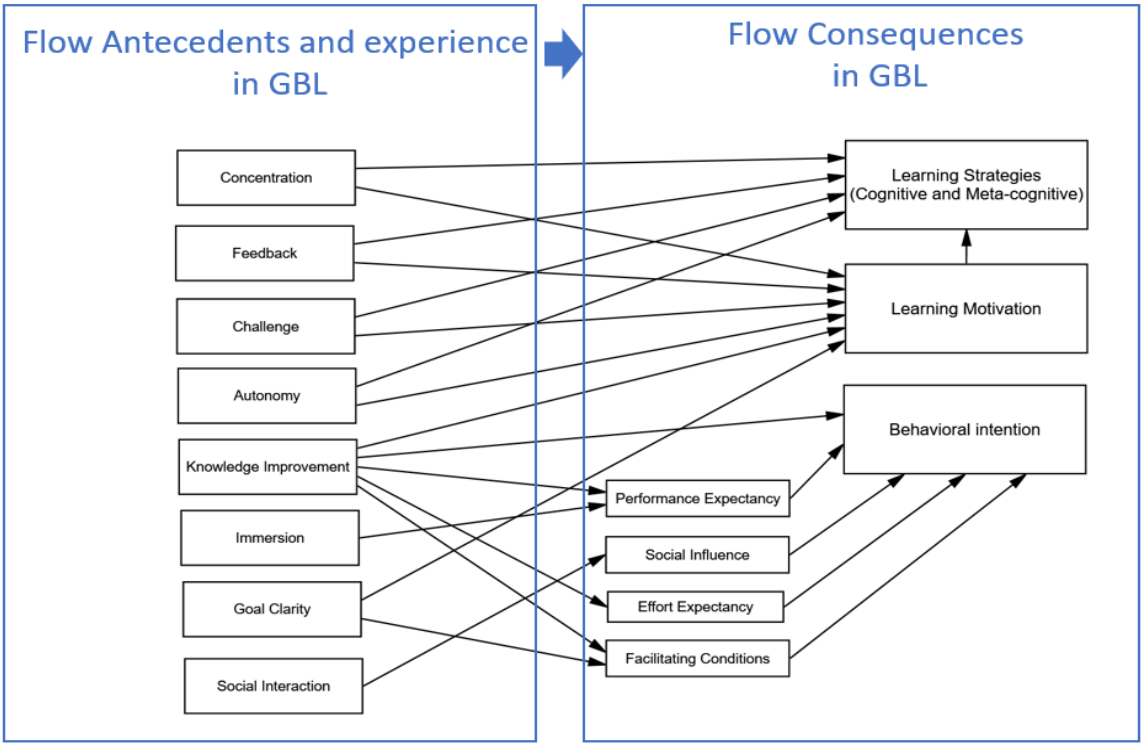

Figure 4: The hypothesized model of game flow, MSLQ & UTAUT (Fu, Su and Yu, 2009; Liu et al., 2012; Venkatesh et al., 2003)

4.2 Hypotheses testing

After modifications to the proposed model, Figure 5 illustrated the final path diagram with significant coefficients. Although preliminary results indicated gender differences, the gender variable was removed from the original model due to the insignificance and minor estimate of key variables such as knowledge improvement and effort expectancy. Upon fitting the study data, the results of the model exhibited an excellent fit ($\chi^2 = 70.939$, df = 57, $\chi^2/df = 1.245$, GFI = 0.966, AGFI = 0.929, CFI = 0.994, IFI = 0.994, RMSEA = 0.030, SRMR = 0.0366). Standardized root mean residual (SRMR) is also provided (Hooper, Coughlan and Mullen, 2008). Table 3 indicates the decomposition of effects from the path analysis. All the regression models were significant ($p < 0.05$) and the t-value > 2.33 followed by the criteria proposed by (Kline, 1998) except knowledge improvement on learning motivation. The effects of concentration ($\gamma = .256$, $t = 3.955$, $p < .0001$), challenge ($\gamma = .216$, $t = 3.378$, $p < .0001$), and knowledge improvement ($\gamma = .150$, $t = 2.279$, $p < .05$) on learning motivation were positive and statistically significant, as hypothesized. Facilitating conditions ($\beta = .158$, $t = 2.983$, $p < .005$) also contributed significant

effects on learning motivation. Of all path coefficients to learning strategies, only concentration (γ = .258, t = 5.066, p < .0001), knowledge improvement (γ = .132, t = 2.676, p < .01), and learning motivation (β = .507, t = 10.684, p < .0001) were significant. Other flow antecedents including goal clarity and autonomy yielded insignificant effects on psychological outcomes.

4.3 Direct and Indirect Effects

Table 4 provides the direct and indirect effects on learning strategies, learning motivation and behavioral intention. Only a significant effect greater than .10 would be displayed. As hypothesized, performance expectancy exhibited the strongest direct effects on behavioral intention. Knowledge improvement also had a significant modest direct and indirect effects on behavioral intention. Apart from these outcomes, the research model unveiled that facilitating conditions also involved a direct effect on learning motivation together with concentration, challenge, and knowledge improvement. Regarding the effects on learning strategies, facilitating conditions only show limited or no indirect effect while the other three domains had modest direct or indirect effects on learning strategies. Despite goal clarity having a significant indirect effect on behavioral intention, such an effect did not reach statistical significance. Goal charity only exerts a significant direct effect on facilitating conditions while knowledge improvement affected in all five domains with a significant direct and indirect effect.

Table 2: Reliability and validity of the measurement scales

Construct	Mean	SD	α	CR	AVE	MSV
Learning motivation	4.66	.93	.92	.92	.50	.61
Learning strategies	4.97	.89	.88	.88	.43	.61
Concentration	4.87	.87	.85	.86	.50	.57
Feedback	4.83	.97	.88	.88	.60	.57
Challenge	4.81	.92	.87	.87	.54	.55
Autonomy	4.71	.03	.84	.84	.64	.45
Goal clarity	4.93	.97	.90	.90	.69	.51
Immersion	4.34	1.00	.88	.88	.52	.61
Social interaction	4.50	1.08	.91	.91	.62	.61
Knowledge improvement	5.06	.90	.89	.89	.62	.46
Performance expectancy	3.63	.66	.87	.87	.63	.63
Effort expectancy	3.65	.61	.78	.78	.47	.63
Social influence	3.32	.63	.81	.81	.52	.52
Facilitating conditions^	3.64	.62	.71	.70	.44	.44
Behavioral intention^	3.68	.63	.86	.86	.68	.48

Note. ^Removed the items with poor performance (inter-item correlation r < .40 and α < .70)

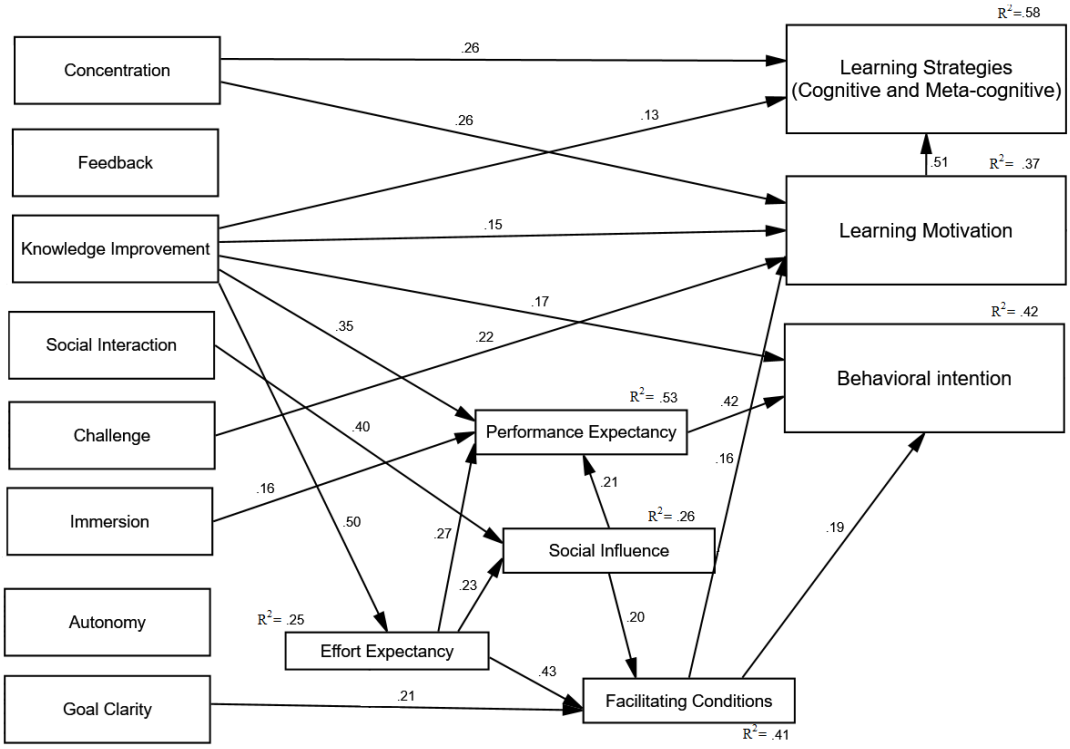

Figure 5: The research model with significant path coefficients.

Table 3: Decomposition of effects from the path analysis

Effect	Standardized estimate	*t*	R^2
On learning motivation			.368
of concentration	.256	3.955***	
of challenge	.216	3.378***	
of knowledge improvement	.146	2.279*	
of facilitating conditions	.158	2.983**	
On learning strategies (cognitive and metacognitive)			.579
of concentration	.258	5.066***	
of learning Motivation	.507	10.684***	
of knowledge Improvement	.132	2.676**	
On behavioral intention			.421
of performance expectancy	.415	6.920***	
of facilitating conditions	.190	3.683***	
of knowledge improvement	.175	2.921**	
On performance expectancy			.531
of immersion	.157	3.354***	
of knowledge improvement	.350	6.777***	
of effort expectancy	.275	5.623***	
of social influence	.210	4.600***	
On facilitating conditions			.407
of social influence	.200	4.003***	
of goal clarity	.211	4.272***	
of effort expectancy	.275	8.555***	
On effort expectancy			.248
of knowledge improvement	.498	9.508***	
On social influence			.257
of social interaction	.397	7.398***	
of effort expectancy	.233	4.336***	

Note. *$p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$

Table 4: Standardized direct and indirect effects from the path Analysis

Effect	*r*	Direct Effect	Indirect Effect
On learning motivation			
of concentration	.527**	.256	
of challenge	.501**	.216	
of knowledge improvement	.485**	.146	.038
of facilitating conditions	.390**	.158	
On learning strategies			
of concentration	.600**	.258	.130
of learning motivation	.707**	.507	
of knowledge improvement	.525**	.132	.093
of challenge	.516**		.110
On behavioral intention			
of performance expectancy	.629**	.415	
of facilitating conditions	.570**	.190	
of knowledge improvement	.526**	.175	.258
of effort expectancy	.508**		.226
of social influence	.504**		.125
On performance expectancy			
of immersion	.463**	.157	
of knowledge improvement	.616**	.350	.161
of effort expectancy	.568**	.275	.049
of social influence	.483**	.210	
On facilitating conditions			
of social influence	.498**	.200	
of goal clarity	.457**	.211	
of effort expectancy	.590**	.434	.047
of knowledge improvement	.502**	.239	
On effort expectancy			
of knowledge improvement	.498**	.498	
On social influence			
of social interaction	.472**	.397	
of effort expectancy	.364**	.233	
of knowledge improvement	.335**	.116	

Note. ** $p \leq 0.01$

5. Discussion

Results from this study responded to the call for a comprehensive framework for understanding GBL in the higher education setting (Mayer, 2014) and an update to the existing model by (Kiili, 2005) in which the effectiveness of GBL is examined in terms of inter-relationships between SRL, attitude towards GBL, and behavioral intentions. Specifically, it examined inter-relations among key characteristics of games that may contribute to psychological outcomes and produce metacognitive activities.

Hypotheses were supported partially by the results. Although preliminary results indicated gender differences, the effect is insignificant toward other variables in the model. It is inconsistent with the previous finding that male tends to have higher flow experience in serious computer game (Bachen et al., 2016). Female learners tend to perceive higher flow experience than male learners in this study. It reflected that the gender difference of flow in serious games may not completely generalizable in a GBL context.

5.1 Flow Antecedents on SRL

H_1 was partially supported by the data. Concentration, challenge, and knowledge improvement have significant direct and indirect effects on SRL, but immersion and feedback do not (Table 4).

Concentration. Learners perceived concentration as a possible approach to initiate learning motivation and accomplish higher-order cognitive activities. It appeared that concentration contributed much to the current

research model on leading learners to learning motivation and metacognitive outcomes. Such findings may inform on the design of educational games because the basic characteristics of educational games should be free from distractions and have an acceptable workload. An earlier finding pointed out that free from distraction (e.g. technological problems) environment enables students to engage more in the education games to have better learning outcomes (Admiraal et al., 2011). Noted that concentration was the second domain, next to knowledge improvement contributing to direct effects on learning motivation and learning strategies in this study. It described the role of concentration in educational gaming which was essential for fostering learners' learning motivation and cognitive and metacognitive outcomes. Prior studies have suggested that concentration is associated with flow, higher-order thinking, SRL and meta-cognitive activities (Hou, 2015; Zimmerman, 2008, 1995). A previous finding also indicated that concentration in GBL group learners was enhanced and improved the learners' cognitive load compared with non-GBL group learners (Chang et al., 2017). (Landers and Landers, 2014) discussed that learners' increased time-on-task would lead to better learning outcomes. Therefore, the current research model suggested that GBL provides a free from distraction environment with minimizing stress from learning overload to learners for sustaining focus on a specific course topic, and thus GBL facilities learning motivation and learning strategies.

Challenge. Our research model suggested that challenge predicts learning motivation. A study mentioned that the perceived challenge was a strong predictor of both learning engagement and outcomes (Hamari et al., 2016). Adopting challenge-based learning design in the GBL context was not new, but it was effective for learners' motivation and engagement (Chen and Sun, 2016). However, to further classify the foundational determinants of learners' learning motives and how they achieve meta-cognitive abilities, the challenge domain contained a small proportion of indirect effects rather than a direct effect on metacognitive abilities. This result did not align with the existing traditional framework of challenge-based learning. In this study, gamified content was at the elementary level with the simple board-game style games featured, and learners might not experience challenging tasks during their playtime. Such results suggested that learners may value the level of challenge in the existing games towards their motivation to further exploration of the course content. Yet the quality of the gamified course content may need to further be revised to crystallize their learning process into a higher-order and metacognitive manner.

Knowledge improvement. Knowledge improvement yielded the greatest effect on learning outcomes. Knowledge improvement in the present study was defined as "increasing an individual's level of knowledge and skills while meeting the goal of the curriculum". As the results pointed out the possible association between knowledge improvement and learning outcomes, the most important asset of GBL must serve the purpose of knowledge gain, which can in turn affect learners' attitudes or behavior. For example, the aim of the game should be to increase learners' meta-cognitive activities (Landers et al., 2015). Learners must spend less effort into adopting a motivational affordance to achieve the goal of knowledge gaining for better learning outcomes. It concluded that knowledge improvement was the main goal for learners to enhance their learning quality without immersion.

Feedback. It is no doubt that timely and informative game-based feedback could enhance students' engagement (McNeill et al., 2010). However, the effects of feedback in this study were limited due to the inherent nature of the GBL environment. As mentioned, the educational games featured in this study were basic online board games. When the participants answered with an incorrect response on a question, they only received a message notifying them on the correct answer choice without any further explanations. Participants might find timely feedback in these educational games insufficient. Past research has found that an informative feedback mechanism, which provides detailed and personal feedback, could improve learners' learning motivation, cognitive, and meta-cognitive performance in a rich ICT context (Chan et al., 2015; Sun, 2014; Dennen, 2005; Xie, Yu and Bradshaw, 2014; Abramovich, Schunn and Higashi, 2013; Aguilar, Holman and Fishman, 2015). It can be concluded that the digital board game had a lack of effective feedback systems such as the mechanism mentioned in previous studies. Further research could, therefore, examine how informative feedback could be effective for learners during their learning process.

Immersion. Surprisingly, immersion did not relate to any learning outcomes in this study. An experiment on serious games confirmed that learners with high game immersion helped them to master the game but not better learning performance (Cheng et al., 2017). It is expected that immersion in GBL could only be used for evaluating performance as a "game" rather than as a tool for learners to master the learning content.

5.2 Flow antecedents on users' acceptance

H_2 was partially supported by the data. Only knowledge improvement has a significant direct effect on all constructs of acceptance of use, including performance expectancy, facilitating conditions, effort expectancy, and social influence. Only social interaction has a significant direct and indirect effect on social influence. Immersion has a direct and significant effect on performance expectancy. Concentration, feedback, and challenge had no significant direct or indirect effects on acceptance of use.

We observed significant mean differences between genders in effort expectancy. Such results were consistent with the earlier findings that females exhibited strong moderating effects on effort expectancy toward behavioral intention over their male counterparts (Venkatesh et al., 2003). Yet, the effects of gender did not constitute a substantial weight in the path analysis results in the current study. Gender as a variable did not statistically predict flow and other outcomes. A strong effect of age in performance expectancy toward behavioral intention was found. Similar to the above-stated findings, younger learners tended to have a stronger effect of performance expectancy on predicting behavioral intention.

Knowledge improvement. Our model suggested that learners identified knowledge improvement directly as the goal and usefulness of GBL. The finding demonstrated that learners who played the educational games may be engaging with a pragmatic and mastery orientation, rather than seeking immersive experience on learning. As a result, the path analysis explained knowledge improvement accounted for a medium proportion for performance expectancy through effort expectancy. Corroborated with evidence on the relationship between mastery orientation and meta-cognitive outcomes (Ford et al., 1998), results from the current study echoed previous arguments that the aims of educational gaming should be focused on knowledge enhancement over gaming experience. This finding was also in line with existing previous research that learners were more engaged in flow experience by solving fewer technology problems (Admiraal et al., 2011). The knowledge improvement also connects constructs including acceptance of use and flow experience in the GBL context. While recent studies on GBL identified the importance of the contextual variable in moderating relationships between GBL and learning outcomes (Buil, 2019; Terras, 2019), we incorporated the UTAUT to incorporate such contextual variation into the model towards reported game flow and learning-related outcomes.

Immersion and social interaction. Social interaction significantly affected social influence. Immersion also indicated a slight effect to performance expectancy. As this is the first study to combine flow and acceptance of use in the GBL context, the present results echoed findings of immersion as one of the flow elements for predicting perceived usefulness (Zhou and Lu, 2011) in a mobile message usage context. Similarly, learners in the GBL context may share some of the flow experience with modern digital technology towards moderating their acceptance and use of GBL. In this study, we defined social interaction as "tasks in the game should become a means for players to interact socially". It showed that learners did not only consider whether people around them would use the system but were also concerned about whether their peers interacted with them by using the system. This result confirmed that the digital learning board games shared the core engagement aspects of traditional computer games particularly in the social perspective (McNeill et al., 2010). However, traditional GBL studies selfdom differentiate group effects (Sheldon and Filak, 2008; Tan et al., 2016; Hamari et al., 2016). As stated by a recent review (Qian and Clark, 2016), immersive and social elements are usually contributing a large effect size on learning performance, future GBL study should consider describing the learning process, addressing the advantages of collective intelligence and how immersive experience affect learners 'acceptance of use.

Goal clarity and autonomy. Goal clarity only slightly explained the facilitating condition with a rather small indirect effect on behavioral intention. This effect could be explained by the study context that students were required to complete the survey for the course continuous assessment. In addition, our preliminary results found that goal clarity had a particularly stronger correlation with knowledge improvement compared with the other flow subscales. The examination of discriminant validity also pointed out that goal clarity might be somewhat absorbed by knowledge improvement. A recent finding of goal setting in GBL reported that a specific goal turns out to yield better learning outcomes (Erhel and Jamet, 2019). Findings from related GBL studies (Hamari and Koivisto, 2014; Koivisto and Hamari, 2019) demonstrated the heavily mixed problems related to the goal, control and autonomy domains. It explains why knowledge improvement yields better results to predict learners' motivation compare with these domains. Given the interdependent nature of these two constructs, the limited effects of goal clarity observed in this study could be attributed to its covariation with the autonomy domain.

5.3 Limitations and Future Directions

This study used educational games to facilitate learners' understanding of basic social science concepts, which can be different in nature by knowing theories that are more complex. The focus of the educational games in this study is grounded at a basic level with less social interactive elements. Still, the results investigated the effect of social interaction despite the limited collaborative learning setting. Future research can, therefore, consider adopting more complicated and cooperative designs for enhancing subject interests and immersive experience. Our study focused on the ways that motivational affordances affect psychological outcomes of learning by self-report, without measuring behavioral outcomes. Nevertheless, the associations between demographic information with motivational affordances and psychological outcomes were not obvious. Some of the psychological outcomes among students, such as acceptance of use, were limited. Whether this could affect behavioral outcomes is still unknown. To further investigate the behavioral outcomes of GBL based on the current work, researchers have suggested adopting a person-centred approach to test whether learners may perform and react to educational games differently. Finally, due to the nature of path analysis is the extension of multiple regression, it may underestimate the possibilities of other clarifications like reciprocal causation (Jeon, 2015). Future researchers are suggested to conduct a latent variable structural model to clarify the effects among variables.

6. Conclusion and Implication

In response to an earlier framework of flow in computer-mediated environments (Kiili, 2005), we incorporate learning concepts and learners' characteristics into GBL from an individual level to verify the learning process in a higher education context. The model examined learners' motivation, acceptance of use as flow consequences in GBL, and how they perceived the games by examining with different flow antecedents. The finding summarized with three components, concentration, challenge, and knowledge improvement are the essential flow antecedents for explaining the learning process in GBL. GBL is an activity that requires learners to apply subject knowledge when they encounter an optimal challenge (Churches, 2008). This entire process keeps the learners at a high level of attention, which may lead to their SRL, as separated into learning motivation and metacognitive activities. This study supports the statement that GBL is a motivational affordance (Koivisto and Hamari, 2019) and motivates learners toward specific behaviors particularly sustaining their attention, providing optimal challenging subject content and space for knowledge gaining. While this study examined the basic elements of the GBL environment, future studies could be based on the present framework to investigate another learning artefact depending on its nature and research purpose.

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Learning Foreign Languages in a Digital Environment: Learners' Perception of the Sudden Transition to e-Learning During COVID-19 Lockdown

Mona Kamal Ibrahim[1], Natalya Spitsyna[2] and Anastasia Isaeva[3]
[1]Al Ain University, Al Ain, UAE; Helwan University, Helwan, Egypt
[2]Far Eastern Federal University, Vladivostok, Russian Federation
[3]Tula State University, Tula, Russian Federation
monakibrahim@yahoo.com
nataspitsyna@rambler.ru
anayisaeva@rambler.ru

Abstract: The research is devoted to the study of the forced and accelerated transition of education to an online environment on the example of learning a foreign language. Despite a large number of studies on e-learning, this study is one of the newest investigating recent education transformation trends. The ultimate goal of this paper was to study changes in students' assessments of the e-learning process, participation in online-based education, and academic success during the transition to virtual training. The study involved 600 students from 5 private specialized educational institutions located in Moscow (Russian Federation) who were forced to switch to e-learning during the lockdown. The examination was conducted by means of a survey assessing the usefulness, comfort, and acceptability of e-learning in three isolated questions formulated by the authors and measured on a five-point Likert scale. The comparison of its outcomes with the results of objective knowledge tests at the beginning and at the end of the three-month e-learning period revealed the following outcomes. First of all, a decrease in the assessment of the acceptability of continuing e-learning for both genders was noted. According to female respondents, the assessment of the comfort of e-learning decreased significantly (from 3.70 to 3.14 points). In the meantime, the usefulness score dropped notably for both male and female research participants (from 4.10 to 2.98 and from 3.80 to 2.26, respectively). Similar changes were found in four age categories ranging from 20 to 42 years old. Thus, the participants over 30 demonstrated lower final scores. Academic success also decreased in the group of men compared to the group of women. The findings of this study can be practically applied for the further transformation of educational programs and additional preparation of educators with the aim of facilitating learning transition to an online mode. Future research on the topic can be conducted in other regions of the world to obtain more comparative data and investigate different learners' perceptions.

Keywords: COVID-19, e-learning, foreign language learning, learning motivation, lockdown, online learning

1. Introduction

In order to reduce social interactions and maintain social distancing during the lockdown introduced across almost all countries worldwide, local authorities imposed temporary closure of educational institutions and thus encouraged the transition to distance learning. According to the United Nations report issued in August 2020, 98% of all educational institutions all over the world were closed (quoted accordingly to Bilawar, 2020). The UNESCO figures issued on September, 30th 2020, confirmed that as many as 132 countries shut their educational institutions, shifting the learning process of a total of 176 784 928 learners at different educational stages to the cloud. This form of education is based on the use of online tools and video conferencing software (e.g., Zoom, Skype), as well as cloud services with shared and ranked access (e.g., Google Class) providing educational content and the ability to track student progress (Bilawar, 2020; Bonal and González, 2020).

The issue of learning in a digital environment has been actively discussed and studied in academia for more than a decade. However, the introduced COVID-related measures made it even more urgent (Athreya and Mouza, 2016; Bennett and McWhorter, 2020). The most important factors determining the student position during the lockdown were represented by unequal digital environment accessing possibilities as well as social inequality and knowledge gap provoked by them (Krishnapatria, 2020; Opaluwah, 2020). This form of inequality is often called the digital divide (Ramsetty and Adams, 2020). Researchers note that many developing countries are characterized by acutely negative trends in the educational system, which turned out to be not ready for the transition to the digital environment due to unexpectedly low levels of digital literacy (Abdulai et al., 2021). The penetration of mobile communications and cloud services, including completely free e-learning methods, turned out to be much weaker than it was estimated (Opaluwah, 2020; Sanad and El-Sayyed, 2020).

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The problem of the digital environment and distance learning was revealed in the fact that they require completely different teaching methods, tools, and sets of practical pedagogical and digital skills possessed by the teaching personnel (Nash, 2020). A significant number of educators, even in developed countries, are rather poorly prepared to regularly generate or find digital learning materials consistent with the curriculum and create engaging and motivating content to ensure learners' academic success (Fryer and Bovee, 2016; Godwin-Jones, 2019). For this reason, much research has focused on finding guidelines or sets of skills and competencies focused on the digital environment that teachers can effectively communicate to students to improve the situation (Buchholz, DeHart, and Moorman, 2020; Dzekoe, 2020; Rosen, 2020).

So far, the academic community has focused on the development of mechanisms to bring the digital environment into the regular face-to-face classroom or solving the problems of blended learning methods (Gergő, 2016; Fryer and Bovee, 2016). However, this approach turned out to be fundamentally inapplicable during the lockdown, which is now forcing students to learn distantly; the latter implies taking into account technological and methodological aspects (Godwin-Jones, 2019).

The most serious problem, which seems to be incompletely understood by researchers of pedagogy, is the position of a learner when they find themselves face to face with the digital environment without the control and support of the familiar social environment encouraging the learning process (Galla, 2016). The purpose of this study was to analyze changes in students' assessment of e-learning itself, of their participation in it, and of their academic achievements during three months of COVID-19, when the training completely switched to the online mode.

2. Literature review

Many researchers note that the problem of distance learning during the lockdown has three major dimensions (Bilawar, 2020; Lo Presti, 2020; Sanad and El-Sayyed, 2020). The first dimension is the socio-technological one. The digital environment is far from being deep enough in all countries of the world. This particularly applies to developing states, where not every family at all has the necessary electronic devices to connect with remote learning content and educators. What is more, this problem is exacerbated by the fact that the capacity of local networks, communications, and cloud services can hardly be called sufficient (Favale et al., 2020; World Bank, 2020). Low-socioeconomic status households and middle-class people with labor-intensive employment are just unable to help their children or control learning quality (Mafunda and Swart, 2020; Opaluwah, 2020).

The second aspect of the problem is methodological. Some works analyze the application of digital technologies and tools for teaching (Yu and Altunel, 2018). Teaching English as the main international language has long and closely been associated with e-learning that involves mobile-based education, the opportunity to contact and communicate with native speakers online, and other remote opportunities to improve language skills (Sheina and Grashchenkova, 2020; Vulchanova et al., 2017). Though, in many cases, there are no methodologies and frameworks for the implementation of all these tools to teach large groups of students. In most scenarios, despite the rapid proliferation of massive open online courses, they still cover a relatively small proportion of learners (Ivleva and Fibikh, 2016). Moreover, there are problems related to the certification of the knowledge gained and the recognition of such certificates by employers, which is a critical issue for most users when choosing a learning method (Langan et al., 2016).

The third aspect of the problem under consideration is psychological. One of the main challenges of the digital environment stems from the dehumanization of the information space. Most of the content offered and actively promoted on the Internet is either commercial or downright useless for a particular user (Santoso et al., 2016). It is mainly entertaining in one way or another and serves as a distraction mechanism. The separation of the learning process from the need for constant interaction with digital information sources and devices often creates conditions for deep learning, which is critical in forming deep knowledge and professionalism in any field (Ahmad, Farman, and Jan, 2019; Ravì et al., 2016). When the learning process takes place exclusively in a digital environment, the only factor in its success is students' deep motivation and involvement (Kurhila and Kotilainen, 2017; Luo et al., 2018).

At the same time, even in developed economies characterized by the well-established digital environment, a number of teachers are cautious about online-based learning and poor digital literacy (Chetty et al., 2018; Rosen, 2020). Accordingly, they face significant practical and psychological challenges when developing e-

learning content, scheduling classes, as well as monitoring the academic success of students online (Seedhouse, 2017). It should be emphasized that in this particular case, digital literacy should be considered not as the capability to use digital devices and technologies that have already become common but as the ability to master new technologies quickly, skipping the period of long psychological adaptation (Rosen, 2020). A large proportion of the world's population, especially over the age of 40, find it difficult to achieve this level of digital literacy (Chetty et al., 2018; Luo et al., 2018; Yeung and Lee, 2019).

A number of researchers point out that in terms of motivation, engagement, and distraction mechanisms, there is no significant difference between adults and children/adolescents in the process of e-learning (Bennett and McWhorter, 2020; Langan et al., 2016). Even though it is known that the lockdown has had almost the same effect on school, university, and post-secondary education, there is still little research on this topic (Bonal and González, 2020; Krishnapatria, 2020; Sanad and El-Sayyed, 2020). The problem touched upon in this study lies in the investigation of changes in the quality of education and its assessment, usefulness, and acceptability in the context of the transition from exclusively or predominantly in-class education to e-learning.

In the modern research literature, there are many quantitative and qualitative studies reviewing the transition processes in education that arose due to the sudden implementation of distance learning and the engagement of the vast majority of school students and adult learners into the digital environment. However, relatively few works were devoted precisely to students' attitudes towards this transition and their self-assessment. The present paper aims to partially eliminate this gap by scrutinizing the Russian experience of teaching English as a foreign language in the context of the COVID-19 pandemic as an example.

Among the tasks of the current study are to identify the nature of the transition from classroom learning to e-learning, analyze changes in academic performance and student motivation, and explain the results obtained. The research question is: How much did students' e-learning assessment, e-learning participation, and academic performance change after three months of online learning because of COVID-19? The practical significance of the research is in the possibility of using its findings to improve all segments of education. Further development of the digital environment, its totalization, and possible future lockdowns of epidemiological, social, or technogenic nature require the readiness of the education system to ensure effective preparation in the context of distance education.

3. Methods and materials

3.1 Participants

The study involved 600 candidates from five private foreign language schools focused on teaching English to adults in the city of Moscow. The sample distribution ensured an even number of candidates from each educational institution participating in the study (120 participants from each school). The research sample was statistically significant for the described general population with the accuracy of $p = 3.90$. The change in the size of the general sample in connection with the change in the number of students during the lockdown was checked, and it did not affect the statistical reliability of the study.

The distribution of participants by gender and age was balanced in order to maximize the statistical reliability of the results. The study involved 296 male and 304 female learners aged 20 to 42 years. A more detailed description of participants' distribution by category is presented in Table 1.

Table 1: Distribution of research participants by gender and age

20-25		26- 30		31-35		35-42	
male	female	male	female	male	female	male	female
73	76	73	74	76	77	74	77

The survey was conducted throughout November 2020. Given the fact that there was an active change in the number of students during the lockdown, the study involved only those participants who had already started learning at the time of transition to e-learning and continued to study in the same group for three months after the beginning of the study.

3.2 Research design

All the persons enrolled in the research process were asked to rate three statements on a five-point Likert scale in a short survey. Score (1) reflected a strong disagreement, while score (5) indicated complete agreement with the statement given. The survey was conducted twice; the first time was after one week of study, while the second time was after three months after complete switching to e-learning mode.

Validity and reliability, in this case, were not determined because instead of a questionnaire in which all items should achieve the overall goal of an adequate factor assessment of the measured parameter, three separate statements were used, each of which was independently measured as a separate variable. Correspondingly, the Likert scale is the most adequate method for measuring such variables.

The survey included the following three statements:

1. E-learning is useful for developing my English language skills and knowledge.
2. E-learning suits me in the process of developing my English language skills and acquiring knowledge.
3. I agree to continue e-learning in the future.

The obtained responses were averaged on the basis of the ordinary arithmetic mean method. For the sake of simplicity, the collected data were given with the accuracy of two decimal places. The means reflecting individual age and gender groups were calculated separately (Figures 1 and 2).

This survey method was chosen because it was possible to obtain immediate assessments of the most important variables from the participants. In this case, the subjectivity of the participants was not eliminated but, on the contrary, taken into account. This is important because the subjective assessment of the participants demonstrates the reasons for their motivation and involvement, for example, reasons for not continuing the course, as indicated further in the Results.

To obtain more reliable data, the assessment of student knowledge was also performed on the basis of the standard tests used in these educational institutions on a 100-point scale. This assessment was also carried out twice: one week and three months after the e-learning started. The distribution by age was not tackled in order not to overload the text as there were no correlations or significant features found in relation to this indicator.

To clarify and triangulate the data collected, another unstructured interview was conducted among the candidates from all study participants willing to participate. They were asked to describe the factors that led them to develop a negative perception of e-learning compared to traditional face-to-face instruction. Those study participants who wished to take part in this unstructured survey were asked to present the data in the form of concise and straightforward statements by e-mail after the experiment's completion. These responses were analyzed from a semantic point of view and brought into groups of the same type. Semantically similar or identical definitions or statements were reformulated to achieve maximum clarity and consistency. Then the resulting formulation was approved by the surveyed for a second time, who confirmed the adequacy of the presentation of their point of view. Hence, possible problems with the incorrect definition of the general semantics of the survey participants' comments were removed. Statistical processing of the results of this survey was not carried out due to its exclusively narrative and qualitative nature.

3.3 Statistical processing

All the averaged survey results and the outcomes of assessing objective knowledge through testing were analyzed to determine the standard deviation in the study group. This step was aimed at determining the acceptable statistical error when comparing the values obtained. The Pearson correlation coefficient was established between all data groups. All correlation values below $r = 0.35$ were discarded as insignificant. In addition, correlations between the values that showed no statistical discrepancy (if they were within the statistical error) were not considered as significant.

3.4 Research instruments

The statistical data were processed and visualized in Microsoft Excel 2017.

3.5 Ethical issues

The study aim, procedure, and objectives were explained to the persons enrolled in the fullest manner possible. Therefore, their participation was completely voluntary. Among those who agreed to take part in the experiment, a limited number of individuals that met the requirements of statistical sample homogeneity (see above) were selected. No personal data of the persons involved were collected, processed, or stored during the study or after it. Each participant had his/her own unique e-mail address with a unique identification number; this guaranteed complete anonymity and, at the same time, the reliability of the obtained results.

3.6 Research limitation

The study is representative only of selected educational institutions. It was conducted in one large city (Moscow, the Russian Federation), whereas the level of education, its quality, as well as other socio-economic factors vary significantly across regions and may also differ from similar indicators obtained in other countries. In addition, the study is dealing only with the shift of learning English as a foreign language to online mode.

4. Results

The results of the survey designed to reveal changes in learners' attitude towards e-learning during the COVID-19 are presented in Figures 1 and 2. Hence, Figure 1 shows that the assessment of e-learning comfort by female respondents decreased greatly (from 3.70 up to 3.14 on a five-point Likert scale), while the assessment by male participants remained virtually unchanged. On the other hand, the usefulness score dropped significantly in the case of both male and female research participants (from 4.10 to 2.98 and from 3.80 to 2.26, respectively). Due to the fact that the learning content, curriculum, and instructional materials did not virtually change, the assessment of their usefulness was subject to variations mainly because of e-learning introduction and the shift from the traditional classroom environment guided by a teacher to the exclusively digital one. It can also be assumed that the initial high positive impression largely reflected respondents' overestimated expectations concerning e-learning. The assessment could be affected by the possibility of continuing education despite the lockdown.

No less important observation was the critical decrease in the perception of continuing e-learning acceptability. It reduced from 4.72 and 4.29 to 3.01 and 2.61 for male and female research participants, respectively. It should be noted that in both cases, female respondents' points of view concerning the usefulness of e-learning and the acceptability of its continuation were much more critical – according to their answers, this learning method lacks convenience.

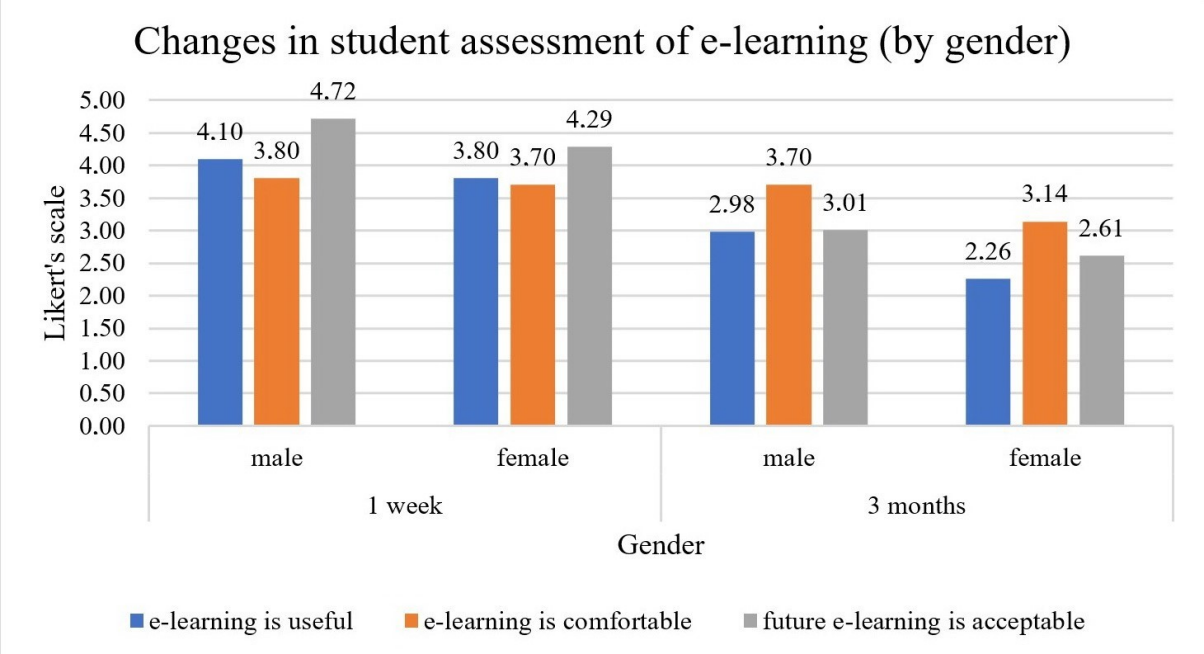

Figure 1: Changes in learners' perception of e-learning (by gender)

Figure 2 visualizes changes in the learners' stance towards online-based education (by gender). As can be seen, there was a critical decrease in their perception of continuing online study acceptability. Table 2 gives these data in numerical terms.

Table 2: Changes in student assessment of e-learning (by gender)

	1 week		3 months	
	male	female	male	female
e-learning is useful	4.10	3.80	2.98	2.26
e-learning is comfortable	3.80	3.70	3.70	3.14
future e-learning is acceptable	4.72	4.29	3.01	2.61

On average, there was a decline in e-learning assessment from 4.74 to its minimum value of 2.37 (in the group of participants aged 26-30). In parallel, in all age groups, except 20-25 years old individuals, a statistically significant decrease in their outlook of e-learning usefulness was observed (from the maximum value of 4.39 to the minimum value of 3.39). A reduction in this indicator in the group of individuals aged 20-25 was also notable. However, provided that it fell within the statistical error, it could not be taken into account.

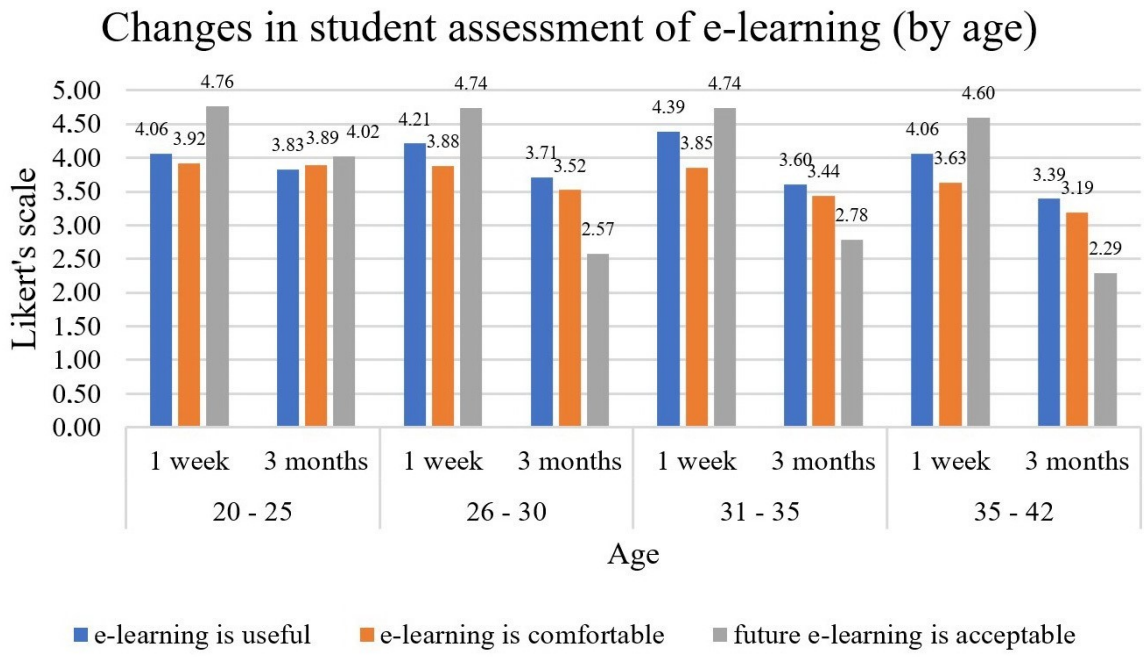

Figure 2: Changes in learners' perception of e-learning (by age)

There was a much smaller discrepancy as regards the suitability of e-learning. A statistically significant difference was noted only in two older age groups: in the 31-35 age group, there was a decrease from 3.85 to 3.44, and in the 36-42 age group, a diminishment from 3.63 to 3.19 was found. These data are presented in Table 3.

Table 3: Changes in student assessment of e-learning (by age)

	20-25		26-30		31-35		35-42	
	1 week	3 months	1 week	3 months	1 week	3 months	1 week	3 months
e-learning is useful	4.06	3.83	4.21	3.71	4.39	3.60	4.06	3.39
e-learning is comfortable	3.92	3.89	3.88	3.52	3.85	3.44	3.63	3.19
future e-learning is acceptable	4.76	4.02	4.74	2.57	4.74	2.78	4.60	2.29

In order to get more reliable data, the results obtained from an objective language proficiency test (conducted at the beginning of the e-learning) and the results collected three months later were compared (Table 4). As a consequence, a considerable drop in the grade point average for both genders was revealed. Among the groups of male and female participants, the standard deviation was no more than 4.75 and 4.18, respectively. Thus, a decrease in academic success was an objective phenomenon that correlated with participants' subjective assessment.

Table 4: Changes in participant performance assessment during the lockdown

1 week		3 months	
male	female	male	female
47.95	52.88	37.18	46.56

Another factor that could influence a decline in academic performance and the evaluation of e-learning by research participants was the change in the number of students during the first three months of the lockdown in the studied educational institutions (Table 5). From the beginning of the quarantine, in the wake of increased interest in e-learning and hopes for acquiring a new job or profession, the number of new students studying remotely increased to 49.73% (excluding the dynamics over three months under consideration). However, 42.14% of students, including those who joined the distance learning course within three months, either stopped participating and did not complete the program or formally announced their decision to drop out. In addition, 64.6% of those who joined the learning process during the lockdown dropped out of the course before the end of the first three months of learning.

Table 5: Changes in the number of participants during the COVID-19-related lockdown

Total at the start of the lockdown	11857
Total at the end of the third month	10271
Joined during lockdown	5896
Dropped out during lockdown	7482
Joined and dropped during the lockdown	3809

A strong correlation was found between all test results and the results of assessing the usefulness of e-learning and its acceptability in the future by all gender and age groups (Table 6). Besides, a certain consolidation of the Pearson's correlation coefficient was noted: for all the indicated groups, it ranged between 0.73-0.81 and thus was recognized as high. In view of the foregoing, an inference could be made that the decline in test scores and the decline in motivation and engagement revealed by student assessments are closely interrelated.

Table 6: Pearson's correlation between participants' e-learning assessment and performance test outcomes

	performance assessment			
	1 week		3 months	
	male	female	male	female
e-learning is useful	0.73	0.74	0.79	0.81
e-learning is comfortable	0.73	0.74	0.77	0.79
future e-learning is acceptable	0.75	0.77	0.74	0.80

Data presented above suggest that the provided e-learning course clearly failed to meet some important learners' needs or was poorly organized. Therefore, another unstructured survey was conducted among the participants who wished to share their opinion (n = 432). Within this examination, they were asked to describe things that interfered with the learning process and factors that led to their negative evaluation of the e-learning experience compared to the traditional face-to-face classes. Since the provided opinions were reformulated and further approved by participants themselves, it was impossible to accurately indicate how many individuals participated in the formulation of each of the presented points.

In general, the reasons for the negative evaluation of the e-learning experience were as follows:

1. Unstructured timetable, class omissions, late delivery of educational materials and feedback by teachers.
2. Lack of a full set of training materials and content in the form of a complete training course. The content was largely created by teachers during the learning process.

3. Homework and language mistakes were not checked and analyzed by teachers in contrast to classroom learning.
4. Lack of communication with the educators and other students resulted in no proper foreign language communication practice.
5. Lack of constant motivation provided by a teacher in the classroom.
6. Lack of ability to allocate time to study at home independently due to the availability of numerous personal affairs and activities as well as the constant presence of other family members.
7. Failure to deal with digital distractions, primarily with those of entertainment nature.

Summing up the obtained results, it can be concluded that the transition to an exclusively online foreign language learning in those institutions that used classroom instruction led to a drop in academic performance, a decrease in motivation to continue learning, as well as a worsened judgment of the quality and usefulness of e-learning by most learners.

The study also revealed that female participants generally found the learning process more important – they showed better academic progress even in the context of deteriorating learning conditions and expected them to be improved. Older learners (over the age of 30) generally had a more pessimistic view of e-learning usefulness, fewer expectations for it, and a weaker intention to continue learning in this way. The drawbacks in education and the unwillingness of educational institutions to operate in a completely digital environment led to the fact that about half of the candidates dropped out or refused to continue training immediately after starting a course. According to the participants, the most important subjective factors of this process were the lack of motivation, little involvement, and scarce contact with a teacher and the social environment.

5. Discussion

The results of the present study overlap with a number of related works that were conducted in developed and developing countries and outlined the processes of transition to e-learning (Chetty et al., 2018; Sanad and El-Sayyed, 2020; World Bank, 2020; Yeung and Lee, 2019). As already mentioned, it is extremely hard, if not almost impossible, to find research on the sudden education shifts during the COVID-19 lockdown period. This research topic is presently being developed and is still under investigation. However, there is some evidence (Krishnapatria, 2020) that the direct transition to e-learning, but not through blended learning, leads to noticeable academic performance deterioration. The results obtained in the present study are somewhat different than those obtained in the cited sources; this may be attributed to tougher transition conditions and lower degree of education system readiness.

Higher educational demands of female respondents compared to those of male respondents are often noted in quantitative studies in the field of education (Stone et al., 2016; Yeboah and Smith, 2016). For the most part, they are associated with women's greater responsibility to their current or future families and other social factors. The present research demonstrates a similar correlation between grades and real objective learning outcomes for men and women, but objective learning outcomes for women are better throughout the entire period of e-learning. According to a number of scholars, similar results can also be explained by the greater psychological stability of women in overcoming difficulties in the learning process (Rosen, 2020; Sanad and El-Sayyed, 2020; Sheina and Grashchenkova, 2020). Besides, women may be less prone to loss of interest and motivation and may retain them longer than men (Stone et al., 2016; Sigit et al., 2019).

It is often suggested that the stress of education digitalization is reduced through gamification tools. Gamification can involve both the use of special computer games with educational content as well as the use of available free game applications for the educational process gamification. For example, a certain level or “rank” can be a reward for achieving a certain level of success. The learning process can utilize the character development pattern of a fantasy role-playing game (Hung et al., 2018; Poole and Clarke-Midura, 2020). As noted by the researchers, the means of gamification affect adults as effectively as they do children and adolescents (Hung et al., 2018; Poole and Clarke-Midura, 2020).

Recently, developed countries with a deep penetration of the digital environment are characterized by the transfer of social communication in the context of learning in virtual reality, which allows, if the necessary equipment is available, to completely eliminate the problems identified in the present study by its participants (Kövecses-Gősi, 2018). Many studies prove that the use of digital tools by the majority of users involved in e-

learning is regarded as improvement in usability (Santoso et al., 2016; Rosen, 2020). The results achieved during this examination demonstrate the importance of this criterion for maintaining involvement and academic achievement.

The problems of establishing online partnerships to communicate with native speakers, other students, and a teacher have been solved for some time with the help of social networks and specialized groups that allow expanding social contacts and even organizing visits to other countries (Al-Shammari, 2020). In the case of the present study, the lack of relevant knowledge, and in particular, the lack of willingness to establish network communication on the part of educators, led to a decrease in the motivation and educational progress of students (Dzekoe, 2020).

E-learning creates additional opportunities for individualizing learning of each student, but only upon the availability of three important factors: technological infrastructure to provide access to information and resources, including communication ones, good digital literacy skills (Chetty et al., 2018; Rosen, 2020), and readiness to accept trending technologies (Gharib et al., 2016; Pallotti, Niemants, and Seedhouse, 2017). In this case, e-learning contributes to the development of critical thinking, promotes the ability to solve real problems competently, and encourages independent development of an individual learning path, which is one of the most important skills of the 21st century.

6. Conclusion

This research addressed one of the most acute and relevant modern-day pedagogical problems - forced digital transformation of education due to the global COVID-19 lockdown. In the wake of this transformation, traditional in-class instruction switched to the fully digital learning model, for which the education system in most countries, even in highly developed ones, has not yet been fully prepared. The novelty of this study lies in the search for the reasons and characteristics of changes in academic performance, motivation, and student involvement in e-learning under the current conditions. The research process involved 600 respondents from five private specialized educational institutions located in Moscow (the Russian Federation), which suddenly switched from traditional classroom instruction to e-learning. The examination process presupposed study participants to undertake two repeated surveys (one week and three months after the lockdown), in which usefulness, comfort, and acceptability of continuing e-learning were rated on a five-point Likert scale. The study showed that the perception of the male and female participants of the acceptability of continuing online English learning dropped from 4.72 and 4.29 to 3.01 and 2.61, respectively. The female respondents' perception of the suitability of e-learning decreased significantly (from 3.70 to 3.14 points). As regards the usefulness of learning English as a foreign language online, the score dropped significantly according to both male and female participants (from 4.10 to 2.98 and from 3.80 to 2.26, respectively). In general, for individuals aged from 20 to 42, similar changes were found. However, especially notable was that the persons over 30 demonstrated lower final scores than others. At the same time, a more pronounced decrease in an objective measure of academic success was inherent to the group of men.

Today there is a need for a further thorough investigation of digital transformation in terms of the effectiveness of various blended learning models and increasing the digital literacy of teachers, including in other areas. The practical significance of this work is in the applicability of its findings for the further transformation of learning programs and additional preparation of educators with the aim of facilitating learning transition to an online mode. Similar research can be conducted in other world regions to obtain more comparative data and investigate different learners' perceptions.

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Exploring Feedback and Gamification in a Data Modeling Learning Tool

Olav Dæhli[1], Bjørn Kristoffersen[2], Per Lauvås jr[3] and Tomas Sandnes[3]
[1]University of South-Eastern Norway, Porsgrunn, Norway
[2]University of South-Eastern Norway, Bø, Norway
[3]Kristiania University College, Oslo, Norway
olav.dehli@usn.no
bjorn.kristoffersen@usn.no
per.lauvas@kristiania.no
tomas.sandnes@kristiania.no

Abstract: Data modeling is an essential part of IT studies. Learning how to design and structure a database is important when storing data in a relational database and is common practice in the IT industry. Most students need much practice and tutoring to master the skill of data modeling and database design. When a student is in a learning process, feedback is important. As class sizes grow and teaching is no longer campus based only, providing feedback to each individual student may be difficult. Our study proposes a tool to use when introducing database modeling to students. We have developed a web-based tool named LearnER to teach basic data modeling skills, in a collaborative project between the University of South-Eastern Norway (USN) and Kristiania University College (KUC). The tool has been used in six different courses over a period of four academic years. In LearnER, the student solves modeling assignments with different levels of difficulty. When they are done, or they need help, they receive automated feedback including visual cues. To increase the motivation for solving many assignments, LearnER also includes gamifying elements. Each assignment has a maximum score. When students ask for help, points are deducted from the score. When students manage to solve many assignments with little help, they may end up at a leaderboard. This paper tries to summarize how the students use and experience LearnER. We look to see if the students find the exercises interesting, useful and of reasonable difficulty. Further, we investigate if the automated feedback is valuable, and if the gamifying elements contribute to their learning. As we have made additions and refinements to LearnER over several years, we also compare student responses on surveys and interviews during these years. In addition, we analyze usage data extracted from the application to learn more about student activity. The results are promising. We find that student activity increases in newer versions of LearnER. Most students report that the received feedback helps them to correct mistakes when solving modeling assignments. The gamifying elements are also well received. Based on LearnER usage data, we find and describe typical errors the students do and what types of assignments they prefer to solve.

Keywords: entity relationship diagrams, ERD tool, automatic formative assessment, automatic formative feedback, gamification in education

1. Introduction

More than 50 years after Codd introduced the relational model of data (Codd, 1970), relational databases are still in use today. Although we have multiple options when selecting a storage medium for our data, the relational database is still often the choice in IT projects today. In IT education, knowledge and skills regarding databases are essential. In the 2008 ACM/IEEE Curriculum Guidelines for Undergraduate Degree Programs in Information Technology (Lunt et al., 2008, p. 19), "Databases" was firmly placed as one of the five pillars within the IT discipline. In the currently newest version (Task Group on Information Technology Curricula, 2017, p. 50), "data modeling" and "database query languages" are examples of topics within the *essential* IT domain: Information management.

The order in which to teach data modeling and database query language (SQL) may vary. Our contribution context is several courses in multiple institutions, where both modeling and SQL are taught in the same course, with SQL first, then modeling. In study programs with multiple database courses, this would translate into having a course with emphasis on SQL followed by a separate course on modeling (e.g. Migler and Dekhtyar, 2020).

When designing a database, we have several modeling notations to choose from. Entity Relationship Modeling (ER) (Chen, 1976), Unified Modeling Language (UML) and Object-Role Modeling (ORM) (Halpin and Bloesch, 1999) are well-known alternatives. We also have multiple professional tools to choose from when developing a model, and later transforming the model into database schemas. But these professional tools require the user to already *have* the modeling skills required to do so.

An educational tool could *help* the students *acquire* modeling skills. Intelligent Tutoring Systems (ITS) are "computer programs that use artificial intelligent techniques to enhance and personalise automation in teaching" (Alkhatlan and Kalita, 2018, p. 1). In database modeling, multiple tools have been developed over the years for that purpose. EER-Tutor (Suraweera and Mitrovic, 2004) is a mature ITS dating back to the early 2000s. Originally named KERMIT (Suraweera and Mitrovic, 2002), EER-Tutor originated from the University of Canterbury, New Zealand, and is still in use. In the last 20 years, several papers describe the tool from multiple angles (e.g., Zakharov et al., 2007; Duan et al., 2010; Mathews et al., 2012; Mitrovic and Holland, 2020). With EER-Tutor, students can select among several available modeling assignments, try to complete the task, and receive formative feedback.

Automatic grading of free-form ER diagrams is a hard problem (Jayal and Shepperd, 2009). In recent years, multiple attempts have been made to automate (or semi-automate) assessment and grading of both ER models (Batmaz and Hinde, 2006; Thomas et al., 2006; Thomas, 2013; Simanjuntak, 2015; Lino and Rocha, 2018) and UML class diagrams (Hoggarth and Lockyer, 1998; Ali et al., 2007; Soler et al., 2010; Hasker, 2011; Stikkolorum et al., 2019; Bian et al., 2019). Semi-automatic grading has the potential both to decrease the workload of teachers and achieve a fairer marking (Batmaz et al., 2010). The efficacy of the automated grading effort has also been evaluated (Bian et al., 2020). Using the grading algorithm described in Bian et al., 2019, they found that the grading strategy needs to be adapted to the level of the student and the grading style of the instructor. Further, they emphasize that the grading must consider multiple possible solutions.

The process of learning the modeling notation and the related formal rules for drawing diagrams, is normally not that demanding. Related to Bloom's taxonomy (Bloom, 1956), a way of classifying learning objectives, acquiring basic knowledge and comprehension are the least demanding part of the learning process. Nor are there so many symbols and rules to learn in this case.

After having achieved an understanding of the basic terminology, students have to learn how to use a requirement specification to analyze the need for storing data, and from this construct an appropriate data structure. This is a more complicated process, where students need to obtain an understanding at a higher level (ref. Bloom). This requires volume training, solving exercises of increasing size and complexity.

Errors made by students trying to learn data modeling have been studied and classified, and also compared with Bloom's taxonomy (Batra and Antony, 1994; Bogdanova and Snoeck, 2019; Rosenthal and Strecker, 2019).

Most students need a lot of help and feedback on their work along the way. Formative feedback should be supportive, timely, and specific (Shute, 2008; Hattie and Timperley, 2007). With a rising number of students in higher education, providing quality feedback is time demanding for teachers and it limits the students' ability to do the work when and where it suits them best.

LearnER is designed to provide students with automatically generated feedback when they are in the process of solving various modeling assignments. It is intended to be used as a tutoring tool, and not for automated grading. Professional data modeling tools should also be included in a database course, but mainly *after* the students have attained a certain level of understanding.

Whether working alone or in teams, several students need extra motivation for solving exercises. To meet this end, elements of gamification are included in LearnER, such as earning points through solving tasks and having leaderboards (high score lists) where students can compare themselves to others. Gamification is the use of game mechanics as motivation in non-game contexts, for example to increase learning in educational applications (Kapp, 2012).

Formative feedback and gamification seem to be a promising combination in educational software (Fuchs and Wolff, 2016; Menezes and Bortoli, 2016; Keuning et.al., 2018; Zainuddin et al., 2020). The latter systematic literature review concludes that "Gamification is an uprising trend that applies gaming mechanics as a driver to motivate, engage and enhance the user experience." (Zainuddin et al., 2020, p. 15).

A recent attempt at gamifying database design learning is MonstER Park (Schildgen, 2020). MonstER Park is a free online game where the learner advances through a game creating ER diagrams along the way in a step-by-step fashion.

In this paper, we have investigated the following research questions:

1. When and how do students use LearnER?
2. To which extent do the formative comments give adequate feedback to students?
3. Do the gamification elements contribute to learning, and if so, in what way?

We have investigated the same questions based on earlier versions of LearnER (Dæhli et al., 2018; Dæhli et al., 2020), this paper is an extended version of the latter paper. We have further developed LearnER since 2020. We present additional data on student experiences from using the tool. We expand our data set with new surveys, and we add a new data set; usage data stored in the LearnER database.

2. LearnER – combining feedback and gamification

LearnER is part of the free online resources of a Norwegian textbook written by one of the authors of this paper. The tool contains a set of predefined exercises of various difficulty, each having a model solution. Teachers may also add extra exercises. Students construct ER models by using words extracted from the model solution and may at any time check their model and receive elaborate formative feedback as well as visual cues.

A stylized version of the user interface is presented in Figure 1. The student is presented with a scenario text and can build a data model by dragging the available labels (words) onto the drawing area.

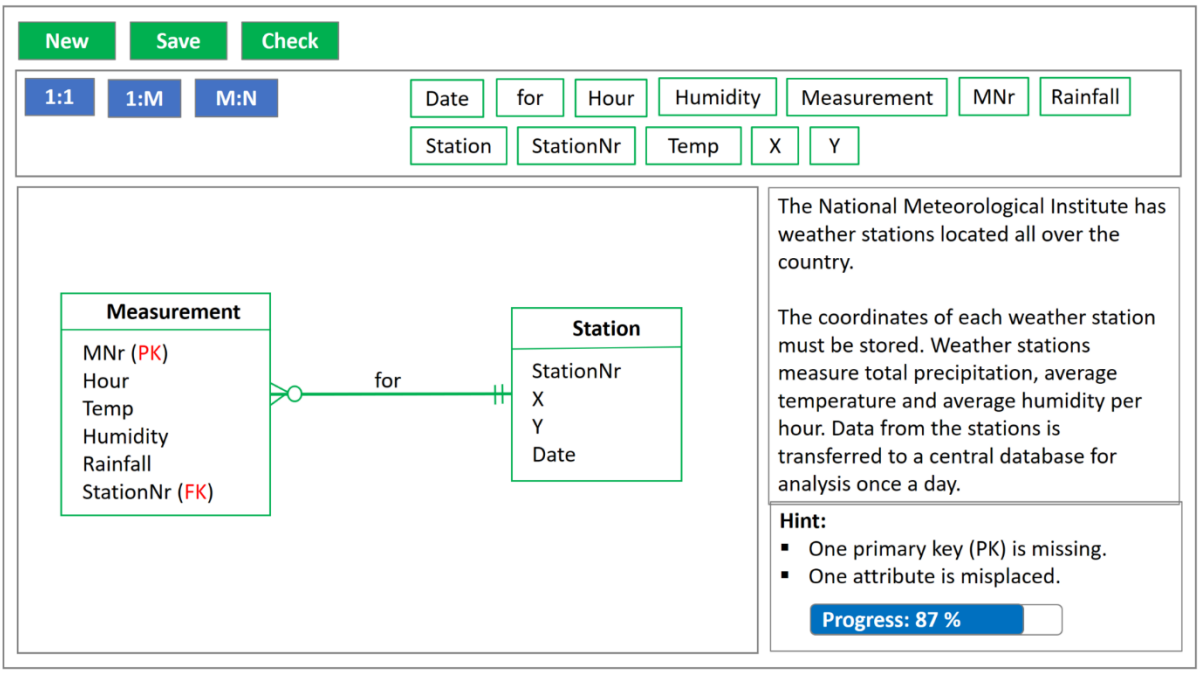

Figure 1: Stylized LearnER user interface

LearnER incorporates gamification as a motivating factor to solve exercises. Each exercise has a maximum number of points that can be achieved. When a student requests help from LearnER to solve an exercise, the maximum number of points the student can achieve is lowered. A leaderboard is kept for each exercise and for the total number of points achieved. A separate panel present feedback and progress bars, on the student's request.

LearnER supports three notations, namely UML and two variants of Crow's Foot. Furthermore, LearnER supports both high-level conceptual models and more implementation-oriented models. In addition, an SQL-script for creating an entire database, based on the student's solution, can automatically be created when students have reached the goal of making a complete model.

A new major version of LearnER has been introduced at the start of each academic year, but minor versions in-between has made it possible to roll out small changes and bug fixes for the spring semester. The most important changes during the project period have been improvements to the UI, better logging, several improvements to the feedback and scoring systems, making the tool more flexible, and adding a much larger exercise bank.

To make some of the exercises more demanding for eager students, some exercises were, in the newest version, supplemented with a few extra "inadequate" words – in the sense of being words that do not fit into the solutions. This makes it harder for students to pick the correct entity and attribute names to be used in the model.

3. Method

Different versions of LearnER have been used as a pedagogical tool in six courses, including one distance learning course, over a period of four academic years from fall 2017 to spring 2021. Qualitative and quantitative research on how students use LearnER and their experienced learning effects have been conducted in several studies. Research findings and feedback from teachers and students have been used to further develop the tool.

3.1 Surveys

Several questionnaires have been designed and distributed to all students in these courses. A core set of 9 multiple-choice questions, mostly of the Likert type, has been included in every survey from fall 2017 to spring 2020, and 5 of these were also included in a final survey conducted spring 2021. A few extra multiple-choice and free-text questions have been introduced in some of the surveys. In fall 2020 we conducted a different type of survey with mainly free-text questions.

The questionnaires have been distributed to more than 1800 students over the four-year period. Figure 2 shows an estimate of the number of active students at each campus (placing the distance learning students in their own virtual campus), which we here define as the number of students attending the final exam – according to the national Common Student System ("Felles Studentsystem", FS).

A total of 1886 active students have received one of the surveys in the period: 406 in 2017/2018, 346 in 2018/2019, 438 in 2019/2020 and 696 in 2020/2021. The number of students receiving the questionnaire were somewhat higher than this. 357 students have responded to the questionnaires, giving an overall response rate of 19% among active students.

The data for campus Oslo covers two database courses in the 2019/2020 column, and the data for the Vestfold campus covers three courses all taught in spring 2021. The response rate for campus Oslo in fall 2019 and fall 2020 were significantly lower than the rest, only 5% and 7%.

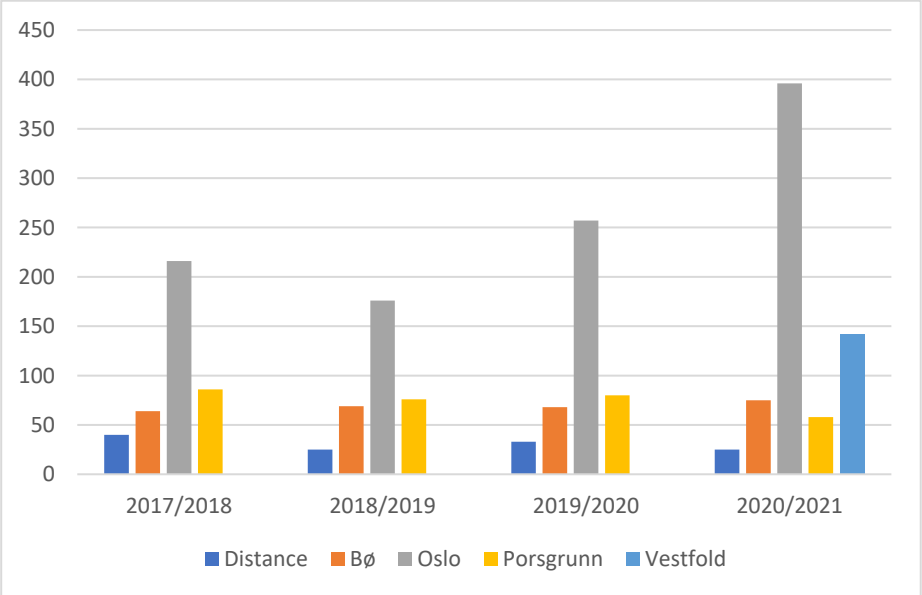

Figure 2: Number of active students at different campuses per academic year

The authors have taught all six courses combined. Some of the courses involved in this study are taught in the fall and some in the spring. Also, the data modeling part of these courses is not always taught in the same weeks within the semester, and the time interval when surveys were conducted varied slightly from campus to campus

and from semester to semester. This may have affected the results somewhat, in particular in the first academic year, when there was bug fixing in between different surveys.

Still, all courses within a single academic year used similar versions of the tool. When comparing results, we therefore regard all responses for courses held in one academic year as one dataset and compare it to the datasets from the other academic years.

3.2 Interviews and observations

In 2017/2018 we did semi-structured individual interviews with 19 students from three campuses, including some distance learning students, about their opinion on LearnER (Dæhli et al., 2018). 8 more students were interviewed fall 2018, following the same procedure, but now based on a new version of LearnER.

In spring 2019, 3 additional students were interviewed, again based on the same interview guide, but now the students solved a data model exercise in LearnER immediately before the interview. The students were told to think aloud during problem solving and one of the authors was passively observing the process.

We have not interviewed students based on the latest version of LearnER. However, all four paper authors also teach the courses being investigated, and have all been involved in LearnER lab exercises, giving rich possibilities for informal observations and oral feedback from students during their work with LearnER. Also, in 2020/2021 surveys, more free-text questions have been included to obtain more qualitative data.

Permission to retrieve non-anonymous data was obtained from Norwegian Centre for Research Data (NSD) and the participating students. Norwegian quotes were translated into English by the authors of the paper. The translated quotes are listed in quotation marks, although they are not language direct quotes.

3.3 LearnER usage data

LearnER is a freely available web tool, but most users are probably students taking our courses. The number of user accounts have increased from a little over 100 in the first year to over 400 per year.

A valid email is needed for user registration but is not permanently stored. Students choose a nickname and a password during registration and can then use the system anonymously. They are warned that nicknames may appear on leaderboards and are also asked not to use passwords they use in other (more critical) applications. All student data models are kept in the LearnER database, together with nicknames and time stamps showing when the student started and finished working on the exercise. Also, each time the student asks for help, the current state of the data model is persisted to the database.

The usage data in the LearnER database is archived at the end of each semester, and then all users and the data models they have built are deleted from the online system, which means that all high score lists are empty at the start of a new semester.

4. Results

All courses are introductory with no prerequisites. Most of the 2017/2018 students reported they had no knowledge about data modeling concepts before taking the course (Dæhli et al., 2018).

4.1 Increased student activity

Students reported that they did more exercises in newer versions of LearnER, see Figure 3. We observe that only 11% of the students said they did more than 10 exercises in 2017/2018. In the following three years, the corresponding numbers are 24%, 34% and 28%.

The apparent increase in student activity based on these self-reporting numbers can be further supported by inspecting LearnER usage data, where the average number of completed exercises goes up from 3.0 in 2017/2018 to 6.5 in 2018/2019, 7.9 in 2019/2020 and 11.9 in fall 2020. The number of exercises for 2019/2020 deviates somewhat from what we reported in (Dæhli et al., 2020), due to improved data cleansing.

Survey data and LearnER usage data is not directly “linked”. Some LearnER users may not be students at our courses. Also, LearnER usage data for spring 2021 is not included, whereas the 2020/2021 data in Figure 3 is

based *only* on spring 2021. What we can say, however, is that both survey data and LearnER usage data indicate that students solve more exercises in newer versions of the tool.

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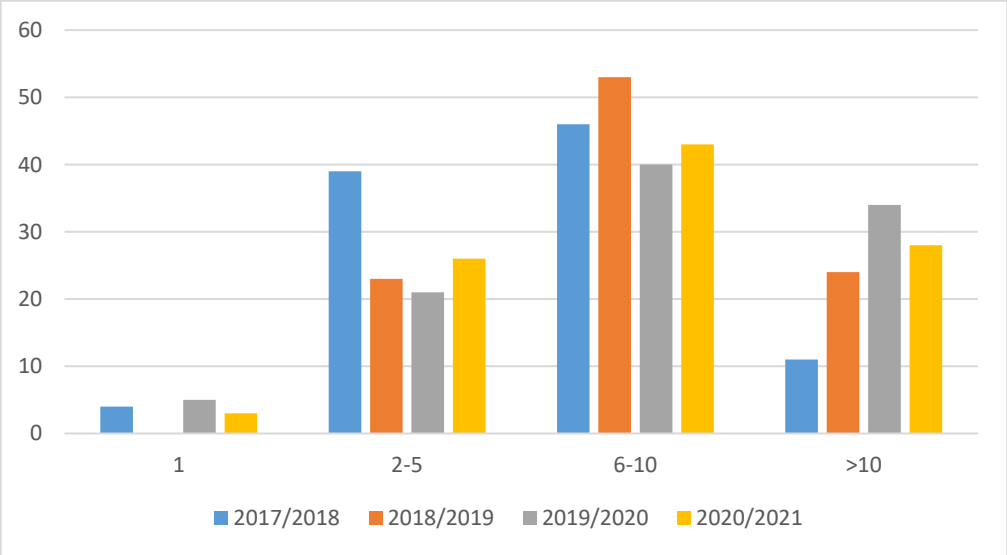

Figure 3: How many exercises did you attempt in LearnER?

We can think of several possible explanations for the increased student activity:

- More exercises have been added to the system before each academic year. In 2017/2018, LearnER had less than 20 exercises, now it contains approximately 50 exercises. This should make LearnER more interesting.
- In early versions of the tool, the teacher labeled exercises “easy”, “medium” or “difficult”. From 2018/2019 onwards, exercises were reassigned a difficulty level from 1 to 10, again discretionary by the teacher. This fine-grained categorization means that a student needs to solve more exercises to reach the “top”.
- The increased activity might also be caused by general improvements to the system. A better tool is more fun and rewarding to work with. As reported in (Dæhli et al., 2018), several 2017/2018 students mentioned the tool was “prototypical” and “buggy”. There were fewer comments about bugs in the 2018/2019 survey, and even fewer again in later surveys.
- Changes in teaching arrangements could also affect the activity, of course, but we have been using LearnER in much the same way in all six courses over the period.

4.2 Collaboration

During the first three years, a relatively large number of students were using LearnER together with others to a large degree – 47%, 32% and 42%, respectively. See figure 4. In spring 2021, this dropped to only 18%. We speculate that this is a coronavirus effect.

Spring 2020 was also affected by the coronavirus, but not until mid-term. The students had already gotten to know each other and had formed relations and study-groups by that time, which could be the reason we did not find a decrease in collaboration for the 2019/2020 academic year.

We observe differences in reported collaboration between the campuses/courses also before the pandemic. The course in Porsgrunn has a high degree of student collaboration, while the distance learning students prefer to work alone. Some of these differences can be explained by how learning activities are organized for various courses, e.g. if LearnER exercises are given as group assignments.

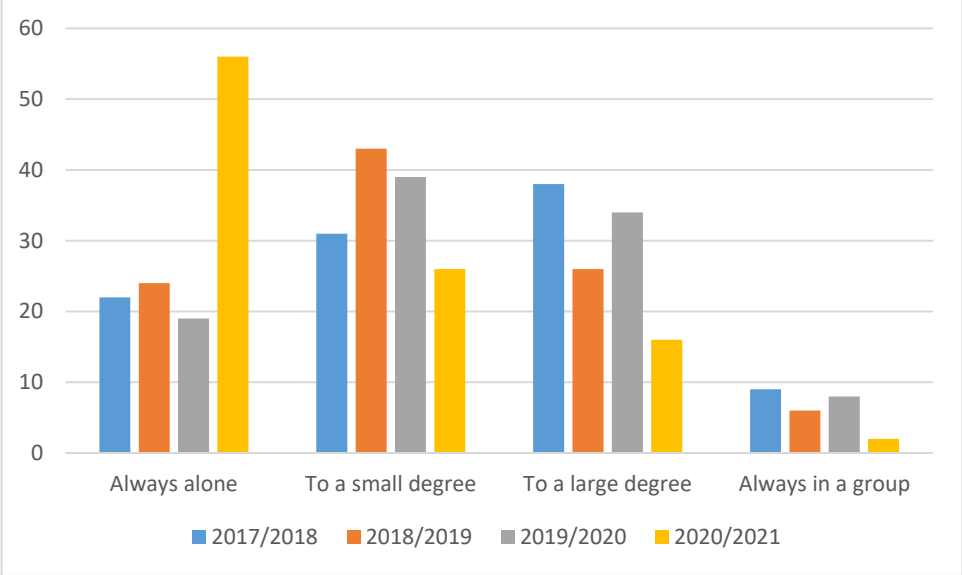

Figure 4: To what extent did you use LearnER together with others?

4.3 Formative feedback and visual cues

The feedback system was redesigned in the summer of 2018. The new system gave more elaborative feedback, first at a general level and then more detailed on the students' request. Students could also get visual cues that pinpointed errors in their models.

In 2017/2018, students said they wanted more detailed feedback (Dæhli et al., 2018), but the surveys indicate that even more students read the feedback carefully in the early versions. 55% of the students strongly agreed with the statement "I read the feedback from LearnER carefully", compared to 30% in 2018/2019 and 37% in 2019/2020. The percentage of students who either agreed or strongly agreed was, however, about the same over the three years. We did not include this question in the 2020/2021 survey.

The amount of feedback text is substantially *higher* in newer version, possibly explaining why fewer students *strongly* agreed with the statement. Clearly, improvements can be made in feedback design, several students find the feedback texts too verbose and perhaps too general or theoretical. A student commented: "LearnER is a good program, but the feedback should be more focused on each exercise. It should provide a little more information about the exercise itself, and not generalize it. Otherwise very happy :)".

A similar argument can be made regarding visual cues that are added to the newer versions, "showing exactly where it is wrong" as one of the 2019 students puts it. Students now have alternative means for correcting their data models and may not *need* to read all the feedback.

It seems more students are now able to *correct* their data models based on feedback from the system. In 2017/2018, 54% of the respondents agreed or strongly agreed that they were able to correct their data model based on feedback from the system. This percentage was 80% in 2018/2019 and 71% in 2019/2020. We did not include this question in the 2020/2021 survey.

We found the same pattern when asking students if feedback from LearnER is helpful in learning data modeling, see Figure 5. 52% agreed or strongly agreed with this in 2017/2018, rising to 88% in 2018/2019, but then a little down to 71% and 75% the last two years.

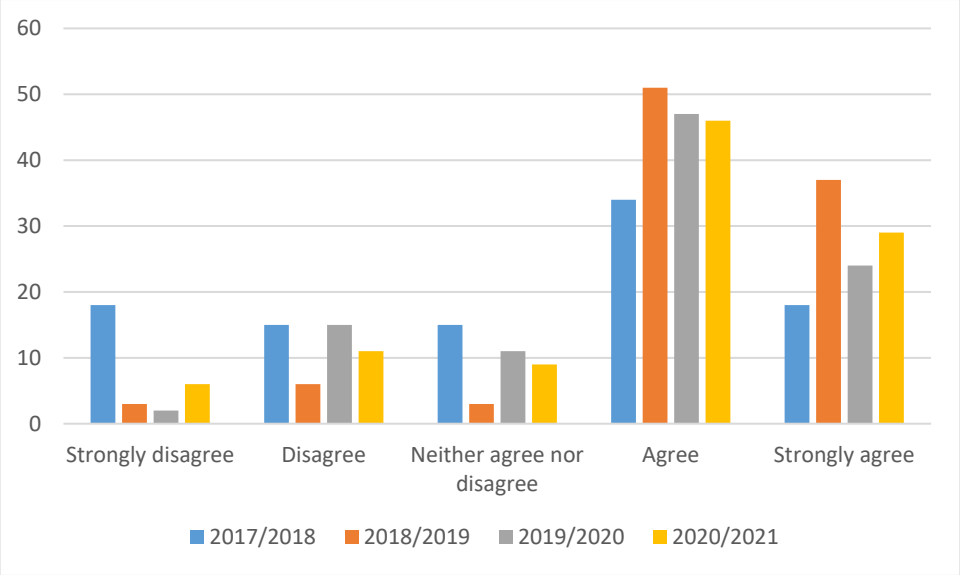

Figure 5: Feedback from LearnER helped me to learn data modeling

The 2019/2020 version of LearnER was made more flexible by allowing several related and equally "good" answers, by introducing what might be called "don't care" constraints. Technically speaking, this means that both "0 or many" and "1 or many" could be defined as correct for a given relationship. In early versions of LearnER, the person adding the model solution, had to somewhat arbitrary choose between one or the other. Students then had to guess the correct solution, but sometimes they got stuck – maybe (correctly) thinking that "This can't be wrong!".

Both visual cues and flexible solutions made it easier for the students to find the correct solution in the 2019/2020 version, and it also possibly made them less dependent on explanations from textual feedback.

4.4 Gamification and motivation

Some elements of gamification are included to stimulate student activity, such as difficulty levels, score points and leaderboards. Results from both interviews and questionnaires indicate that most students find this motivating and solve more exercises because of it, even though a few find it irrelevant. "To me, it's motivating. Absolutely. For me who likes games, I look at it as a challenge. It's an exciting part of the challenge."

Students who like the gamification often say they have a competitive instinct. It triggers them to try to get on the high score list, and to compete against classmates or team members. "Extremely good concept. For people with competitive instinct, it is always fun to get points and be measured against others."

After redesigning the algorithm for computing scores before the second year (2018/2019), more students found the game mechanics motivating, see Figure 6. 59% of the students in 2017/2018 agreed or strongly agreed that earning points are motivating, rising to 89% in 2018/2019, but (again) down, to 79% in 2019/2020 and 78% in 2020/2021. Very few students disagreed in the newer versions.

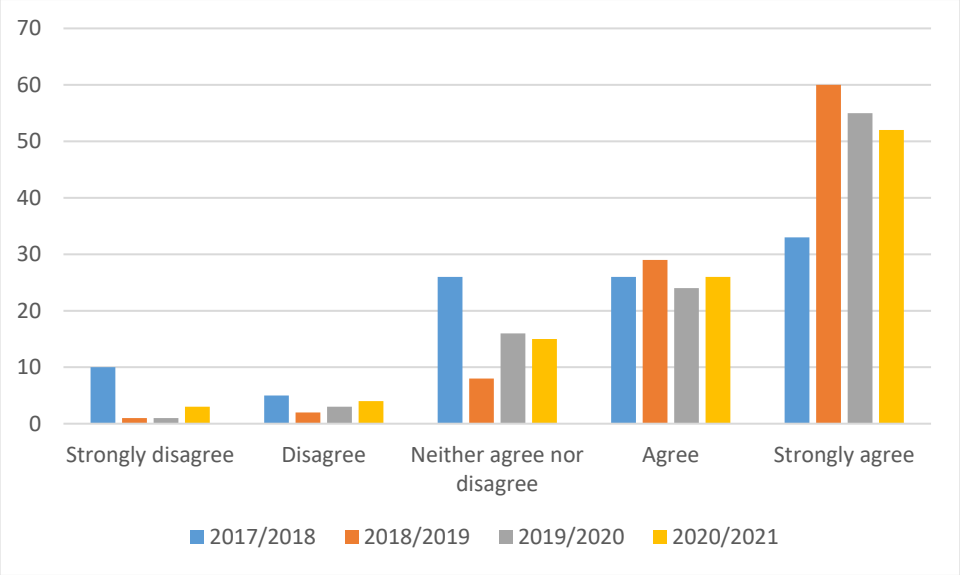

Figure 6: I find it motivating to get points for each exercise

The way scores are calculated is quite simple, and should perhaps be made more sophisticated, as several students point out. A student said it like this: "So one can get a high score by taking many, many exercises, and one can get a high score by just taking a few and being good at it. So maybe the number of times you've tried should count." Even if students "see through it", some are still able to fool themselves into being motivated: "Looked through it a bit, but other than that it was fun, it was motivating."

4.5 Exercises organized by difficulty levels

Figure 7 shows the number of exercises solved at each difficulty level, for the last three semesters, based on LearnER usage data. We observe that many students attempt to do exercises up to level 5. The number of exercises solved at difficulty level 1 to 5 make up for 88 %, 86 % and 84 % of the total number of exercises solved for the three semesters.

It seems that almost every student starts with a demo exercise at level 1, then works their way through the exercises of increasing difficulty levels. Looking at the numbers for attempts per exercise (disregarding a couple of exercises we encourage students to start with), these are evenly distributed within each difficulty level, suggesting that the students pick their exercises within a difficulty level at random, or possibly does all exercises within a level before they move on to the next difficulty level.

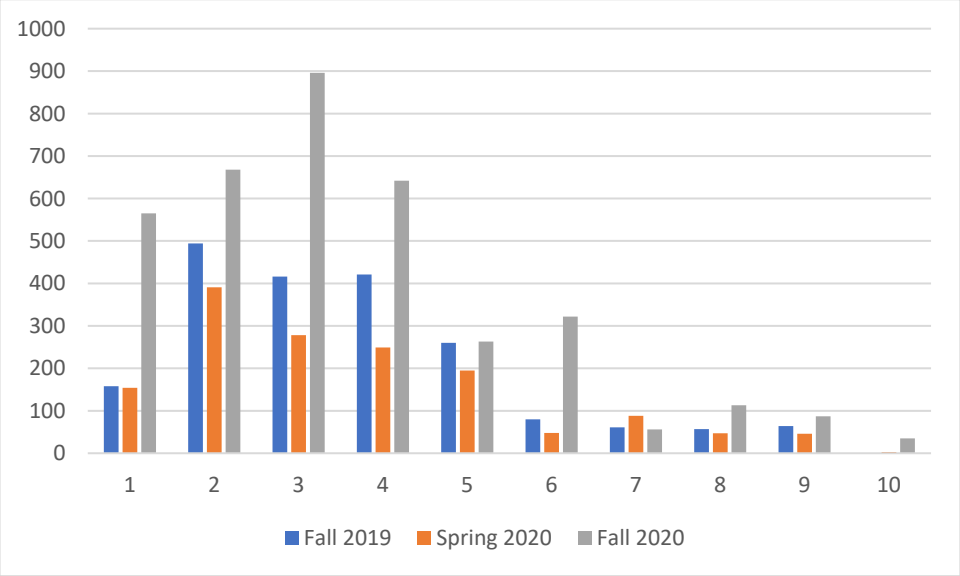

Figure 7: Exercises solved for each difficulty level

Figure 8 shows the average amount of time spent to solve exercises at each difficulty level. Difficulty levels are set at the teacher's discretion, by an overall assessment based on both size and complexity of the proposed solution as well as the exercise text itself. According to Figure 8, it seems fair to say that the difficulty levels have been set reasonably "correct", possibly with an exception for some of the level 6–7 exercises.

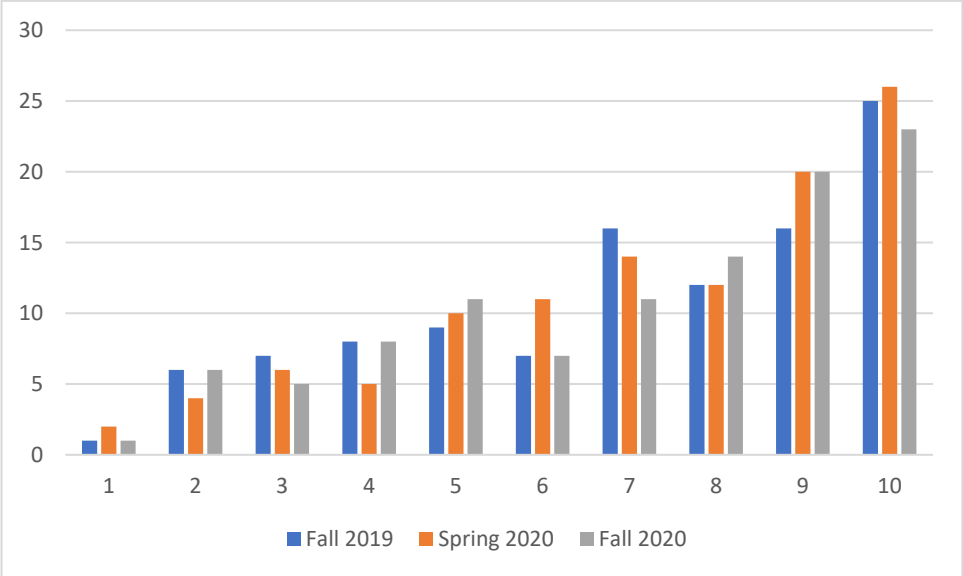

Figure 8: Average amount of time spent to solve exercises at each difficulty level

4.6 The useful, but possibly dangerous Check button

When students solve exercises in LearnER, the idea is that it should happen in a similar way as when working on assignments where they can get guidance from a supervisor. In such a situation, students will be able to request assistance if they are unable to move forward on their own. A clever supervisor will not give answers to students straight away, but will rather guide them in the right direction, with the aim of enabling them to complete the tasks themselves. This is also how we think about LearnER and how it should be used.

To achieve something in this direction, a Check button is made available. It is not possible to view the solution model in LearnER, you must solve it yourself, but the Check button gives the student an opportunity to ask for help. The response will not be a definitive solution to the problem, but rather some hints about parts of the solution that needs to be corrected.

The students use this Check button a bit more than we expected, especially for difficult and large exercises. See Figure 9. One explanation for this is that even though the Check button in LearnER shows explanations for all errors in the model, students often fix only one or two errors, and then click the Check button again.

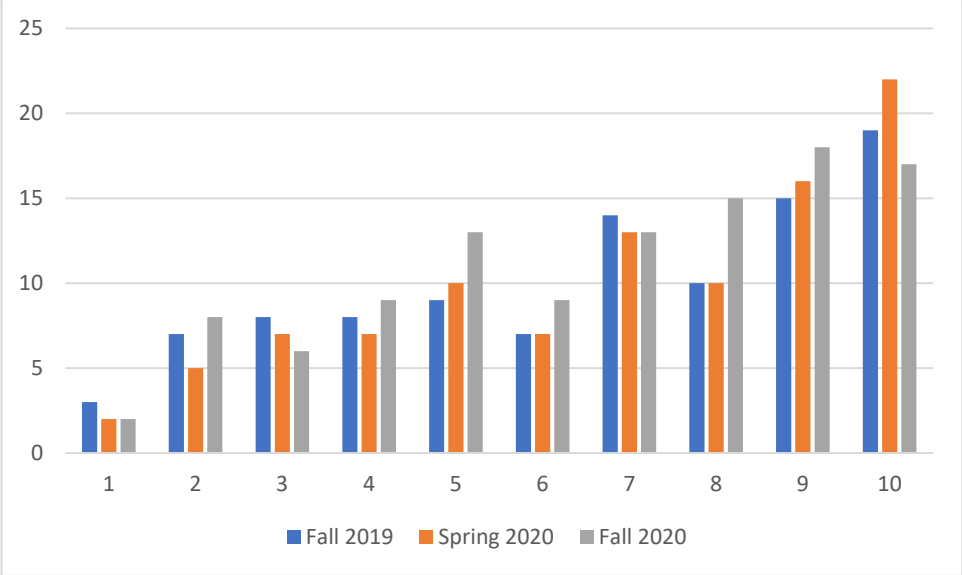

Figure 9: Average number of checks for each difficulty level

In the follow-up interviews, students said that some of the feedback texts were cryptic or too general, especially those concerning relationships: “Could have been even better feedback explaining why the answer is what it is. Sometimes it's just trial and error until you get it right, but you don't always understand why it's right.” Other students found it difficult to understand the scenario text itself. That is not necessarily something that should be fixed. After all, learning to translate an informal text into a data model is what this is all about.

Of the three 2019 students that accepted to be observed and interviewed, there were one campus student and two distance learning students. All three used between 12 and 14 minutes to complete a given (and new) exercise at level 7. They used similar strategies, starting with entities and attributes before adding relationships. They all used both textual feedback and visual cues combined with some trial and error to get all the relationships correct. But the number of clicks on the Check button was significantly lower than average. With only three students, this could be a coincidence, but there could also be other explanations: the three students were all high achievers, the exercise was new and maybe assigned a “wrong” difficulty level, or the fact that the teacher was observing them could make the students read the feedback more thoroughly.

Many students are aware that they lose points by clicking on the Check button, and some try to avoid it: "I used it a few times (i.e., the Check button). I tried not to use it, because then I lost too many points.” Others are determined on solving problems on their own. One of the 2019 students, being asked about the new two-level feedback system and more possibilities for getting help, answered: “Yes, that’s a good feature. But preferably you don't want to press help at all, (pause), at least I want to figure it out myself. It's a bit like, ah, if you have to press for help, it feels a bit bad.”

4.7 Typical data modeling errors

The system detects the following errors and omissions:
Entity: Incorrect entity name, i.e., an attribute or relationship name is used as the name of an entity.

Attribute: Either an attribute is placed in the wrong entity, or a word selected as the name of an attribute is not an attribute.

Keys: An attribute is incorrectly marked as primary key or foreign key.

Relationship: Errors in cardinality or requirements for participation in relationships, e.g., that it is set to “0 or many” where it should have been “exactly 1” or maybe “1 or many”. Relationships created between wrong entities or wrong relationship name. Identifying relationships defined as non-identifying – or vice versa.

Missing elements: Entity, attribute or relationship is missing. Primary key or foreign key is missing.

Inspection of student models for simple exercises shows that most of the entities and attributes are in place when students click Check for the first time. For difficulty levels 5–10, most students choose a more step-by-step procedure with checking along the way.

Figure 10 shows the distribution of these different types of errors for different difficulty levels. Relationship errors is by far the most common type of error, and many of these are cardinality errors. Level 1 exercises include only one entity and are therefore without relationship errors. Misplaced attributes are overall the second-most common error.

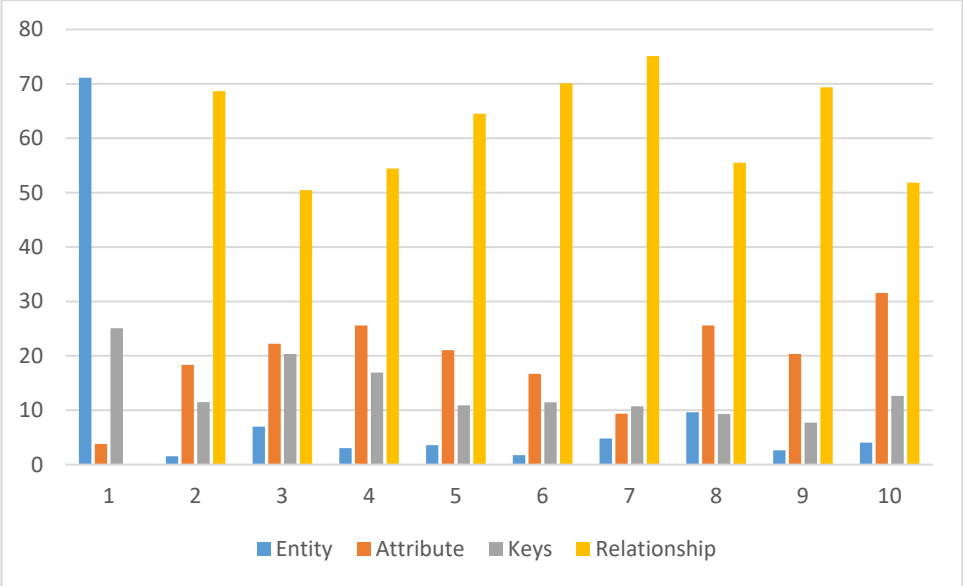

Figure 10: Types of errors for each difficulty level (fall 2020)

4.8 Extra, inadequate words and working without help

To make an exercise more challenging, extra, inadequate words may be added to an exercise's dictionary. These extra words are listed among the relevant words but are not part of the solution. Exercises facilitating extra words state that they use this feature at the start of their descriptive text.

The option to include extra words in exercises was added as a feature from autumn 2020 onwards. The student surveys for autumn 2020 and spring 2021 both have questions regarding the usage of extra, inadequate words.

Many of the extra words were values that are natural to store in the database, but which were not suitable as part of the structure (table or column names), e.g., specific genres “thriller” and “western” in a movie database, or “red”, “white” and “blue” in a clothing store database. Other words were imprecise or too general words such as “overview”, “percentage” or “database”.

Inspection of student models shows that the extra words are rarely chosen. But students seem to appreciate the opportunity for more challenging work. One student writes: “It gives us the opportunity to think more, and actually ponder a bit.”

Several students also observe that extra words is a step towards doing data modeling in a professional tool, with no assistance, as this student puts it: “A good middle ground between finding all the words from the assignment text alone and getting only the words you need.”

LearnER also includes the possibility of solving exercises without assistance. If so, students choose entity and attribute names freely. LearnER does not offer any assistance or feedback in this case, so this is the same as solving exercises in a standard ER modeling tool or by free hand on paper.

Some students have tried this, and naturally also want to get help in this situation: "It would be nice with a middle ground [...] where you could choose your own names for the entities and attributes but get some help along the way and some tips."

One of the 2019 students talked about this in the interview, explaining how he had developed an interesting learning strategy: "It's a really cool tool and I feel like I'm learning from it. But the best strategy is to solve the exercises on paper first. Find the entities based on the scenario text, and then go in and check that, yes, [my data model] matches this and that."

4.9 Experienced learning effects

In a final multiple-choice question, we asked students how they felt LearnER contributed to their learning of data modeling, see Figure 11. In 2017/2018, 31% of the respondents reported that LearnER contributed to a high degree or to a very high degree of their data modeling learning. This increased to 56%, 50% and 57% in the following three academic years, respectively.

Students think LearnER is a useful tool to get started with data modeling: "Easy way to learn modeling without knowing much in advance." One student mentioned the effect of being aware of proper naming (which is important): "It showed how to name tables and columns."

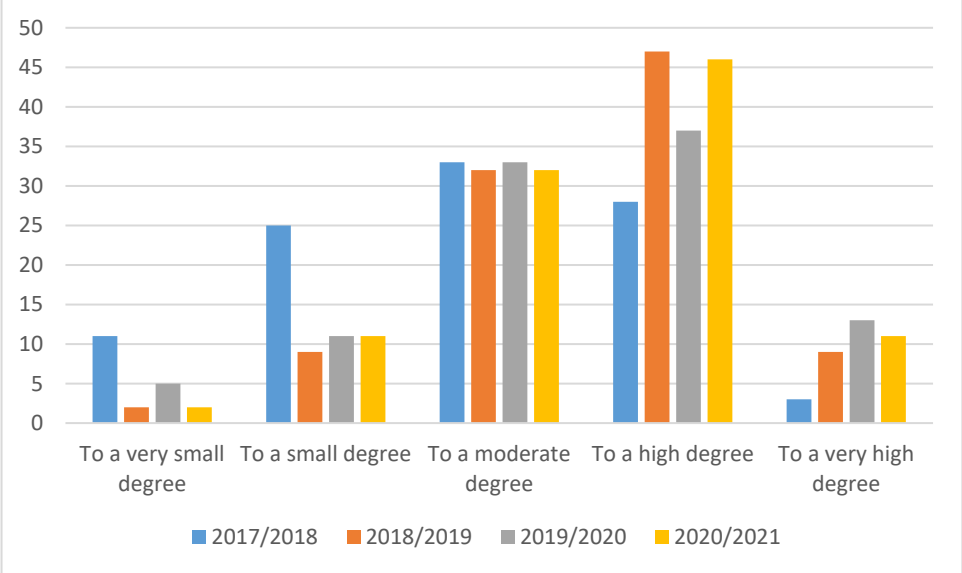

Figure 11: To what degree did LearnER contribute to your learning of data modeling?

5. Discussion

We will now discuss findings related to each research question stated in the introduction.

5.1 When and how do students use LearnER?

As stated in the introduction, formative feedback should be supportive, timely, and specific (Shute, 2008). LearnER meets these requirements to a large extent. It enables students to solve problems when and where it suits them, while still having the opportunity to receive formative feedback aimed specifically at the task they are working on.

The pandemic situation worldwide from march 2020, due to Covid 19, has made it even more important to support the learning process with tools that enable students to work actively on their own, without having a supervisor physically available to support the learning process. LearnER provides precisely this opportunity.

LearnER was designed primarily for individual work but seems to be well suited also for collaboration. In classes where students have been physically divided into teams, feedback from supervisors tells us that students often collaborate when they solve exercises in LearnER. Collaboration takes place through discussing solutions

together, helping each other when someone is not moving forward, as well as competing to be the first to complete a task.

We observe that students have been able to solve more tasks by themselves using feedback from the tool, or by collaborating with others. Our experience is that LearnER facilitates active learning, allowing teachers to focus on non-trivial issues, which is beneficial for both teachers and students.

It can be hard to engage students in voluntary use of learning tools. LearnER usage data and survey results show that students solve more exercises in newer versions of the tool. We find this promising since LearnER exercises are not mandatory assignments in our courses. It would be interesting to get more exact data for different courses, like the results reported for EER-Tutor (Mitrovic and Holland, 2020).

It is important that the use of such applications is put into a pedagogical context. In courses where LearnER is used, students are first introduced to the basic concepts of modeling, then they are working with LearnER to construct their own understanding, as well as gaining practice by solving many exercises. Finally, after having achieved sufficient skills, they work out "real world" solutions on their own, by using professional modeling tools.

5.2 To which extent do the formative comments give adequate feedback to students?

Even if students have access to the entity and attribute names in the model solution, they sometimes "get lost". Still, it seems that this happens less often with newer versions of LearnER. Visual cues and flexibility in relationship cardinalities are probably the most important new measures for guiding students towards the solution. Adding several different solutions to each exercise is an alternative approach (Bian et al., 2020).

More elaborate feedback is useful and was requested by many students in the early versions. It seems that some explanations, in particular concerning relationships, are still considered to be too verbose and general. LearnER usage data shows that relationships errors are the most common, and this is also reported in (Rosenthal and Strecker, 2019).

Instead of trying to understand the feedback, some students use the Check button in a trial-and-error manner, when working with difficult or large exercises. By experience, we know that many students want to have a solution available, while they are working on exercises. But that makes it easy for students to "trick themselves" into thinking they have solved the tasks themselves, while they mainly have recreated another's solution. It is by purpose we don't give away complete solutions in LearnER. We want the students to actively create solutions by themselves.

5.3 Do the gamification elements contribute to learning, and if so, in what way?

Gamification has been shown to motivate and engage students in learning (Zainuddin et al., 2020). In the introduction we referred to MonstER Park (Schildgen, 2020). There, the entire application is developed as a game, guiding the students step-by-step through the phases of modeling.

We have taken a different approach, with a user interface looking more like a traditional modeling tool, but with several game mechanics added, such as progress bars and high score lists, where students earn points by solving tasks and loose points when they ask for help.

As reported in (Dæhli et al., 2018), students found LearnER to be a useful tool for learning basic data modeling skills. Many students reported that gamification, even though quite simple, were something that motivated them to do more exercises, in particular earning points and viewing and comparing their own and other student's results on high score lists. But they wanted clearer information about what led to points, such as solving many tasks, solving tasks quickly, etc. We also found that some students would be further motivated by more advanced game mechanics.

Students freely choose exercises marked with a level of difficulty. LearnER usage data shows that students work their way up from simple to more difficult tasks, as we expected and hoped for. The introduction of extra inadequate words in some exercises was appreciated.

6. Future work

The combination of gamification and formative feedback seems promising in learning tools (Fuchs and Wolff, 2016) and is not yet fully explored. We are looking for even more specific and context dependent ways of providing feedback to students. The game mechanics are simple and can be enriched along several dimensions (Toda, et al., 2019), e.g. lead the players from level to level based on their achievements, award them with badges, or adding more advanced forms of cooperation and competition.

We are also looking into ways to let students solve problems more freely, which means that they can choose names of entities and attributes, but still get feedback and help. The solution must then be extended with a matching algorithm, and one must solve problems related to typos, synonyms, word contractions and so on (Bian, 2019).

LearnER is a tailer-made tool for IT students, but we think this way of stimulating active learning can be applied also in other subjects. Within the field of ITS, data modeling can be considered an ill-defined domain (Fournier-Viger et. al., 2010), in the sense that modeling problems can have several valid solutions. We believe that the approach taken for developing LearnER, based on exercises having a single (but flexible) solution, combining gamification and formative feedback, can be used to build similar tools for other diagram types, such as flowcharts and different UML diagrams within the IT field, or even mind maps used as learning tools in various subjects.

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Student Emotion in Mediated Learning: Comparing a Text, Video, and Video Game

Aubrie Adams[1] and Weimin Toh[2]
[1]California Polytechnic State University, San Luis Obispo, USA
[2]National Institute of Education, Nanyang Technological University, Jurong West, Singapore
aadams45@calpoly.edu
a0019282@u.nus.edu

Abstract: Although serious games are generally praised by scholars for their potential to enhance teaching and e-learning practices, more empirical evidence is needed to support these accolades. Existing research in this area tends to show that gamified teaching experiences do contribute to significant effects to improve student cognitive, motivational, and behavioural learning outcomes, but these effects are usually small. In addition, less research examines how different types of mediated learning tools compare to one another in influencing student outcomes associated with learning and motivation. As such, a question can be asked in this area: how do video games compare to other types of mediated tools, such as videos or texts, in influencing student emotion outcomes? This study used an experimental design (N = 153) to examine the influence of different types of mass media modalities (text, video, and video game) on college students' emotions in a mediated learning context. Research examining the impact of video games on instruction has begun to grow, but few studies appropriately acknowledge the nuanced differences between media tools in comparison to one another. Using a media-attributes approach as a lens, this study first compared these mediated tools along the attributional dimensions of textuality, channel, interactivity, and control. This study next tested the impact of each media type on thirteen emotion outcomes. Results showed that six emotion outcomes did not indicate differences between groups (fear, guilt, sadness, shyness, serenity, and general negative emotions). However, six of the tested emotion outcomes did indicate differences between groups with students experiencing higher levels of emotional arousal in both the text and video game conditions (in comparison to the video condition) for the emotions of joviality, self-assurance, attentiveness, surprise, hostility, and general positive emotions. Lastly, students also felt less fatigue in the video game condition. Overall, implications for e-learning suggest that when a message's content is held constant, both video games and texts may be better in inducing emotional intensity and reducing fatigue than videos alone, which could enhance motivation to learn when teaching is mediated by technology.

Keywords: emotion, game-based learning, media comparison, motivation, text, video

1. Introduction

Technological advances provide new ways for instructors to implement computer-mediated learning opportunities; in particular, serious games have been adapted to facilitate educational processes. Although scholars have praised serious games' potential to enhance teaching and learning practices (Koster, 2004; McGonigal, 2011; Squire, 2011; Schrier, 2016), more empirical evidence and scholarly work is needed to support these accolades (Connolly et al., 2012; Hilton and Honey, 2011; Jacobs, 2021; Mayer, 2014). As such, this study examines how video games compare with other mass media educational technologies in their ability to influence student emotion-related outcomes. Pragmatic research is needed to identify the affordances, limitations, and implications of using serious games in university settings to better understand their impacts on outcomes related to e-learning processes.

This experiment examines three types of mass media tools: text, video, and video game. Each platform varies in its degree of textuality, channel, interactivity, and control. Although research examining video games' effects on instruction continues to grow (Prensky, 2005; Sailer and Homner, 2020; Squire, 2003; Yee, 2013), few studies test the nuanced differences among instructional mass media tools to specifically examine student emotions. Therefore, this study seeks to examine these key differences to explore the implications this may have on student learning. In reviewing existing literature, the following topics are outlined in this paper: (1) an explication of serious games; (2) a broad overview of the mixed attributes approach to media research; and (3) a review of emotion outcomes as they relate to motivation and educational processes.

2. Background

2.1 Serious games

Scholars have contested the conceptualisation of what is considered a "game" (for a review, see Juul, 2005). One definition purports that games are activities containing six features: (1) rules, (2) variable quantifiable

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outcomes, (3) valorisation of outcomes, (4) player efforts, (5) player outcome attachments, and (6) negotiable consequences (Juul, 2005, p. 8). A broader definition claims that games simply exist as rule-defined activities where players seek to reach goals (Galloway, 2006, p. 19). Between both definitions, the current study utilises and extends the broader conceptualisation, claiming that video games are rule-based activities where players seek to accomplish tasks in digitally constructed environments.

Although many video games function as entertainment and recreational activities, serious games work as training and educational tools (Connolly et al., 2012). Numerous types of serious games are available, including advergames, newsgames, educational, persuasive, health, art, social impact (Grace, 2020), and productivity games. Related to serious games, gamification is a process that uses elements of play to modify and enhance pre-existing educational and training practices. Games are constructed to teach a range of topics, including ethics (Brown, 2006), physics instruction (Jackson, 2011), mitigation of cognitive biases (Dunbar et al., 2013), computer coding (Mandaro, 2014), deception detection skills (Miller et al., 2019), and coping with anxiety (Heumos and Kickmeier-Rust, 2020). A meta-analysis that synthesised research findings on game-based learning effects found overall significant, but relatively small, positive effects on cognitive, motivational, and behavioural learning outcomes (Sailer and Homner, 2020).

In related research on serious games, Ferguson, van den Broek, and van Oostendorp (2020) tested how varying interaction modes (active versus passive) and story structures (explicit versus implicit) affected participants' sense of presence, cognitive interest, and engagement in a virtual reality game. Results showed that allowing players freedom to navigate their gameplay positively influenced their cognitive interests and feelings of presence. Additionally, the use of implicit story structures contributed to the players' increased recall of spatial information. Nonetheless, players in this study still needed guidance to enhance student learning of fact-based knowledge.

Essentially, games offer general benefits to the educational environment and a key reason why is because they may enhance student motivation to learn. Indeed, research on digital games suggests that the lure of game play may motivate an assortment of positive behaviours in tasks that users may not ordinarily be inclined to perform. In this area, augmented reality games have been shown to motivate users to increase their physical activity in games like *Pokémon Go* (Althoff, White and Horvitz, 2016) and civic games can encourage users to get more involved in participating in community-based projects like those designed to improve local parks (Coulter et al., 2012).

However, despite the affordances that games offer the educational environment, challenges do exist. For example, scholars have questioned whether learning from gameplay will suitably transfer to real life contexts (Shaffer, 2012). In addition, Mayer (2014) performed a review of research on serious games and found that in comparison to traditional teaching methods, serious games did not always provide substantial differences in learning outcomes. As such, modern educators have begun to look more closely at issues such as these to better identify the contexts that games can be used to make learning more effective and to share best practices in games for learning "(Ferdig, Baumgartner and Gandolfi, 2021; Schrier, 2019).

Clearly, serious games have the potential to enhance educational processes to some degree. However, more research is needed to identify the precise mechanisms that affect learning in video games (Sailer and Homner, 2020) and to examine how these mechanisms compare between different types of mass media tools, such as texts or videos. Building on prior research on the use of serious games for mediated learning, this paper offers a mixed attributes approach that enables researchers to investigate how different types of educational technologies comparatively affect learning-related outcomes, such as emotional arousal.

2.2 Mixed attributes approach to media studies

According to McLuhan's (1964, p. 2) well-known axiom, "the medium is the message," the vehicle or type of tool that is used to deliver a message can have a substantial impact on how that message is perceived and the subsequent information processing of that message. This truism suggests that even when a message's content is held constant, different types of media tools likely contribute to varying outcomes (Detenber and Lang, 2010). From this perspective, researchers can examine a range of educational technologies that contribute differently to teaching and learning effects. For example, distance learning options from the past and present (for a review, see Moore, 2013) have included various media tools, such as mail correspondence (Bittner and Mallory, 1933), television broadcasting (Benschoter and Charles, 1957), and internet discussion boards

(Howland and Moore, 2002). Given these tools and newer educational technologies, such as serious games, it is reasonable to predict substantial variations in the quality of teaching and learning afforded and limited by each media type. As such, this paper uses a media effects perspective to examine the ways in which learning outcomes may vary depending on the type of media tool used to deliver educational content.

In drawing on a media effects perspective, Eveland (2003) describes a *mixed attributes approach* that scholars can use to analyse specific outcomes induced by different media types. This approach proposes a framework to conceptualise, explicate, and compare media to better understand the underlying mechanisms that affect the outcomes directly resulting from differences among media types. This framework differs from earlier media effects research in three primary ways. First, the mixed attributes approach does not solely rely on the qualitative categorisations of different media forms (e.g., books as a category compared with videos as a category); instead, it uses more quantitative descriptions to assess the specific attributes of each medium along a spectrum. Eveland (2003, p. 398) outlines six related attributes: (1) interactivity, (2) structure, (3) control, (4) sensory channel, (5) textuality, and (6) content. The key to applying a mixed attributes approach is recognising that different media often vary to some degree in these attributes (e.g., books feature more textuality than videos).

Second, this approach assumes that media tools feature multidimensional attributes. For this reason, researchers should not focus on one attribute per tool but examine attribute groupings (e.g., videos feature lower textuality, more channel visualisations, less interaction, and less control). Third, this approach situates modern findings in a historical context. For example, instead of describing a phenomenon such as internet surfing as new, researchers can draw on earlier research on television channel surfing to explore the implications of this media-related behaviour. Therefore, even new educational technologies can be described under existing conceptualisations to some degree.

Utilising Eveland's (2003) mixed attributes approach, this study compares three educational tools (i.e., text, video, video game) and focuses on four of the six media attributes: (1) textuality, (2) sensory channel, (3) interactivity, and (4) control. Structure and content are not compared because these attributes remain constant across the media experiences tested in this research. Additionally, a complete review of all four media attributes is beyond the scope of this investigation (for a more thorough review, see Adams, 2016). Nonetheless, a summary is provided so unfamiliar readers may understand the nuanced differences in media attributes in the text, video, and video game used in this study.

2.2.1 Textuality

Textuality refers to the degree that textual symbols (e.g., words) are used in media. Although textuality is primarily interpreted through the visual sense, it can also be interpreted via tactile channels, such as Braille (Eveland, 2003). Books and newspapers typically feature a higher degree of textuality compared with videos and video games. Although some videos and video games heavily rely on communicating through text, many modern video games typically depend little on text components. Therefore, textbooks are typically rated higher in textuality than videos and video games.

2.2.2 Sensory channel

Sensory channel refers to the degree that a person's five senses are engaged by a media experience. Typically, many media tools activate a person's senses of sight and sound (Eveland, 2003). Still, regarding sight, textual media are limited because they only activate low visual sensory levels using one-dimensional pictures compared with videos that fundamentally exist as continuous audio and video streams (Lang, 2006). Similarly, video games afford rich audio–video experiences and dynamic interactive events that enable a higher degree of social presence (Kaplan and Haenlein, 2010; Tamborini and Skalski, 2006). Depending on the media type used, a person's ability to experience different levels of sensory information may affect learning-related outcomes in various ways. From this perspective, videos and video games typically engage a person's sensory channels more than texts.

2.2.3 Interactivity

The degree of interactivity refers to the extent that a medium allows for participant feedback and response (Eveland, 2003; Newhagen and Rafaeli, 1996). Because a user cannot typically alter pre-written texts or videos, both media offer less interactivity. Comparatively, video games enable a higher degree of interactivity. In single-player games, users can interact with the game environment and non-player characters to affect the

game's outcome in variable ways (Pivec, 2007). Similarly, in multiplayer games, users can collaborate with others to solve problems and attain goals (Upchurch and Wildermuth, 2014; Yee, 2009). As such, video games are rated higher in interactivity than texts and videos.

2.2.4 Control

Lastly, control refers to the users' ability to exercise free will during the media experience. This attribute overlaps with interactivity yet remains distinct. Whereas interactivity refers to users' ability to participate in and affect media content, control refers to the degree that they can influence the content's pausing and pacing (Eveland, 2003; Eveland and Dunwoody, 2001). In this way, text offers a higher degree of control because users can read at their own pace, with the options to go backward, skip ahead, and re-read. To some degree, videos also facilitate control when they allow users to pause, rewind, play, and fast-forward. However, in a video shown in a classroom environment, users have little ability to affect the presentation's order or timing. Similarly, video games typically afford players the ability to influence the pacing, interactions, and movements of their gameplay, yet they may be constrained by rules in the digital environment (Upchurch and Wildermuth, 2014). Therefore, in this study, the text condition is rated higher in control compared with videos and video games.

In summary, this study identifies the media attributes of textuality, sensory channel, interactivity, and control to describe how they vary amongst a text, video, and video game. As mentioned, the mixed attributes approach recommends that scholars should examine attribute groupings for each medium. Table 1 (see Method) summarises the different media tools used in this study to display the precise mechanisms and how they vary so scholars can understand what media features contribute to different outcomes. With this perspective in mind, we next describe the outcome variable of interest in this study: emotion.

2.3 Emotion

In a meta-analysis that reports empirical outcomes associated with serious games, Connolly et al. (2012, p. 662) found that the three most commonly examined outcomes were (1) knowledge acquisition, (2) affective outcomes, and (3) motivational outcomes. Although knowledge acquisition itself is central to learning, affective and motivational components are necessary as well. Sufficient motivation is needed to engage learners in educational processes and emotional aspects often strengthen their motivation to learn (Bigge, 1982). This investigation adds to the body of literature on serious games by extending the research on emotion as a motivational learning outcome and applying a mixed attributes approach.

Emotions are short-lived, internal mental states that vary in intensity; represent evaluative reactions to events, agents, or objects; and direct attention towards external stimuli (Nabi and Green, 2015, p. 142). Two primary perspectives describe different types of emotions: (1) the *discrete* view that focuses on emotions as unique sets of cognitive appraisals (Frijda, 1986; Lazarus, 1991) and (2) the *dimensional* view that focuses on emotions as motivational states that vary by levels of valence, arousal, and dominance (Lang et al., 1993). The dimensional perspective claims that experiences of emotion map on to appetitive (wanting to move towards) and aversive (wanting to move away from) motivational systems (Detenber and Lang, 2010). The present study focuses on the dimensional view given its connection to motivational dynamics as students who are more emotionally connected to learning material are thus more likely to be motivated to seek out and actively engage in teaching and learning processes.

As mentioned, the dimensional view describes three aspects of emotions: (1) valence, (2) arousal, and (3) dominance. Valence refers to the degree that an affect response ranges from pleasant to unpleasant (Detenber and Lang, 2010, p. 278), which maps on to the motivation attention-related aspects of approach (positive emotions) and avoidance (negative emotions). Arousal refers to a response that varies along a continuum ranging from thrilled to composed, which maps on to the degree of intensity of the approach and withdrawal motivations. Dominance refers to the perception of stimulus control. Educational literature shows that providing learning opportunities with more choices (high dominance) leads to increased cognitive engagement and positive affect (Kohn, 1993); although increased choice can also have a negative effect on cognitive task performance (Flowerday and Schraw, 2000). Still, less research has found support for the relevance of the dominance component within emotions (Detenber and Lang, 2010). As such, this study focuses on the dimensions of valence (negative to positive) and arousal (less intense to more intense) when examining student emotion outcomes.

Overall, studies examining emotion in the context of media messages find that the modification of non-content related features (e.g., making changes to a media message's size, colour, motion, etc.) can influence levels of emotion (Detenber and Reeves, 1996; Reeves et al., 1999). In addition, positive emotions may function as motivating forces that can encourage learners to better engage in educational processes. However, it is unclear which media tool may better contribute to emotion in e-learning contexts. Because texts, videos, and video games vary in their attributional components, this study utilises a mixed attributes approach to examine how each type of media tool differs. It then investigates the differences' subsequent impacts on outcomes related to emotion arousal and valence. Given the existing research on media attributes, a research question (RQ) is posed: Which media tool will contribute to higher levels of positive emotion in an e-learning context?

3. Method

This study utilises an experimental design to manipulate each type of media experience (text, video, or video game) to examine the subsequent impact on student emotion. Although the content remains relatively consistent across all three conditions, each type of media experience varies to the degree that textuality, channel, interactivity, and control are present.

3.1 Participants

In total, 153 college students from a large western university in the United States of America were recruited via convenience and volunteer sampling techniques and received a nominal amount of course credit for participation. They represented the following demographics: 69.3% females and 30.7% males with a mean age of 19.73 years old (*SD* = 1.59). Participants reported their races as 43.8% White, 20.3% Hispanic, 15.7% East Asian, 7.2% multiracial, 2.6% Black, 2.6% Middle Eastern, 2.6% South Asian, and 5.2% did not report a racial category.

3.2 Procedure

The participants were directed to an online questionnaire hosted by *SurveyGizmo*. The questionnaire started with a consent form notifying respondents of their voluntary and confidential participation. Second, they were randomly assigned to one of three stimulus media conditions (text, video, or video game). The participants read the instructions for their specified condition and then either read a narrative, watched a video, or played a video game. The content was controlled across all conditions. Next, the participants completed outcome measures of emotion and additional measures unrelated to the RQ. Lastly, they answered demographic questions.

3.2.1 Stimulus: video game

In the video game condition (*n* = 58), the participants played a short digital game: *The End of Us* (www.the-end-of-us.com/), created by Molinari and Howe for the 2011 *Global Game Jam (see figure 1).* The game lasts approximately four minutes with rudimentary interaction (as players can only control the direction of forward movement). The game builds a simple narrative using a metaphor to explore themes of companionship, life, and death. The player controls a purple comet that flies through outer space. Conflict occurs when an orange comet arrives, with no explanation of its motives. The game has a mostly pre-determined outcome, except for the player's choice that determines which comet survives at the end (either the purple or orange comet). Ultimately, the game's relatively minimalistic style of gameplay is well-suited to compare outcomes across media modalities.

Figure 1: Screenshots for the video game, *The End of Us*

3.2.2 Stimulus: video

In the video condition (*n* = 48), the participants viewed a recording of the game's play-through. Thus, the video game and the video condition stimuli were similar (except that the participants in the video condition could not interact in the game environment or control the final outcome). This method allowed for a realistic comparison between the two modalities with the content between them held reasonably constant.

3.2.3 Stimulus: text

Using the recorded video, a description of the observable action in the video game was translated into a written description for the text condition (*n* = 47). The text described the action that occurred in the game and the video. As such, the video game, the video, and the text stimuli were similar, except that the participants in the text condition could not interact in the game environment and lacked a pictorial experience in the visual sensory channel. However, they could read the text description. Additionally, the same music played in each condition to control this variable across the three media types, again facilitating a reasonable comparison. Given the specific video game, video, and text generated for this study, users can apply a media-attributes perspective to examine how each modality differed. Table 1 summarises these differences.

Table 1: Summary of media attributes for text, video, and video game

Media	*Textuality*	*Sensory channel*	*Interactivity*	*Control*
Text	High	Low	Low	High
Video	Low	High	Low	Low
Video game	Low	High	High	Medium

3.3 Measures of emotion

This study utilised a modified version of Watson and Clark's (1999) *Positive and Negative Affect Schedule* (PANAS). The PANAS is a self-report measure that assesses four broad categories of emotion: (1) *general dimensions* (negative and positive affect); (2) *basic negative emotions* (fear, hostility, guilt, and sadness); (3) *basic positive emotions* (joviality, self-assurance, and attentiveness); and (4) *other affective states* (shyness, fatigue, serenity, and surprise), totalling 13 emotion types.

This study used these 13 emotion types under the four original categories. Individual emotion items were averaged to form composite measures for each type of emotional state. Although the PANAS typically comprises 60 emotion items, this study added 9 additional items. Semantic deferential scales (1–7, from "not at all" to "extremely" experienced) were used to measure all emotions. Each item was randomised in a different order for all participants. Table 2 summarises the emotion categories and the individual emotion items used for each measure. Each emotion measure had acceptable reliability (see Table 3).

Table 2: PANAS outcome measures; additional variables added for this study marked with an asterisk (*)

Category	Emotion	Individual emotion items
General	1. Negative	afraid, scared, nervous, jittery, irritable, hostile, guilty, ashamed, upset, distressed
	2. Positive	active, alert, attentive, determined, enthusiastic, excited, inspired, interested, proud, strong, pleased*
Negative	3. Fear	afraid, scared, frightened, nervous, jittery, shaky
	4. Hostility	angry, hostile, irritable, scornful, disgusted, loathing, annoyed*, frustrated*
	5. Guilt	guilty, ashamed, blameworthy, angry at self, disgusted w/self, dissatisfied w/self, remorseful*
	6. Sadness	sad, blue, downhearted, alone, lonely
Positive	7. Joviality	happy, joyful, delighted, cheerful, excited, lively, energetic, energised*
	8. Self-assurance	proud, strong, confident, bold, daring, fearless, confident*
	9. Attentiveness	alert, attentive, concentrating, determined, careful*, motivated*
Other	10. Shyness	shy, bashful, sheepish, timid
	11. Fatigue	sleepy, tired, sluggish, drowsy
	12. Serenity	calm, relaxed, at ease, peaceful*
	13. Surprise	amazed, surprised, astonished

Table 3: PANAS outcome measure reliabilities

Category	Emotion	α	*MN*
General	1. Negative	.92	2.13
	2. Positive	.91	3.10
Negative	3. Fear	.92	2.22
	4. Hostility	.90	2.11
	5. Guilt	.91	1.71
	6. Sadness	.89	2.48
Positive	7. Joviality	.95	2.99
	8. Self-assurance	.93	2.59
	9. Attentiveness	.84	3.46
Other	10. Shyness	.84	1.90
	11. Fatigue	.85	2.94
	12. Serenity	.87	3.84
	13. Surprise	.84	2.78

4. Results

SPSS version 26.0 was utilised to analyse the experimental data. Given the RQ, statistical analyses were performed to examine which media tool would contribute to higher levels of emotion. For each measure of emotion, a one-way ANOVA was performed to examine differences in the emotional arousal levels experienced by the participants assigned to the text, video, and video game conditions.

Out of the 13 emotion outcomes, 6 indicated no differences among the conditions (general negative emotions, fear, guilt, sadness, shyness, and serenity) but 7 emotions did indicate differences between groups (general positive emotions, hostility, joviality, self-assurance, attentiveness, fatigue, and surprise). For a summary of all outcomes, see Tables 4–7. In addition, the text description following the tables further describes the differences among groups that emerged for the 7 emotion outcomes that showed statistically significant results. These results are described to allow readers to see these differences in greater depth.

Table 4: ANOVA comparisons for general emotions; asterisks distinguish p values: *p < .05, **p < .01, ***p < .001

					Tukey HSD comparisons		
Emotion		*n*	*MN*	*SD*	*Text*	*Video*	*Game*
1. Negative	Text	47	2.14	1.03	.		
	Video	48	1.85	1.08	.439	.	
	Game	58	2.36	1.27	.589	.062	.
2. Positive	Text	47	3.17	1.16	.		
	Video	48	2.51	1.25	.02*	.	
	Game	58	3.53	1.16	.270	.000***	.

Table 5: ANOVA comparisons for negative emotions; asterisks distinguish p values: *p < .05, **p < .01, ***p < .001

					Tukey HSD comparisons		
Emotion		*n*	*MN*	*SD*	*Text*	*Video*	*Game*
3. Fear	Text	47	2.30	1.28	.		
	Video	48	1.87	1.19	.245	.	
	Game	58	2.44	1.43	.853	.069	.
4. Hostility	Text	47	1.92	0.96	.		
	Video	48	1.91	0.99	.998	.	
	Game	58	2.42	1.33	.062	.051*	.
5. Guilt	Text	47	1.70	0.80	.		
	Video	48	1.53	0.96	.674	.	
	Game	58	1.87	1.10	.657	.183	.
6. Sadness	Text	47	2.77	1.54	.		
	Video	48	2.40	1.30	.390	.	
	Game	58	2.31	1.24	.210	.943	.

Table 6: ANOVA comparisons for positive emotions; asterisks distinguish p values: *p < .05, **p < .01, ***p < .001

					Tukey HSD comparisons		
Emotion		*n*	*MN*	*SD*	*Text*	*Video*	*Game*
7. Joviality	Text	47	3.26	1.38	.		
	Video	48	2.42	1.37	.011*	.	
	Game	58	3.24	1.43	.998	.008**	.
8. Self-assurance	Text	47	2.66	1.18	.		
	Video	48	1.97	1.27	.030*	.	
	Game	58	3.04	1.47	.329	.000***	.
9. Attentiveness	Text	47	3.42	1.11	.		
	Video	48	2.94	1.22	.135	.	
	Game	58	3.91	1.30	.105	.000***	.

Table 7: ANOVA comparisons for affective states; asterisks distinguish p values: *p < .05, **p < .01, ***p < .001

					Tukey HSD comparisons		
Emotion		*n*	*MN*	*SD*	*Text*	*Video*	*Game*
10. Shyness	Text	47	1.91	.98	.		
	Video	48	1.72	1.21	.670	.	
	Game	58	2.03	1.14	.849	.320	.
11. Fatigue	Text	47	2.82	1.21	.		
	Video	48	3.39	1.52	.110	.	
	Game	58	2.65	1.38	.805	.018*	.
12. Serenity	Text	47	4.09	1.42	.		
	Video	48	3.86	1.48	.720	.	
	Game	58	3.63	1.46	.249	.706	.
13. Surprise	Text	47	2.87	1.38	.		
	Video	48	2.17	1.33	.038*	.	
	Game	58	3.20	1.45	.452	.001**	.

For *general positive emotions,* emotional arousal was lowest in the video condition (M = 2.51, SD = 1.25), somewhat higher in the text condition (M = 3.17, SD = 1.16), and highest in the video game condition (M = 3.53, SD = 1.16). Differences among the conditions were significant overall, $F(2, 150) = 9.861$, $p < .001$. However, a post hoc Tukey analysis test indicated that despite significant differences between the text and the video ($p = .02$) and the video and the video game ($p < .001$), there was no significant difference between the text and the video game ($p = .27$). Positive emotions appeared relatively equal in the text and the video game conditions but lower in the video condition.

For *hostility,* emotional arousal was lowest in the video condition (M = 1.91, SD = .99), somewhat higher in the text condition (M = 1.92, SD = .96), and highest in the video game condition (M = 2.42, SD = 1.33). Differences among the conditions were significant overall, $F(2, 150) = 3.706$, $p = .027$. However, a post hoc Tukey analysis test indicated that the difference between the video game and the video only approached significance (p =

.051) and that there was no significant difference between the text and the video (p = .998) or the text and the video game (p = .062). Therefore, hostility in the video game condition was only slightly elevated in comparison to the video condition.

For *joviality,* emotional arousal was lowest in the video condition (M = 2.42, SD = 1.37), somewhat higher in the game condition (M = 3.24, SD = 1.43), and highest in the text condition (M = 3.26, SD = 1.38). Differences among the conditions were significant overall, $F(2, 150) = 5.814$, p = .004. A post hoc Tukey analysis test indicated that despite significant differences between the text and the video (p = .011), and the video and the video game (p= .008), there was no significant difference between the text and the video game (p = .998). Joviality appeared relatively equally higher in the text and the video game conditions and again lower in the video condition.

For *self-assurance,* emotional arousal was lowest in the video condition (M = 1.97, SD = 1.27), somewhat higher in the text condition (M = 2.66, SD = 1.18), and highest in the video game condition (M = 3.04, SD = 1.47). Differences among the conditions were significant overall, $F(2, 150) = 8.689$, $p < .001$. A post hoc Tukey analysis test indicated that despite significant differences between the text and the video (p = .03) and the video and the video game ($p < .001$), there was no significant difference between the text and the video game (p = .329). Self-assurance appeared relatively equally higher in the text and the video game conditions and again lower in the video condition.

For *attentiveness,* emotional arousal was lowest in the video condition (M = 2.94, SD = 1.22), somewhat higher in the text condition (M = 3.42, SD = 1.11), and highest in the video game condition (M = 3.91, SD = 1.30). Differences among the conditions were significant overall, $F(2, 150) = 8.357$, $p < .001$. A post hoc Tukey analysis test indicated that despite significant differences between the video and the video game ($p < .001$), there was no significant difference between the text and the video (p = .135) and the text and the video game (p = .105). Therefore, attentiveness was higher overall for the video game condition, although this result seemed to overlap with the text condition.

For *fatigue,* emotional arousal was lowest in the video game condition (M = 2.65, SD = 1.38), somewhat higher in the text condition (M = 2.82, SD = 1.21), and highest in the video condition (M = 3.39, SD = 1.52). Differences among the conditions were significant overall, $F(2, 150) = 4.050$, p = .019. A post hoc Tukey analysis test indicated that despite significant differences between the video and the video game (p = .018), there was no significant difference between the text and the video (p = .110) and the text and the video game (p = .805). Therefore, fatigue was lower overall for the video game condition, although this result again seemed to overlap with the text condition.

For *surprise,* emotional arousal was lowest in the video condition (M = 2.17, SD = 1.33), somewhat higher in the text condition (M = 2.87, SD = 1.38), and highest in the video game condition (M = 3.20, SD = 1.45). Differences among the conditions were significant overall, $F(2, 150) = 7.436$, p = .001. A post hoc Tukey analysis test indicated that despite significant differences between the text and the video (p = .038) and the video and the video game ($p < .001$), there was no significant difference between the text and the video game (p = .452). Surprise appeared relatively equally higher in the text and the video game conditions and again lower in the video condition.

5. Discussion

This experiment examined three types of mass media tools: text, video, and video game to better understand the mechanisms (comparing media attributes of textuality, channel, interactivity, and control) that might contribute to positive emotional outcomes related to teaching and learning. Of the 13 emotion outcomes examined, 6 indicated no differences between the conditions (general negative emotions, fear, guilt, sadness, shyness, and serenity), but 7 emotions did indicate differences in groups (general positive emotions, hostility, joviality, self-assurance, attentiveness, fatigue, and surprise). Although, it is worth mentioning that on a seven-point scale, the participants indicated relatively low emotional intensity levels overall, all averaging less than four. This finding might be explained by the fact that the story's overall content did not contribute to intense emotional responses.

Still, a consistent pattern emerged for differences among the conditions. When examining the 5 positive emotional aspects of general positive emotions, joviality, self-assurance, attentiveness, and surprise, it is clear that both the text and the video game conditions were better at contributing to higher levels of positive emotional arousal than just the video alone. When examining this outcome through a media-attributes lens, previously this study established that the video condition featured attributes low in textuality, high in sensory channel, low in interactivity, and low in control. Therefore, these attributes together overall lead to a less positive experience. These findings align to some degree with past research results as Plass et al. (2019) also found that simple 2D characters on a screen alone did not influence the positive emotion of happiness.

In addition, results also indicated that participants experienced somewhat higher levels of hostility in the video game condition in comparison to the video condition (although these results overlapped with the text condition and were only approaching significance). Still, speculation suggests that this result is likely due to the higher degree of interactivity in the video game. This attribute likely enabled the participants to feel more intense arousal due to the actions afforded by the video game condition (Klimmt et al., 2010), allowing the participants to experience the story from the character's perspective and likely increasing their perceptions of hostility to some degree.

Lastly, feelings of fatigue were generally lower in the video game condition compared with the video condition (although the text condition had some overlap between the two again). This finding makes sense as past research indicates that video games can create motivational experiences (Ryan, Rigby and Przybylski, 2006), and given the attributes identified in this study, this motivational quality is likely afforded by a video game's higher degrees of sensory channel, interactivity, and control that help reduce feelings of fatigue. Overall, this study's implications suggest that when content is controlled but delivered via different mediated learning technology tools, video games and texts are more likely to trigger higher levels of emotional arousal than videos.

5.1 Limitations and future research

This study was subject to three primary limitations. First, the study was quantitative, so the authors could not understand the detailed reasons for the differences between the positive emotions in the video game and the text conditions or the lower levels of such emotions in the video condition. It is necessary to further explore why this was the case. For example, a thematic analysis using open-ended emotion-related questions may provide deeper insights into how students respond to mediated e-learning experiences. In addition, future research may also consider exploring user preferences, engagement, and other mediated factors, including pre-existing video game usage. Using research methods such as interviews and the "think aloud" protocol (to examine player experiences) may also be used to derive the tacit assumptions that could teach researchers more about emotional arousal and differences across media tools.

Second, the measures of emotion were self-reported. Future research could adopt more objective measures to examine emotional arousal to triangulate the findings. For instance, objective assessment methods using non-invasive physiological responses, such as heart rate variability and galvanic skin conductance using a wearable device, could track the participants' emotional arousal during tasks.

Lastly, the media experiences in this study triggered relatively low levels of emotional intensity. To better examine this phenomenon, using media content that would more likely result in higher emotional arousal could better teach researchers about differences among mediated learning tools. Although this research provided an initial step as a comparison study examining levels of emotion through the lens of media attributes, much work remains for researchers to explore in this area.

5.2 Final thoughts

This study sought to answer the research question, which media tool would contribute to higher levels of positive emotion in an e-learning context? Key findings showed that both a text and a video game contributed to similar higher levels of positive emotional arousal in comparison to watching a video alone. When examining these findings through a mixed attributes lens, we can identify the more precise mechanisms that may be driving these outcomes.

In the case of the text and the video game used in this study, both were more likely to facilitate a higher level of control over the media experience in comparison to the video condition. The text enabled more control

because students could adjust the pausing and pacing of their reading based on their individual needs. Similarly, the video game enabled more control because students could make decisions in the game that ultimately impacted their playthrough experience. Therefore, providing users with more control and autonomy during e-learning may be more likely to better facilitate student emotion.

In our modern teaching landscape today, instructors have numerous options available in designing a course and in selecting what kind of media will best deliver meaningful learning experiences to students. While more work is needed to further examine the effects of teaching medium on outcomes related to student learning, these results may be useful to educators considering both the affordances and limitations of different kinds of media tools and the role they may play in the academic environment.

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The Effectiveness of Cooperative Learning in an Online Learning Environment Through a Comparison of Group and Individual Marks

Marelize Malan
University of Johannesburg, South Africa
mmalan@uj.ac.za

Abstract: Cooperative learning is a learning approach where students are placed into groups to work towards a common goal. Prominent learning theories state that students learn best when they construct their own knowledge in an active learning environment where they can socially interact and collaborate to reach a desired outcome. Cooperative learning provides such a learning environment and has the benefit of creating an active learning community where students can develop transferable skills. Online learning has grown steadily over the past few years, but even more so during the COVID-19 pandemic where tertiary institutions' only option was to continue with their academic programmes remotely through online learning platforms. With online learning becoming a prominent feature, calls are made to educators to examine teamwork and cooperation and how this can be facilitated in an online setting. In the online learning environment it is important to promote collaborative engagement to counteract feelings of isolation and encourage deep learning to occur. In the second accounting module of a fully online degree, students are exposed to a case study, with a group assignment as well as an individual assignment component. The aim of this study is to determine whether group work can be effective by comparing group marks to individual marks. The study further elicits the perceptions of the online students to determine their views regarding group work, the process that they followed to collaborate, as well as their perceptions regarding skills developed using the case study approach. A mixed-methods approach was followed, using the group and individual marks and combining those with the survey analysis and qualitative data analysis from a questionnaire. It was found that the average mark for the group assignment is higher than for the individual assignment and that the individual assignment shows a greater spread of marks. For male students who prefer to work within a group, their group mark is higher than their individual mark, showing that they did receive the benefit from working within a group. Students agreed that group work is a valuable skill that will be needed in their future careers and that the group work enabled them to learn from their group members. Working in a group requires a lot of time and effort, but students will elicit the strategies required to gain the necessary knowledge and solve the problem posed to them. Students mentioned several other skills that they perceived were developed through their exposure to the group work; skills such as communicating well, listening with intent, negotiating a point of view, researching alternatives and solving a problem were all enhanced through their participation in their groups. The results suggest that group work can be effectively achieved and managed in an online setting, albeit with special care around the logistical and technological challenges that can be experienced. Cooperative learning in the form of group work is not always welcomed by all students, but it will enable them to navigate their future careers where teamwork will be a prominent feature.

Keywords: Cooperative learning, online learning, group work, case study, skills

1. Introduction

The COVID-19 pandemic has resulted in schools and tertiary institutions closing their doors and continuing with the academic curriculum remotely through online learning platforms. According to a UNESCO report, by the beginning of March 2021, 144 697 476 pre-primary to tertiary education learners were still affected by lockdown measures, with 26 country-wide closures of institutions (UNESCO, 2021). Even before the pandemic, the global e-learning market was expected to grow at a compound annual growth rate of USD 14.6% from 2019 to 2026 (Globenewswire, 2020). Several tertiary institutions now provide online programmes as part of their institutional offering, either in the form of short-learning programmes or complete degree programmes.

Online learning requires a unique approach to be effective and explicit forethought of the learning strategies are required for pedagogical benefits to be reached. These strategies include creating a well-designed learning environment, scaffolding the learning opportunities and ensuring that students are actively engaged so that deep learning can occur (Holzweiss, et al., 2014; Mystakidis, Berki and Valtenen, 2019). A theoretical view of engagement through the lens of online learning distinguishes between five interrelated elements that provide a tool for educators so that student engagement can be facilitated. These elements are the building of community through social engagement, activating metacognition through cognitive engagement, developing academic skills through behavioral engagement, committing to learning through emotional engagement and learning with peers formally and informally through collaborative engagement (Redmond, et al., 2018).

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A learning approach which may provide students with the opportunity to engage with their peers whilst navigating complex academic tasks posed to them, is cooperative learning. Cooperative learning has been defined as pedagogies that involve the use of groups with a robust structure to encourage interdependence and interaction and where the facilitator plays a key role in the group formation, management and structure (Ballantine and Larres, 2007; Johnson and Johnson, 2009).The terms cooperative learning and collaborative or group learning are used interchangeably at times, yet they have different features (McInnerney and Roberts, 2004). Collaborative learning is where social interaction occurs in student groups as a way of acquiring knowledge, but each student submits their own work. In cooperative learning, the group task is structured in such a way that group members will work as a team to achieve a common goal and are dependent on each other to complete the task (Ballantine and Larres, 2007; Johnson and Johnson, 2009). The end result might be a single group submission although each student will be individually accountable for their contribution (McInnerney and Roberts, 2004).

Virtual work teams emerged in organizations to share knowledge and expertise and work together on projects (Yazici, 2004). In online learning, cooperative learning can be established that will simulate in part these virtual organizational teams (Graham and Misanchuk, 2004). Research has shown that to establish cooperative learning online, it is necessary to integrate the constructivist approaches to learning with available technologies (Garrison, Anderson & Archer, 2000; Haythornthwaite, 2006). A way to achieve this is to center the construction on solving a real-world case study, whilst ensuring that a strong community is built amongst the group members (Hernándes-Selles, Munoz-Carril and Gonzáles-Sanmamed, 2019). This will counteract feelings of isolation often experienced with online learning (Swan, Shen and Hiltz, 2006; Wolverton, Guidry Holler and Lanier, 2020). There are many benefits for including cooperative learning as a learning tool in any curriculum, but it is also included to develop graduate skills and specifically the ability to work in a team, together with the necessary communication and leadership skills (Paguio and Jackling, 2016; Yazici, 2004.).

This study focuses on the introduction of cooperative learning into a fully online accounting module with the aim to establish student engagement, simulate work teams and develop graduate skills. It further explores the effect of such a learning approach, coupled with using a real-life case study, on the performance of online students. Prior research has provided empirical evidence of the effects of cooperative learning on student performance, albeit with mixed results. Bay and Pacharn (2017) found that students on average performed better in group exams compared to individual exams, if the group exam was given a considerable weight of the final course mark. Clinton and Kohlmeyer (2005) investigated the effect of group quizzes on performance in the final exam and found no significant improvement in performance. They did however find students showing a greater motivation to learn and an increase in their ability to problem solve. Two group projects used in a statistics course had different results according to a study by Delucci (2007). The second project had a significant effect on the final exam scores, while the first project did not. Possible explanations for the differences could be the free-riding experienced in the first project that was mitigated with different group selections in project two. Using an experimental design, Opdecam and Everaert (2012) placed students randomly in team-learning tutorial groups, while other students attended lecture-based tutorials. They found that due to increased time spent by students working in teams, a higher performance on the final exam grade was achieved. Shawver (2020) also compared two groups of students – students in a cooperative learning cohort and students in traditional learning cohort – and found that quiz scores for the cooperative learning cohort was on average higher. Although studies have shown how cooperative learning interventions can affect the performance in final exams, few studies have made a comparison between group marks and individual marks using the same case study, where constructing the knowledge first is a prerequisite in solving the case study problem. The first research question is thus:

RQ1: Is cooperative learning effective when comparing the marks obtained as a group to the marks obtained as an individual within a case study format in an online learning environment?

With online learning becoming a prominent feature in tertiary education, especially in the light of the pandemic, calls are made to educators to examine teamwork and cooperation and how this can be facilitated in an online setting. This will inform the practice of educators in the years ahead, where a changed delivery model will most probably be required (Sangster, Stoner and Flood, 2020). The perceptions of online students are of particular importance here to determine their views regarding group work, the process that they followed to cooperate, as well as their perceptions regarding skills developed using the case study approach. The second research question is thus:

RQ2: How do online students experience cooperative learning or group work?

The rest of the paper is structured as follows: In the next section, the theories on which cooperative learning is based are explored, along with the literature views on cooperative learning. The assignment used in the online module is described, as well as the mixed-methods approach employed by the study. This is followed by the results and the discussion thereof.

2. Literature review

2.1 Theoretical framework

Online learning is underpinned by theories that support student engagement, and specifically theories of active learning and social constructivism. According to Piaget's constructivist views (1971), students should construct their own knowledge; they learn best when they are active; learning should be student-centered; and social interaction and collaboration play a significant role in the learning process. This interaction with others is also seen in Vygotsky's (1978) theory of social constructivism that promotes the development of cognition in the context of social interaction. Learning based on these theories is therefore viewed as a process of active knowledge construction where cognitive and social aspects of learning are combined to solve problems together (Borthick and Jones, 2000).

Johnson and Johnson (1996) provide a further theoretical basis for cooperative learning by expanding on the cognitive development theories with theories of social interdependence. Social interdependence is characterized by individuals coming together within a group setting, sharing resources, knowledge and information, giving and receiving feedback, while experiencing greater social support and increased individual achievement. Students that prefer a deep approach to learning place a high value on such cooperative learning opportunities (Chan and Chan, 2011; Mystakidis, Berki and Valtenen, 2019).

Unique to the online learning environment are frameworks proposed by Garrison, Anderson and Archer (2000) and Redmond, et al. (2018). Consistent with constructivist approaches to learning, their frameworks propose multi-faceted elements with a strong emphasis on social connection and engagement to ensure an optimal online learning environment. In this study, cooperative learning is based on the premise that a group of individuals share in the construction of knowledge, built through the ideas and thoughts of each individual situated within an online setting (Hämäläinen and Vähäsantanen, 2011).

2.2 Benefits and challenges of cooperative learning

The pedagogical benefits of cooperative learning have been well-documented and substantiated in the literature. Firstly, cooperative learning provides an active learning experience for students, fitting in strongly with the reform of tertiary education to focus more on student-centered learning activities. The back-and-forth discussions that take place in groups, as well as consideration of multiple viewpoints, causes better decision-making in groups and more creativity (Healy, Doranand McCutcheon, 2018; Hiltz, et al., 2011). It promotes knowledge retention and an increase in motivation (Khosa and Volet, 2013). In the online environment, this could lead to an increase in the amount of participation in the online activities and quality of learning (Hiltz, et al., 2011).

Secondly, cooperative learning creates a community of learners that engages socially to form well-rounded students. Students further establish a learning network, building social capital as they learn together (Venter, 2019). As they engage socially, they confront their own beliefs and perspectives and find different ways to interpret their world (Pittaway and Moss, 2014). Thirdly, cooperative learning can foster the development of transferable skills. Interpersonal skills, including the ability to communicate well, to listen to group members and to negotiate, can all be enhanced through cooperative learning (Ballantine and Larres, 2007; Shawver, 2020). Other skills that can be improved are critical thinking and problem-solving skills (Kumi-Yeboah, Yuan and Dogbey, 2017; Opdecam and Everaert, 2012; Samkin and Keevy, 2019). What is further beneficial to the students exposed to cooperative learning is that the skills gained from cooperative learning are found to be highly transferable to work environments, where working within a team is an integral part of the business world (Kumi-Yeboah, Yuan and Dogbey, 2017; Oosthuizen, et al., 2020).

Cooperative learning at tertiary level can, however, be "demanding for lecturers and challenging for students" (Healy, Doran and McCutcheon, 2018, p.287). For educators not skilled in using cooperative learning, it might be time-consuming to set up as decisions have to be made about group size, group formation and how the group work will be assessed (Ballantine and Larres, 2007; Healy, Doran and McCutcheon, 2018). In the literature,

debates on the ultimate group size and whether groups should be formed by the educator or by the students themselves have not provided definitive answers. Gillies (2014) found that groups of 3-4 students were most effective, whilst Christensen, et al. (2019) considered 5 students per group to be an effective group size. Groups can be formed by the students selecting their own group members or by the instructor assigning students to groups. Educators can assign students to groups by either forming homogeneous groups, heterogeneous groups or randomly select groups where group size is the only criteria (Hilton and Phillips, 2010; van der Laan Smith and Spindle, 2007). Although self-selected groups might outperform instructor-assigned groups as found by Hilton and Phillips (2010) or even increase the effectiveness of individual learning as seen by the study of van der Laan Smith and Spindle (2007), the goal of the cooperative learning task should guide the decision. If that goal is to prepare students working with a diverse mix of people one day, then randomly selected groups will better achieve the goal according to Ballantine and Larres (2007).

Students do not always find working in a group enjoyable, having to deal with lazy or uncooperative team members (free riders) and team members missing deadlines (Malan and van Dyk, 2020; Opdecam and Everaert, 2018; Shawver, 2020). To counteract these challenges, the educator should include elements in the task that will promote positive interdependence and individual accountability (Ballantine and Larres, 2007; Johnson and Johnson, 1996). When the task requires each student to contribute and they need to work together to complete the task successfully, then positive interdependence will be achieved. Similarly, individual accountability is achieved when group members are held accountable for their part in the task by the educator either conducting individual tests or a requiring a declaration from each member to confirm their contribution (Ballantine and Larres, 2007). Peer assessment can also be implemented to encourage individual accountability, but does not always solve the problem as students either refuse to complete the peer scores or prefer not to rate their peers harshly (Ballantine and Larres, 2007; Opdecam and Everaert, 2018).

Online cooperative learning can be just as effective as face-to-face collaboration, albeit with accommodation for logistical challenges. “Time, distance, technology and connectivity inadequacies” might impede the group work to be conducted, if not addressed (Robinson, Kilgore and Warren, 2017, p. 39). Educators will be required to provide additional instructions and guidance to students, specifically on how to use synchronous and asynchronous communication methods to beat the logistical challenges. The engagement of online students in cooperative learning tasks is strongly influenced by the support that they receive from the educator and it might be necessary for the educator to step in when conflict arises (Swan, Shen and Hiltz, 2006). Even though cooperative learning in the online environment has the potential to be challenging, it can be a positive experience for students, where deep learning can occur, especially when real-world case studies are used (Healy, Doran, and McCutcheon, 2018).

2.3 Case study approach

A case study approach to learning or case-based learning is known in a range of disciplines as a strategy to provide an active and cooperative learning space (Nkhoma, et al., 2017). When the case given is either a real-life example or based on one, then a connection with the real world is established and will require students to engage in decision-making and problem-solving (Dyball, et al., 2007; Samkin and Keevy, 2019). Case-based learning will require a shift in the way that students normally receive and process disciplinary knowledge. They will have to critically assess the case, seek the necessary knowledge and, within a group case study, discuss and listen to the ideas of their group members before being able to solve the case study problem (Borthick and Jones, 2000; Tan, 2019). When students work independently on a case, then analytical skills can be improved, while in a group setting, critical thinking skills through participation in discussions can be enhanced (Tan, 2019). It can be concluded that case-based learning is an effective teaching method that enhances learning motivation and where this is combined with cooperative learning, a range of skills can be developed (Raza, Qazi and Umer, 2020).

3. Description of the assignment

3.1 Aim of the assignment

The accounting module which is the focus of this study is part of a fully online Bachelor of Commerce accounting degree. It consists of 24 modules with each module completed over a seven-week period. The modules include several activities, designed in such a way within the Learning Management System (LMS) that students engage with the material, their peers and their educators. In the second accounting module of this degree, students are exposed to a case study, with a group as well as an individual assignment component. The case study is based

on an actual company in the retail sector of South Africa. In the case study the company is exploring the possibility of manufacturing their own range of products, increasing loans sought and lease contracts negotiated to set up the manufacturing business. The case study is divided into four sections that pertain to these loans and leases (liabilities). Each section requires the students to first gain the knowledge of the specific liability from their textbook or other resources, before answering the questions posed. The aim of the assignment is two-fold: firstly to provide students with practice to construct knowledge first, on their own and within a group, giving them the ability to practise this in different settings. This will be valuable to students, improving their adeptness to seek knowledge first before coming up with solutions (Dyball, et al., 2007). Secondly, to expose students to a cooperative learning environment where they can develop their team work skills in an online environment.

3.2 Group formation

There were 66 students enrolled in the module and it was decided to use the random selection of groups available within the LMS, rather than having self-selected groups. Self-selected groups can outperform randomly selected groups (Clinton and Kohlmeyer, 2005), but can only be used effectively where the students have had prior social or academic interactions with one another (Hilton and Phillips, 2010). The students enrolled in this module are still new to the degree and might not have had any prior interactions. In this online degree, students can also take different modules at different times, exposing them to new classmates with every new module. The simple random allocation of students to groups with regard only to final group size provides for deliberately unbalanced groups (Healy, Doran, and McCutcheon, 2018). There were 14 groups in total created (with four to five members in each) and each group was given one section of the case study to solve.

3.3 Group management

To prepare the students for group work and to encourage them to get acquainted as quickly as possible, the groups were created within the second week of the module. This provided the students with ample time to meet and discuss the case study before the due date at the end of the fifth week of the module. Extensive guidance was given to the students on how to communicate within a virtual environment, whether or not to choose a leader for the group, and how to resolve conflict within the group. The final group deliverable could be in any format (video, written document or narrated slides) and examples were provided as well as links to software that could be used. This was all done to provide clarity and guidance at the start of the group process which could result in better performance and an overall improved group experience (Opdecam and Everaert, 2018).

To further maximize cooperation in groups, elements of cooperative learning was specifically included (Johnson and Johnson, 2009). The mark for the group work amounted to a substantial weight of the final course mark to provide for interdependence and an incentive to the group work (Bay and Pacharn, 2017). To achieve individual accountability, students were required to provide confirmation of their contribution within the final group submission and to respond to the question regarding group dynamics posed to them. Due to the problems associated with peer assessment, it was decided not to incorporate it in the grading process (Opdecam and Everaert, 2018).

3.4 Assessment of the assignment

To ensure the reliability of the scores, the group assignment and the individual assignment were marked based on a rubric with clearly defined parameters that were communicated to the students at the start of the assignment (Gikandi, Morrow and Davis, 2011). For the individual component of the assignment, students could choose any of the other case study sections to solve individually. They were not allowed to collaborate on this section with their group members and had to work through the problem on their own.

4. Methodology

A mixed-methods methodology was considered appropriate (Tashakkori and Creswell, 2007), combining group and individual marks, survey analysis and qualitative data analysis into the interpretation phase. This was done to determine the extent to which the findings from one data collection method complemented the findings of the other. Marks for the assignments were retrieved from the LMS and analysed. Survey data were collected through a self-administered questionnaire using a purposive sampling technique (Palys in Given, 2008). Both closed- and open-ended questions were included in the questionnaire. Closed-end questions were asked to limit students' responses for more consistency and better comparability of responses and were based on the questions of Healy, Doran and McCutcheon, (2018). The open-ended questions were included in the

questionnaire for deeper insight into the students' perceptions of the group management process and the possible skills developed by their exposure to the assignments.

A link to the web-based questionnaire was emailed to all students enrolled in the module. Before distribution, students were informed of the study and purpose thereof and that the results will only be used for research purposes. The questionnaire consisted of three sections: Section 1 contained questions of a biographical nature that were used to create a profile of the participants; Section 2 contained the closed-ended questions, measured on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree); Section 3 contained the open-ended questions requesting the students' comments and perspectives.

An independent statistician analysed the quantitative data using Statistical Package for Social Sciences (SPSS). Data from the open-ended questions were analysed through a process of thematic content analysis (Henning, van Rensburg and Smit, 2004).

5. Findings and discussion

5.1 Respondent profile

A total of 54 (82%) responses were received from the student population. Of this sample, 29 (53.7%) were female and 25 (46.3%) were male. The majority of the respondents, 29 (53.7%), indicated that English is their home language, while 13 (24.1%) speak Afrikaans and 12 (22.2%) an indigenous South African or African language at home. The age of the respondents ranged between 19 and 86 years, with most of the respondents (32) being older than 25 years. This finding is similar to those from other studies that also found online students to be older and with various social roles in life providing them with the opportunity to work, study and have a family at the same time (Jopp and Cohen, 2020).

5.2 Group and individual mark

To determine the effectiveness of cooperative learning by comparing the marks obtained from a group assignment to those of an individual assignment, the following results as shown in Table 1 were noted.

Table 1: Group and individual mark (as a percentage)

	N	Mean	Minimum	Maximum
Group assignment mark	54	77.81	70	88
Individual assignment mark	50	72.24	44	96

All students had a group mark, but four students did not complete the individual assignment. On further investigation, three of the four students indicated that they were unable to complete the individual assignment due to work commitments, while the other student decided to terminate his studies at the time. From Table 1 it can be seen that the average mark for the group assignment is higher than for the individual assignment, but that a higher mark was achieved by a student for the individual assignment. A greater spread of marks is noticed for the individual assignment, with two students receiving less than 50% for their individual assignments. A Spearman's Rank Order Correlation test showed no statistical correlation ($p<0.05$) between the group mark and the individual mark ($t(54) = 0.037$, $p = 0.801$), indicating that a high group mark did not necessarily result in a high individual mark. This could show that some students benefited from the group's problem-solving abilities and better performance but were unable to copy that approach fully to their individual assignments.

Students were asked to indicate their preference for working on their own or within a group and 44 (82%) indicated that they preferred to work on their own. As online learning is often chosen by students for the flexibility it affords them and autonomy in how and when they engage, this result is not unexpected (Barnard, et al., 2009). Four females and six male students indicated that they prefer to work within a group, contradicting the findings of Opdecam, et al. (2014), where female students were found to prefer team learning. When the group and individual marks were compared to the students' preference to work on their own or within a group, it was noted that for female students the marks were mostly within range of each other (between 70% and 80%), apart from three outliers, as shown in Figure 1.

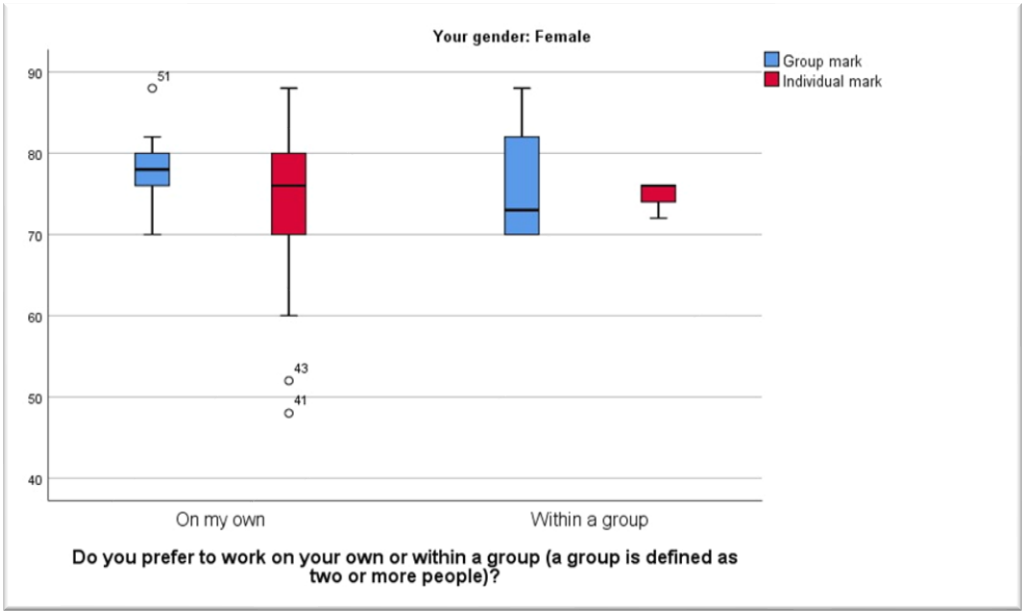

Figure 1: Preferences compared to marks for female students

For male students, Figure 2 shows that the group mark was higher than their individual mark for those that prefer to work within a group and that they received the benefit from working within a group. The possibility of free riding, where advantage is taken of the group members' knowledge and effort and subsequent higher marks, could be a reason for the lower individual mark obtained (Shawver, 2020).

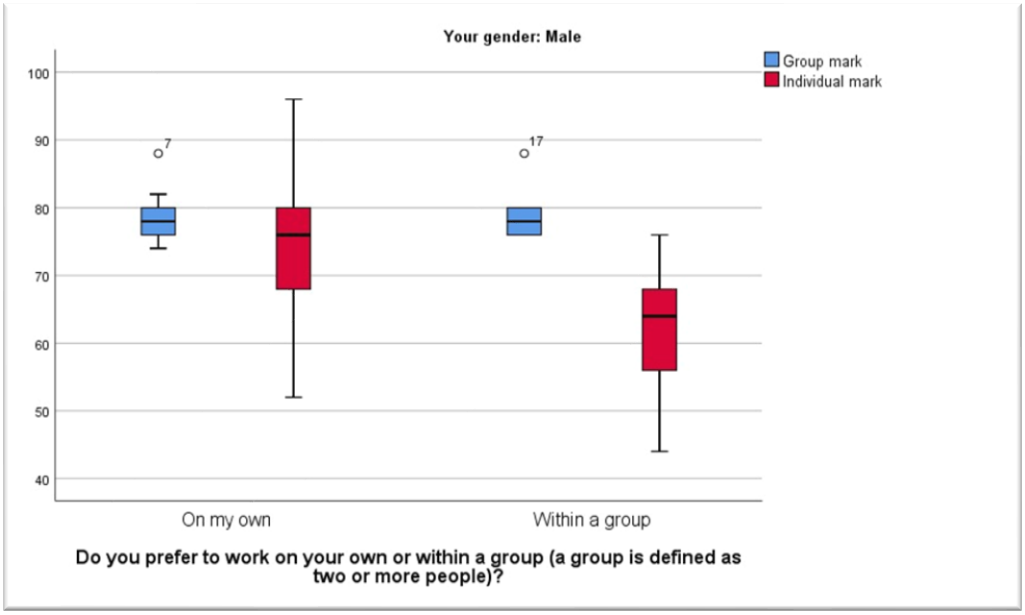

Figure 2: Preferences compared to marks for male students

Although differences can be observed from Figure 1 and Figure 2, for both males and females that prefer to work on their own, their individual marks are within range of their group marks. This may indicate that these students will make an effort and apply themselves, whether they are working on their own or within a group.

5.3 Findings from the survey's closed questions

Respondents were asked eight questions about the value and assessment of group work to determine their perceptions on how it enabled learning. The results are shown in Table 2.

Table 2: Students' perceptions on the value and assessment of group work

Question number and item	N	1-2	3	4-5	Mean	SD
7. Group work enabled me to learn from other students	54	4	7	43	4.17	0.986
8. Group work helped me to learn more about the subject area	54	8	11	35	3.81	1.150
9. I learn more about the subject area from individual assignments than from group work	54	9	17	28	3.67	1.099
10. The group assignments taught me how to work effectively in a team	54	4	9	41	4.04	1.027
11. Group work provides a skill which is valued by employers	54	3	1	50	4.35	0.850
12. I produce better work by working alone than by working in groups	54	7	19	28	3.57	1.002
13. Group work required more effort than individual assignments for the marks involved	54	9	6	39	3.85	1.188
14. Some individuals get higher marks than they deserve in group work	54	15	14	25	3.28	1.235

Scale: 1 = Strongly disagree; 2 = Disagree; 3 = Neither disagree nor agree; 4 = Agree; 5 = Strongly agree

From Table 2 it can be seen that students understand the importance of group work as they view it as a skill valued by employers, with 93% agreeing or strongly agreeing with the statement (Question 11). Their responses further show that they did learn from other students through their exposure to group work, with 80% agreeing or strongly agreeing with the statement (Question 7). The mean result for this statement (4.17) is slightly higher than the mean result reported (3.96) in the study by Healy, Doran, and McCutcheon (2018) for the same question asked of undergraduate students in Ireland. From the results it also appears as though students learned more from the subject area within a group (Question 8) than what they reported on within their individual capacity (Question 9). As the case study required students to seek the necessary knowledge first to solve the case study problem, working within the group may have contributed to the higher perception that more knowledge was gained in the group setting than individually.

What is further noticeable from the results of question 12 is that only 28 (52%) students agreed or strongly agreed that they produce better work by working on their own. With 44 (82%) of the students indicating at the start of the questionnaire that they prefer to work on their own, this result is surprising. It appears that in this group assignment, with the critical analysis of the case study that was required as well as the knowledge that had to be gained, students were skeptical of their individual ability to solve the case study problems. They might have gained from the group problem-solving and decision-making abilities that are enhanced within a real-life case study (Dyball, et al., 2007). It further appears that in this study students did not feel cheated with the group marks received, with more students disagreeing or being neutral (54%) on the question of whether some individuals get higher marks than they deserve in group settings (Question 14). This is in contrast with the findings of Healy, Doran, and McCutcheon (2018), where more students appeared to have been unhappy with their group mark and the possibility of free riders within their groups (mean of 4.39 reported).

5.4 Qualitative findings

5.4.1 Group management process

On the question of group formation, it was interesting to note that most students (42) preferred to have been placed in a group rather than selecting their own group members. This might be a product of the diversity of students within the module and that they have not yet formed strong social bonds. The easy method of group formation through the LMS confirms the notion set forth by van der Laan Smith and Spindle (2007, p. 164) that "group formation need not involve a complicated and time-consuming mechanism".

One respondent, however, commented on the mismatch in experience and age of the different group members and how group members unskilled in teamwork could not cooperate effectively (Johnson and Johnson, 2009):

> *I feel in this program you have young students who has not group experience and other guys with plenty, which I think does not work well. It should be a positive but because of time constraint other guys take over and the younger guys just follow which is not the best in my view* (Respondent 53).

Students used a combination of platforms to meet as a group, with most groups indicating that they communicated with each other regularly on social media platforms such as WhatsApp. They also made use of video platforms such as Zoom, Blackboard Collaborate and Jitsi, where they could share their work and interact more formally. From their response to the question of how often they met, it was confirmed that group work requires significant time, with one student indicating: "We had 7 sessions ranging from ±30 min to 2 hours" (Respondent 21). Even though there is the perception that group work reduces the workload on students, other studies have also indicated that the coordination of the group, the discussion of the problem and possible solutions, as well as bringing it all together in a final deliverable, necessitates additional time to complete group assignments (Healy, Doran, and McCutcheon, 2018; Opdecam and Everaert, 2018).

5.4.2 Group process to solve the case study problem

Respondents were asked to describe the process that they followed as a group to gain the necessary knowledge of the specific liability that they identified and to solve the questions posed by the case study. Similarly to the findings of Hilton and Phillips (2010), the qualitative analyses of the question revealed two strategies followed by the groups to solve the case study problem: together-divide-then-regroup; or divide-then-regroup. The "all-for-one" strategy identified by Hilton and Phillips (2010, p. 27) was slightly adjusted by the students in this study to still include a component of individual work after their initial discussions and brainstorming. This might have inadvertently saved them some time as a disadvantage of the all-for-one strategy is the immense amount of time it takes when all aspects of a case study are completed together (Hilton and Phillips, 2010).

Those groups that followed the together-divide-then-regroup strategy met as a group at the start to identify the specific liability, then researched the liability individually, meeting again to discuss their findings and come up with an appropriate solution. They would then divide the work into different sections to be completed by each individual member and then bring it all together into the final deliverable. This is how two respondents described their group process:

> *We identified the applicable material in the text book as well as 1 or 2 external sources and then instructed everyone to go through it in order to get a better understanding of the liabilities. On the second meeting a solution was tabled as a starting point for the discussion and everyone's opinion heard. We finally reached consensus on our approach/identification and then gave each member a certain part of the accounting process to prepare and present* (Respondent 21).

> *We read through the brief and try to establish a good understanding of what is required, then we compiled a outline of deliverables. We then allowed each member to research and read through the textbook, find examples, extra information regarding the topic. Relating back to the deliverables of the assignment, we each volunteered a task to produce information for the PowerPoint, we then had 2 zoom sessions where we put the PowerPoint together and worked through the assignment on what journal entries must go where, the calculations to be done etc. Each member giving their input of understanding and challenging each other to clarify and gain understanding* (Respondent 28).

It appears from groups using this approach that more cooperative learning occurred and that they could benefit from the discussion that unfolded in the groups. It further appears that these groups unconsciously used a deep approach to learning, as confirmed by this comment:

> *It was a co-operative process where we all attempted a task and shared it with each other and received feedback in order to make corrections and learn* (Respondent 37).

The divide-then-regroup strategy seemed to be no less rigorous, although more individuality was necessary to complete the case study:

> *We gathered our subject matter according to the task given. We broke up the work amongst the 5 of us, by giving each person a topic, i.e. identification, recognition, measurement, presentation and disclosure. Afterwards we would discuss how we [were] going to fit everything together and whether or not there are people with different views that need to be considered* (Respondent 39).

> *We first planned on how the whole assignment will be constructed and allocated parts that each group member will do. All completed files were posted on the group file exchange bar on Blackboard. Each member had a chance to review the work and make any changes/corrections/additions* (Respondent 43).

Although not specifically asked, a few groups did mention making use of a group leader and one respondent indicated how frustrating it is when leadership skills were not applied appropriately:

> *The process was quite difficult as there was a lack of communication and the group leader not fulfilling her role* (Respondent 31).

Most respondents indicated that they followed the same process with the individual assignment – they identified the liability from the case study first, then they researched that liability before answering the question posed. A few respondents mentioned that when it came to completing the individual assignment, they missed having the decision-making abilities and generating options found within the group setting (Hiltz, et al., 2011):

> *But as an individual you cannot ask anyone if you are experiencing difficulties* (Respondent 3).

> *I actually enjoyed comparing my answers with someone in the group* (Respondent 8).

5.4.3 Skills developed

Students were asked two open-ended questions regarding skills development. The first question asked them whether working collaboratively is a skill that they will need in their current or future careers, while the second question explored whether other skills were developed by completing the assignments. On the first question only four respondents answered negatively, with one respondent explaining it as follows:

> *I work better by myself as others bring me down with either their pace or laziness. I delegate work when I don't have the capacity to complete it by myself in a certain time frame. I work well with others but don't feel that it is a skill that will benefit my career* (Respondent 36).

In the online environment, it might be more challenging to gauge every group member's commitment as a lot of interaction happens 'offline' and uncommitted members can hide more easily:

> *Unfortunately, the online environment/setup in which we are currently doing these group tasks can be very frustrating as one cannot control everyone's commitment and dedication to the process and places unnecessary pressure on individual member of a team through no fault of their own* (Respondent 21).

Quite a few students were able to make the connection between this group assignment and work teams that they have either already encountered or envisage that they will encounter in their future careers:

> *Few meaningful deliverables have a scope or size that requires the effort of only an individual. Most projects require a team to successfully deliver the agreed outcomes* (Respondent 1).

> *I will be honest that I am not a fan of collaborating with others – I prefer to work be on my own, in my own space and work. But that's not how life works. Almost always in companies you are required to work as a team, especially in bigger corporations* (Respondent 20).

It was encouraging to note that students were able to identify several skills that were developed through completing the assignments. They identified interpersonal skills that included good communication both by expressing themselves clearly as well as by listening to someone else's point of view. The art of negotiating and the "ability to compromise and work and accommodate people with a different style and perspective to mine" are valuable skills to have for the diverse work environment that these students will be exposed to one day (Respondent 35). They also mentioned that time management and a work ethic is necessary to not let the team down:

> *I was a little lazy at doing work but when you don't work alone, you than have to pressure to perform because you are not the only one (Respondent 34).*

For students to answer the question posed by the case study they had to gain the necessary knowledge in some way. It was therefore encouraging to note that several respondents added the ability to research and assess different alternatives as a skill that was developed. Quite a few of the groups presented their final deliverable in a video or presentation format and this was also mentioned as a valuable skill that was developed. As one respondent commented:

> *Using technology to create a video and summarizing the work in a simpler but more powerful and interesting way* (Respondent 33).

All the skills mentioned by the students were comparable to those in other studies that also identified verbal communication skills, listening skills, negotiating, researching and presenting findings as skills enhanced through group work activities (Ballantine and Larres, 2007; Healy, Doran, and McCutcheon, 2018; Paguio and Jackling, 2016).

6. Conclusion

Cooperative learning can be seen as an effective learning approach with the average of group marks shown to be higher than individual marks earned for a case-based assignment. The results indicate that cooperative learning allowed students to exchange ideas, evaluate the input of other students and so become part of the knowledge creation process. Within the online learning environment, cooperative learning can be equally effective if time and connectivity challenges are closely monitored by the educator. Although most students indicated that they prefer to work on their own rather than in a group, they did understand the benefit of immersing themselves in a community where they can solve problems together and imitate the work environments to which they will one day be exposed.

Within group work, there might always be students that take advantage of the group effect to free ride and spend minimal effort to receive the same mark as their group members. It appears that, in this study, most group members did cooperate, gained the necessary knowledge and helped to solve the case study problem. This might be due to the higher level of maturity of the online students. The use of peer assessment might be considered to curtail uncooperative member, but is not without its challenges (Opdecam and Evereart, 2018).

In this study, although adequate guidance was given to students on how to manage and work within their groups, they were able to navigate the online environment with minimal input from the educator and found ways to connect, meet and share their ideas. Social media platforms and online meeting software played a significant role in achieving their connectedness. Group formation in this study was through randomly selected groups and although it will always be a matter of debate, it should fit in with the objectives of the cooperative learning assignment and the current status of the students (van der Laan Smith and Spindle, 2007). More intentional group formation or self-selected groups might be considered, but randomly selected groups present students with "social, communication and organizational challenges" to overcome that might be more beneficial to them in their future careers (Hilton and Phillips, 2010, p. 31).

It was encouraging to note that respondents were able to identify a number of skills that were developed through the case study approach and group assignment. Skills such as communicating well, listening with intent, negotiating a point of view, researching alternatives and solving a problem were all enhanced through their participation in their groups. Some students were also able to develop technological skills by meeting online and presenting their final work using video software. All these skills will be necessary for a successful career as a professional accountant.

This study was based on a modest sample of students within one online module. As the author is a proponent of cooperative learning, this might have affected the qualitative analysis performed. The mixed-methods approach may, however, provide a more balanced picture of the students' perceptions. As online learning has grown during the COVID-19 pandemic and forced many institutions to offer it as the only alternative, cooperative learning opportunities can be included in other programmes and modules. In order for cooperative learning to be effective in the online learning environment, educators will do well to follow a structured approach to achieve maximum benefit. Choices regarding group size, group formation and group management play an important part in the success of the group work. So too the ability of students to interact with each other virtually in synchronous as well as asynchronous formats. The set-up and management of the approach will require forethought by the educator but can lead to a rich and student-centered environment.

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Active Student Learning through Gamification in a Learning Management System

Satrio Raffani Raharjo, Putu Wuri Handayani and Panca Oktavia Hadi Putra
Universitas Indonesia, Indonesia
satrio.raffani@ui.ac.id
putu.wuri@cs.ui.ac.id
hadiputra@cs.ui.ac.id

Abstract: E-learning through a learning management system (LMS) is expected to be a solution to the needs of distance learning, especially during a pandemic situation. However, learning through an LMS can lead to a lack of focus, reduced classroom efficiency, and a feeling of boredom for the user. One solution to this problem is to use gamification (e.g., rankings or points, badges, and leaderboards) to enhance active learning. This study uses a mixed-methods approach and data from weekly reviews and forum discussions, questionnaires, and data students' interviews to assess the implementation of gamification elements in an LMS. The data from the questionnaires were analyzed using descriptive statistics, and the data from student interviews were analyzed using general inductive analysis. The results show that gamification in an LMS had a positive influence on active learning. The students have also provided positive feedback on the rated weekly review activity. The badges and leaderboard were also positively accepted by most students. Awarding points for activities was also found to improve students' performance in class. Badges were found to increase students' active participation, and the leaderboard motivated students to participate actively in online classes. This study could provide guidance to universities or LMS providers wishing to implement gamification in an LMS.

Keywords: e-learning, learning management system, gamification, active learning, rating, points, badges, leaderboard

1. Introduction

Currently, most universities around the world have started using e-learning due to COVID-19. E-learning can facilitate interaction between students and their teachers, while minimizing time and space constraints (Utomo and Santoso, 2015). Abdullah, Bakar and Mahbob (2012) demonstrated the importance of class participation and active learning. Active learners seek information and engage with that information. They have an intention to learn and choose to participate in the learning process by reaching out for new information (Faria, Scurfield and Diaz del Castillo, 2016). Active learning is a student-centered, iterative, dialogical, and collaborative approach, the application of which must be conscious and well designed.

The COVID-19 pandemic has caused lecturers to encourage their students to make more active use of learning management systems (LMSs), as the lack of face-to-face interactions in e-learning can generate feelings of loneliness and boredom (Olsson, Mozelius and Collin, 2015). Herzberg et al. (2009) also found potential drawbacks of LMSs, such as reduced focus and student attention due to a lack of face-to-face communication between teachers and students. Interestingly, Azmi and Singh (2015) and Tuparov et al. (2018) found that a gamified LMS is more interactive and engaging to students than a standard LMS. Thus, gamification is one solution that can increase class participation (Hanus and Fox, 2015).

Gamification refers to the use of game design elements in a non-game context (Deterding et al., 2011). Research on aspects of gamification in non-gaming environments, such as education, has increased in recent years (Domínguez et al., 2013; Seaborn and Fels, 2015). Gamification aims to combine intrinsic motivation with extrinsic motivation to foster engagement and motivation for active participation (Mishra and Kotecha, 2017). The distinction between intrinsic motivation and extrinsic motivation comes from self-determination theory (SDT; Ryan and Deci, 2000). Intrinsic motivation can be understood as an action or activity that is carried out for the satisfaction that can be experienced simply by performing the activity, while extrinsic motivation is an action or activity that is carried out for reasons other than the satisfaction gained from the activity itself (Ryan and Deci, 2000). Mekler et al. (2017) explained that both types of motivation can improve a person's performance in carrying out activities. However, Ryan and Deci (2000) found that only intrinsic motivation can have a positive influence on creativity and learning outcomes (Mekler et al., 2017). This study draws on SDT to increase student motivation to engage in active learning through an LMS.

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Gamification has many elements, including points, badges, leaderboards, performance graphs, and avatars (Sailer et al., 2017). These elements can be implemented in an LMS. Wang (2020) adopted the design-based research (DBR) method to explore whether integrated technology-reinforced learning can help college teachers design more interactive classrooms and help undergraduate students engage in active learning. Wang (2020) used interactive response system such as Kahoot! for his study. Barata et al. (2013) described an experiment in which game-like elements were used to improve the delivery of a master's level college course. Barata et al. (2013) suggest that points and badges that can be earned by students may eliminate intrinsic motivation. Davis et al. (2018) analyzed active learning strategies to determine the most appropriate ones for digital learning environments and investigated the effectiveness of these strategies. For their study, they combined simulation and gamification into a single category rather than separating them into different categories.

To date, few studies have been conducted on the application of gamification in LMSs. Azmi and Singh (2015) conducted research on gamification for and LMS, focusing on a proprietary software package for Malaysian students. They found that gamification in LMS is interactive and engaging for users. In addition, Simionescu, Šuníková, and Kubincová (2017) and Tuparov et al. (2018) identified gamification features in open-source e-learning environments but focused only on student assessment. However, the application of gamification in higher education is a rare topic of research in Indonesia. To fill this gap in the research, we evaluate the impact of gamification on active learning through an LMS called Student-Centered E-Learning Environment (SCeLE Fasilkom) used by the Faculty of Computer Science at Universitas Indonesia (UI). The gamification elements used in this study are badges, ratings and points, and a leaderboard. These gamification elements were chosen because badges and ratings/points are already available in SCeLE Fasilkom, making it easy to integrate, and the leaderboard was constructed according to previous studies.

2. Literature Review

2.1 Active Learning

According to Fayombo (2012), active learning is a crucial component of the learning process, as learners should be actively engaged during lectures. Active learning is an approach whereby students participate in the learning process by building knowledge and understanding. Active learning is a broad concept that generally encompasses student-centered learning methods and activities led by an instructor (Felder and Brent, 2009; Mitchell, Petter and Harris, 2017). It also includes any course-related activity, other than simply watching, listening, and taking notes, that all students in a class session are asked to perform (Felder and Brent, 2009). Hess (1999) described several characteristics of active learning, such as developing students' skills, involving students in high order thinking (analysis, synthesis, evaluation), engaging students in activities (reading, discussing, writing), and encouraging students to explore their own attitudes and values. Therefore, in general, active learning is not a learning concept but a teaching concept.

Previous research on active learning from the point of view of student learning outcomes has been mostly positive (Freeman et al., 2014), supporting active learning as a superior approach compared to traditional, more content-centered approaches, such as lectures. Active learning can include setting questions in an online forum, concept sketching and mapping, and case studies (Felder and Brent, 2009). Azmi and Singh (2015) implemented an avatar and a leaderboard in LMS to improve the student learning process, while Simionescu, Šuníková, and Kubincová (2017) and Tuparov et al. (2018) used badges to represent the students' progress in peer assessment.

2.2 Student Engagement

Nisiotis and Kleanthous (2019) defined student engagement as a commitment or effort made by students to participate in learning activities, while Nakamaru (2011) suggested that engagement relates to purposeful efforts by students to commit time and energy to educational activities. Student engagement can be categorized into three components: behavioral engagement, emotional engagement, and cognitive engagement (Sun and Rueda, 2011). Behavioral engagement can be interpreted as a form of student behavior in learning that is considered quite important (Fredricks, Blumenfeld and Paris, 2004) such as student behavior in class, student participation in school-related activities, and student interest in their academic work (Cooper, 2014; Yazzie-Mintz and McCormick, 2012). Emotional engagement can be defined as emotional or psychological reactions to friends and class teachers and can include feelings of attraction, boredom, happiness, and sadness (Ding, Kim and Orey, 2017). Finally, cognitive engagement can be defined as student investment in the learning process, which involves students' inner psychological qualities or invisible traits that drive their efforts to learn, understand, and master the knowledge or skills promoted in their academic work (Cooper, 2014; Yazzie-Mintz

and McCormick, 2012). Research by Khan et al. (2017) showed that active learning strategies often encourage student engagement and have a significant impact on student learning when applied effectively throughout a course.

2.3 Gamification

According to Deterding et al. (2011), gamification refers to a non-gaming environment that includes gaming elements with the aim of improving the user experience and increasing engagement to achieve certain goals. Groening and Binnewies (2019) found that the experience of engaging in activities that involve elements of gamification is similar to the experience of playing a game. Sailer et al. (2017) also found that gamification can improve motivation and performance. Gamification provides visible benefits in several non-game settings, such as the fields of health (Hammedi, Leclerq and Van Riel, 2017) and learning (Aparicio, 2019), and is one of the most effective learning strategies for promoting active learning (Davis et al., 2018).

2.4 Self-Determination Theory (SDT)

This study aims to evaluate the impact of the gamification elements points, badges, and a leaderboard on student learning. Various perspectives can be used to analyze the motivational strength of game elements, including emotional, cognitive, and behavioral perspectives, traits, interests, and self-determination (Sailer et al., 2017). The self-determination perspective was chosen for this study because it incorporates some of the contents of other perspectives (Sailer et al., 2017).

Self-determination theory is a theory of human personality and motivation that involves how an individual interacts with and depends on the social environment (Legault, 2017). It emphasizes the inherent motivational tendencies of people to learn and grow and how they can be supported (Ryan and Deci, 2020). According to Legault (2017), SDT assumes that everyone will try to develop and understand themselves by integrating new experiences; developing their needs, wants, and interests; and connecting with other people and the outside world.

3. Methodology

3.1 Data Collection and Analysis

This study uses a mixed-method approach and the DBR method. The DBR method is a method of conducting experiments in which various designs of gamification elements are incorporated at different stages of the research and integrated into an iterative cycle. This research follows a DBR process, which involves defining problems, designing experiments, facilitating, and evaluating methods, and determining findings at each stage and then providing suggestions for the next stage. For this study, the research method and data presentation were separated into three stages due to time limitations, which required that the experiment be carried out in a single semester of lectures.

In phase one, a points system was implemented in the form of a weekly review. The weekly review was a special forum for each SCeLE Fasilkom class to write down what they had learned each week. It was decided that the points system would be implemented first because SCeLE Fasilkom already has points feature, so the researcher did not need to design these elements and they were able to be implemented immediately. Points were also chosen because they can motivate students to actively participate in weekly reviews by establishing a clear relationship between participants' efforts and their performance. When implemented, the points system was received positively by the students as a way of increasing active learning. We then implemented the other gamification elements in the subsequent phases.

In phase two, badges were introduced. These were earned by students who participated in discussion forums and weekly reviews. The discussion forum was a special forum for each SCeLE Fasilkom class on which discussion materials, such as case studies, were posted every week. Badges were chosen for the second implementation because SCeLE Fasilkom already has a badge feature, so the researcher only needed to provide images for the badges and criteria for earning them. Badges were also chosen because they can be awarded as prizes to motivate students to participate more actively in weekly reviews and forum discussions. Badges also received a good response from students and improved active learning. Therefore, we implemented another gamification element in the next phase. The first and second phases are linked because the badges are awarded based on the points earned by participating in the weekly reviews.

In the third stage, the leaderboard was implemented. The leaderboard was implemented last because SCeLE Fasilkom does not have a leaderboard feature, so the researcher had to create it from scratch. A leaderboard was chosen because it can inspire students to maintain their performance and continue to participate in weekly reviews and forum discussions. The leaderboard also received positive responses from students and increased active learning. Figure 1 presents the sequence of the DBR research, and the topics covered in each phase. This phase is linked to the first and second phase, as the leaderboard has three categories: one for points, one for badges, and one for a combination of the two.

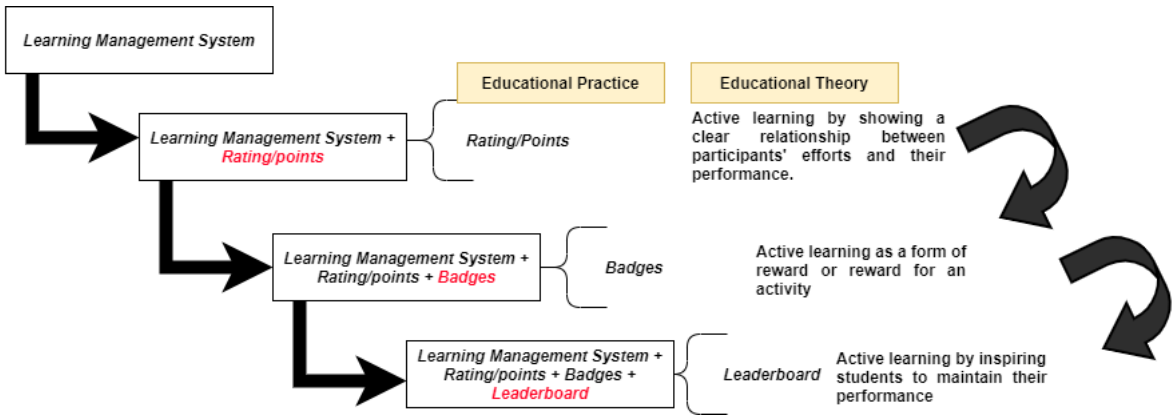

Figure 1: DBR Iteration Phases

This study involved students in three classes: Enterprise Systems (SIP-MTI), Business and Technical Communication (Kombistek), and Electronic Health (E-Health). Data on the implementation of the gamification element is taken from replies to weekly reviews and forum discussions, questionnaires, and student interviews. Data from questionnaires and replies were analyzed using the descriptive statistics mean and standard deviation. The average (mean) can provide an overall picture of the data set, while the standard deviation shows how scattered the data is by revealing how far each observed value is from the mean (Ilola, 2018). Data from interviews were analyzed using general inductive analysis. The sole purpose of implementing gamification in these three classes was to improve active student learning, which was explained by the lecturers at the beginning of each class.

Data collection was carried out in three stages, one stage for each of the DBR phases. The SIP-MTI class had 142 class members, the Kombistek class had 235 members, and E-Health had 80 class members. Of all the participants, 301 were completing bachelor's level courses (Kombistek and E-Health) and 156 were completing master's degree courses (SIP-MTI). An online questionnaire was distributed via a link, which was shared with the class members through various social media outlets, including Instagram, WhatsApp, and Line, and through class announcements on SCeLE Fasilkom. Each phase of data collection had a duration of two weeks. The first phase was carried out between 11 October 2020 and 24 October 2020, the second phase ran from 25 October to 7 November 2020, and the third phase started on 30 November 2020 and ended on 13 December 2020. The interviews to obtain qualitative data were conducted at the end of the third phase. Interviews were conducted with two UI students. The first phase had a total of 103 respondents, the second phase had 171 respondents, and the third phase had 149.

3.2 Gamification Component Design Making

When designing the gamification elements, we drew on the results of previous studies. When designing the badges, we chose the completion of the weekly review and forum discussion as the badge category. The researcher referred to various sources, including PlayerUnknown's Battlegrounds (PUBG) and League of Legends, when creating the badges. Both games have the same four levels, namely bronze, silver, gold, and platinum, which are also used for various other applications, such as membership of customer reward programs.

We did not design the points element, as the points design integrated into SCeLE Fasilkom could not be changed. Therefore, this existing design was used. Figure 2 shows the points gamification element in SCeLE Fasilkom.

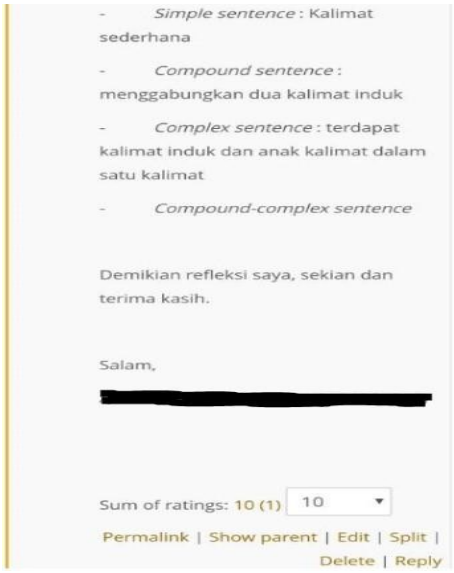

Figure 2: Weekly rating points design

Finally, when designing the third gamification element, namely the leaderboard, the researchers created a leaderboard with references using various sources, such as Kahoot!. Because SCeLE Fasilkom does not have a built-in leaderboard feature, we created a separate online leaderboard that could be accessed through SCeLE Fasilkom. Participants could see the leaderboard for their class. The leaderboard consisted of three categories: the accumulated score for the weekly review, the number of badges obtained, and a combination of these two categories. We adopted the podium concept used in Kahoot!, which displays ranks one, two, and three differently from other ratings. Ranks four to ten are shown next to ranks one, two, and three. Figure 3 shows the improved online leaderboard interface after testing. The design of the leaderboard page adheres to the eight golden rules set out by Shneiderman and Plaisant (2010), which include universal usability, error prevention, and reduced short-term memory load.

Figure 3: Leaderboard page for the SIP-MTI weekly reviews

The badges used in this study were participatory badges, which means badges were given for participation, regardless of the quality of the user's performance (Abromovich et al., 2013). Each class that participated in this research provided four participatory badges that were awarded to students who participated in the activities specified for earning the badges. Figure 4 shows how badges were implemented in the LMS.

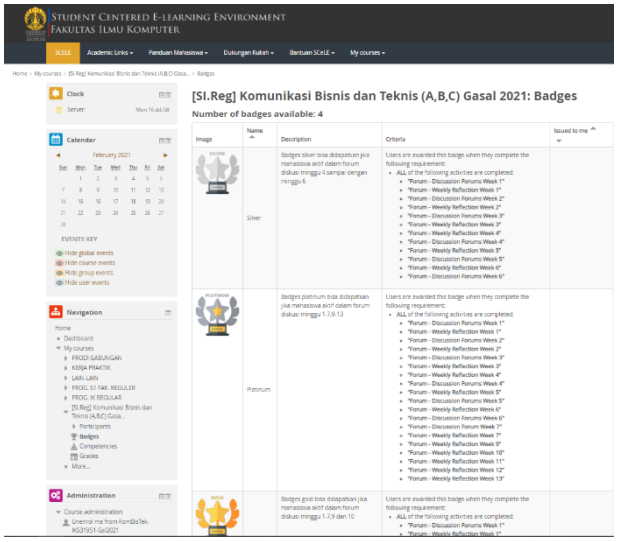

Figure 4: Kombistek badges page

3.3 Research Instrument

Study participants were required to complete three questionnaires. Questionnaires were distributed for completion by participants in each phase. Each questionnaire consisted of two parts: the first part asked about the respondent's personal feelings about the relevant topics, and the second part consisted of quantitative questions to evaluate the feedback on each gamification component. The questionnaires were prepared based on a review of the literature, and each used a Likert scale. The first phase questionnaire was adapted from the DBR phase one questionnaire used by Wang (2020). The second phase questionnaire was adapted from the questionnaire used by Kyewski and Kramer (2018), and the third phase questionnaire was adapted from the questionnaire used by Fotaris et al. (2016).

4. Results

4.1 Analysis Results

4.1.1 Phase one data analysis: Points implementation

The data for phase one came from weekly reviews and forum discussions from week four to week six. The first phase of data analysis showed that the students gave positive feedback on the rated weekly review activity (Table 1). The respondents indicated that this activity increased their involvement in the class (Q2), which is supported by their responses to the weekly review. Respondents' interaction with lecturers and lecturing assistants (Q1) also increased because they replied to discussion forums and weekly reviews initiated by lecturers or teaching assistants, and some of the respondents' replies received responses from the lecturer or teaching assistant. Respondents also felt that rating weekly reviews increased active participation in the reviews (Q3), which is supported by the number of responses on the discussion forum. The use of points was also found to increase respondents' willingness to participate in the reviews (Q4), which is evident from the number of forum replies. Likewise, the points system improved students' concentration during online classes because they wanted to earn high points when participating in weekly reviews (Q5).

Table 1: Results of the first phase of data analysis

Code	Question	Average	Standard Deviation
Q1	I feel that I have good interaction with lecturers and teaching assistants in the rated weekly review activities.	3.70	0.86
Q2	I feel more involved in the class by participating in the rated weekly review.	4.10	0.74
Q3	I feel that using ratings increases active participation in the weekly review.	3.99	0.91
Q4	Using ratings increases my willingness to participate in the weekly review.	3.95	0.94
Q5	To perform well in the rated weekly review, I concentrate more during online classes.	3.83	0.96

Based on the results shown in Table 1, it was concluded that integrating points into weekly reviews can increase active learning. Therefore, based on the findings of phase one, it was decided to add a new gamification element, namely badges to the LMS to further promote active learning. The criteria for earning badges include participating in the weekly review, which is rated. This means that students are more motivated to complete the weekly review.

4.1.2 Data analysis phase two: Points and badges implementation

The data used for the second phase of the analysis came from weekly reviews and forum discussions in the seventh to the tenth week. The second phase of analysis showed that students gave positive feedback regarding the implementation of badges (Table 2). Respondents indicated that the badges increased their motivation (Q3), which is evident from the level of activity in weekly reviews and discussion forums, which is a criterion for earning badges. The respondents also considered the badges interesting (Q5). They felt that getting badges was important (Q1). Again, this is supported by the activity level in the weekly reviews and discussion forums. The students liked receiving badges (Q2) and were happy that their fellow students could see their commitment to the course when they received a badge (Q4). The use of badges was also found to improve respondents' willingness to try an activity (Q7) and to engage in activities that would earn them a badge (Q8). This explains their initial willingness to participate in the discussion forums and weekly reviews. Respondents also seemed to want to try to collect all possible badges (Q6). However, they did not seem particularly willing to compare the badges they had obtained with those obtained by their fellow students (Q9).

Table 2: Results of phase two of the analysis

Code	Question	Average	Standard deviation
Q1	I feel it is important to get badges.	3.88	0.88
Q2	I love getting badges.	4.08	0.86
Q3	I feel motivated because of badges.	3.93	0.92
Q4	I am happy that other fellow students can see my commitment to the course with these badges.	3.67	0.92
Q5	I find badges interesting.	4.00	0.86
Q6	I am trying to get to all possible badges.	3.91	0.98
Q7	Badges can get me to try an activity.	3.95	0.90
Q8	I will engage in activities if I can earn badges for doing so.	3.43	0.98
Q9	I like to compare the badges that I have got with those of my fellow students.	2.88	1.17

After the second stage of analysis, it was concluded that the addition of badges was received positively by most students. However, while the data obtained from the questionnaire showed that badges were generally received positively, the second phase of data collection (Appendix A, weeks 7 to 10) included the midterm exams, which may have affected the data on active learning from the weekly reviews and forum discussions. The results of interviews support this assumption.

> *"Yes, because sometimes I forgot that I had to fill out the forum after midterm; the problem was that when it was midterm, I didn't need to fill in the forum, so I got out of the habit."* (Respondent 2, Male)

Based on the findings of the second stage, it was decided to add a new gamification element, the leaderboard, to the LMS to further promote active learning. The leaderboard had ranking categories based on the gamification elements implemented in phase two and phase one, namely badges and ratings, aimed at motivating students to participate in weekly reviews and forum discussions.

4.1.3 Phase three data analysis: Points, badges, and leaderboard implementation

The data for phase three of the analysis came from weekly reviews and forum discussions in weeks 11 to 13. The third phase of data analysis showed that students gave positive feedback regarding the implementation of the leaderboard (Table 3). They reported that the leaderboard activity increased their motivation (Q3), which is evident from the level of activity in the weekly reviews and discussion forums, participation in which is one of the criteria for earning badges and for determining a participant's ranking on the leaderboard. The respondents

also felt motivated to learn so that they would rank high on the leaderboard (Q5). They also thought that the leaderboard made the learning environment interesting (Q2) and fun (Q1). They were happy that their fellow students could see their commitment to the course by their ranking on the leaderboard (Q4). Respondents also felt that the use of the leaderboard improved their performance in class (Q7) and that their self-confidence increased when they ranked well on the leaderboard (Q8). Being ranked on the leaderboard gave respondents a sense that they were valued in class (Q9). They also expected that the leaderboard would be used for other classes (Q6).

Table 3: Results of phase three of the data analysis

Code	Question	Average	Standard Deviation
Q1	I find the leaderboard makes for a great learning environment.	3.64	1.01
Q2	I find the leaderboard makes the learning environment interesting.	3.76	1.01
Q3	I feel motivated because of the leaderboard.	3.72	0.99
Q4	I am glad that my fellow students can see my commitment to the course with the leaderboard.	3.52	1.01
Q5	I feel motivated to study in class so that my ranking on the leaderboard is high.	3.70	1.00
Q6	I hope the leaderboard is implemented in other classes.	3.74	1.03
Q7	I feel that the leaderboard has improved my performance in class.	3.50	1.04
Q8	I feel more confident when I get good rankings on the leaderboard.	3.92	0.89
Q9	I feel appreciated when I get ranked on the leaderboard.	3.81	0.87

After the third phase, it was concluded that the addition of the leaderboard was positively accepted by most of the students. The data obtained from the questionnaire showed that badges were generally received positively. However, the leaderboard had to be accessed through a separate link in SCeLE Fasilkom, which may have made participants less aware of its existence and, thus, affected active learning in the weekly reviews and forum discussions (Appendix A, weeks 11 to 13). The interview results support this suggestion.

"Yes, if you forget the leaderboard link, you have to search again." (Respondent 2, Male)

The results of the questionnaire (Table 4) showed that students gave generally positive feedback on the implementation of gamification and indicated that it increased their motivation to continue attending the classes (Q3), their involvement in class (Q2), and their enjoyment of the class (Q1). Respondents also felt that gamification improved their performance in class (Q4) and their productivity (Q5). They reported that their interactions with their classmates had increased (Q6). They also hoped that gamification would be implemented in other classes (Q7).

Table 4: Gamification analysis results

Code	Question	Average	Standard Deviation
Q1	I feel that the leaderboard, badges, and weekly reviews with ratings increase my involvement in the classes I participate in.	3.94	0.81
Q2	I feel like the leaderboard, badges, and weekly reviews with ratings increase my enjoyment of the class.	3.64	0.95
Q3	I feel that the leaderboard, badges, and weekly reviews with ratings increase my motivation to continue attending the classes.	3.72	0.95
Q4	I feel that the leaderboard, badges, and weekly reviews with ratings improve my performance in class.	3.63	0.96
Q5	I feel that the leaderboard, badges, and rated weekly reviews increase my productivity in class.	3.73	0.95
Q6	I feel that the rated leaderboard, badges, and weekly reviews improve my interactions with my colleagues in class.	3.51	0.97

Code	Question	Average	Standard Deviation
Q7	I hope the leaderboard, badges, and rated weekly reviews will be implemented in other classes.	3.72	0.94

4.1.4 General inductive analysis

Apart from the quantitative data described above, qualitative data was also collected through interviews conducted at the end of the third phase (Table 5). The interviews were conducted to obtain deeper qualitative data to strengthen the results obtained from the questionnaires. This qualitative data was analyzed using general inductive analysis. The results of the interviews indicated that gamification had benefits for the respondents, such as providing an overall picture of student activity in class, motivating them to take part in lecture activities, and enabling them to see their performance through points earned (Table 5). Respondents also felt safer because they were given an indication of the work they were doing. This is also consistent with the results of Von Ahn and Dabbish (2008), who found that points clarified the relationship between students' efforts and their performance. Respondents also felt happy when they obtained points, received badges, or appeared on the leaderboard. This is in accordance with Sitra et al.'s (2017) finding that gamification that uses badges as rewards provide strong encouragement for students to more actively participate in learning activities. Respondents also felt that class activity had increased due to gamification. This is also consistent with the finding of Mekler et al. (2013) that points can motivate an individual to engage in an activity.

Table 5: Summary of Interview Results

Questions	Answers
The benefits felt from the gamification element	"It can provide a picture of the overall activity in class" (Respondent 1), "I was motivated to participate in all lecture activities." (Respondent 1) "Looking at my performance through ratings" (Respondent 1) "Feeling more motivated, although only a little" (Respondent 2)
Feelings about the gamification element	"So, I feel more secure because the scores are more transparent" (Respondent 1) " I was motivated to be better than other participants " (Respondent 1) "I feel a little more motivated by the rating" (Respondent 2)
Feelings after receiving a good rating or a badge or entering the leaderboard	"Happy" (Respondent 2) " I can be arrogant toward friends " (Respondent 1)
Do you like it when other people see your activities/commitments in class?	"Happy; badges can be a personal collection" (Respondent 1) "Happy because, for example, someone with a better performance could be a source for questions" (Respondent 2)
Do you feel activity in class increased?	"Yes. I respond to every forum, so I can collect badges. " (Respondent 1)

4.2 Discussion of Research Results

This study shows that lecturers can use gamification elements on an LMS to improve active learning in their classes. The results show that ratings/points were motivated more than 50% of students to complete weekly reviews almost every week (Appendix A). Appendix A also shows that new master's students are not as active as new or old students at undergraduate level because new master's students tend to be working as well, so they do not have much time to explore the LMS. A decline was noted in the last week of lectures, which could be due to students being busy with many lectures and preparations for the end of semester exams. The results of the interviews show that ratings motivated the students, which is in line with the findings of Mekler et al. (2013), Huang and Hew (2015), and Dahlstrom (2017) and with the responses to one of the questions in the phase one questionnaire, which showed that 59.22% participated more in class activities with points. Points were also found to improve respondents' performance in class, which is supported by several other studies, such as those of Mekler et al. (2013) and Von Ahn and Dabbish (2008), which show that points clarify the relationship between an individual's efforts and their performance.

Badges were also found to increase active participation, which can be seen from the number of replies to the forum discussions and weekly reviews. This is in line with Sitra et al.'s (2017) finding that gamification in the form of a badge as a reward provides strong encouragement for students to participate more actively in learning activities. This is also in line with Hamari's (2017) finding that badges can motivate an individual to engage in an activity. The results of the interviews also show that badges can encourage students to participate in active learning by taking part in weekly reviews and discussion forums. Students were also found to be less likely to compare their badges with those of other students, which aligns with the findings of Kyewski and Kramer (2018). For students who do not like competition, the badges and leaderboard results could be displayed so that students can only see their own level or ranking. In addition, the leaderboard could also display an avatar that has been determined by the student instead of their name so that the results could be kept anonymous.

Finally, the results of the analysis found that the leaderboard had an impact on active learning in the LMS. The leaderboard motivated students to participate actively in class and to engage in forum discussions and weekly reviews, which is in accordance with the findings of Mekler et al. (2013) and Hamari, Koivisto, and Sarsa (2014). The leaderboard also improved students' performance in the classroom by enabling them to set clear goals to strive for (Mekler et al., 2013; Farzan et al., 2008; Hamari, 2013). The results of the interviews show that the leaderboard also motivates students to keep trying to perform well. This is supported by the results of Mekler et al. (2013), who found that leaderboards can inspire participants to maintain their performance for longer.

5. Implications

This study contributes to research in the field of gamification and e-learning, especially in relation to the design of gamification elements and analysis of the effects of gamification on active learning in LMS applications. This study enriches the research in this field and contributes to the application of gamification elements in LMSs using the DBR methodology. The results of the questionnaires and interviews show that gamification could increase active learning through LMSs. This is in line with the findings of Davis et al. (2018), which show that gamification is one of the most effective active learning strategies for the digital learning environment, in this case, an LMS.

The study also found that points have the most visible impact on active learning, followed by badges, and finally the leaderboard. Factors such as the ability and motivation of students to participate in these learning activities need to be studied when designing gamification components for implementation in an LMS. Accessibility should also be a consideration for LMS managers because students should not feel burdened by gamification. Therefore, LMS managers should focus on the various components of gamification that will be applied in the LMS and their positive and negative aspects.

6. Conclusion

This study proves that gamification applied in an LMS had a positive influence on active learning in the sample considered for this study. This influence can be seen in the replies to the forum discussions and weekly reviews. Points were found to be motivating, as they provided a clear link between students' efforts and their performance (rating/point). Badges were also found to be motivating, as the participants wanted to obtain them and increased their active participation or learning to do so. The leaderboard was also motivating, as it made students try to maintain their performance. Future research could examine other gamification components, such as avatars, progress bars, and levels, to test whether they improve active student learning. One limitation of this experiment was that midterm occurred during one of the phases. Further research could be carried out without any pause in the implementation that might cause a disturbance in the habitual activities of respondents and thus affect the results of the study.

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Appendix A. Weekly Review Students Participation

Week	Gamification	Kombistek		SIP-MTI		E-Health	
		Number of Students	Percentage (%)	Number of Students	Percentage (%)	Number of Students	Percentage (%)
1	Points	206	87.66	132	92.96	80	100.00
2		196	83.40	121	85.21	74	92.50
3		163	69.36	123	86.62	74	92.50
4		166	70.64	97	68.31	77	96.25
5		177	75.32	128	90.14	78	97.50
6		159	67.66	96	67.61	63	78.75
7	Points and badges	173	73.62	96	67.61	64	80.00
8		175	74.47	92	64.79	71	88.75
9		175	74.47	93	65.49	71	88.75
10		169	71.91	92	64.79	67	83.75

Week	Gamification	Kombistek		SIP-MTI		E-Health	
		Number of Students	Percentage (%)	Number of Students	Percentage (%)	Number of Students	Percentage (%)
11	Points, badges, and leaderboard	173	73.62	78	54.93	57	71.25
12		168	71.49	70	49.30	52	65.00
13		154	65.53	60	42.25	44	55.00

Design, Development, and Evaluation of Haptic- and Olfactory-based Application for Visually Impaired Learners

Chit Su Mon[1], Kian Meng Yap[1] and Azlina Ahmad[2]
[1]Sunway University, Malaysia
[2]Universiti Kebangsaan Malaysia, Malaysia
07013782@imail.sunway.edu.my
kmyap@sunway.edu.my
azlinaivi@ukm.edu.my

Abstract: Educational entertainment or edutainment is a popular approach to allow learners experience a fun learning environment while acquiring knowledge. Currently, this approach is widely used and has promising benefits, whereby not only it provides a fun learning environment but also cause learners to hardly notice the learning process. However, as there are a minimum of 2.2 billion people worldwide with vision impairment or blindness, this approach can be a challenging experience for them. It is thus important to provide equal opportunities for these members of the community in the teaching and learning environment. Owing to the limited applications available for the visually impaired in virtual edutainment tailored for them, this research aims to design and develop an edutainment application for visually impaired users using a user-centered design. The application allows users to touch 3D objects using Touch by 3DSystems. In addition, sounds and smells will be released from the speaker and olfactory devices, respectively. The usability and satisfaction of users toward this application was tested on the visually impaired as well as blindfolded users using a 7-point Likert scale questionnaire. This questionnaire was constructed in accordance with USE (Usefulness, Satisfaction, and Ease of use) by Lund. A total of 10 participants – including visually impaired teachers and blindfolded students – participated in this study. Participants in this study agreed that the proposed application is useful, easy to use, easy to learn, and were satisfied with the application. The average rating of the results out of 7 was 5.92 for usefulness, 5.6 for ease of use, 6.22 for ease of learning, and 6.25 for satisfaction.

Keywords: Haptic, Audio, Olfactory, Edutainment learning, Visually Impaired

1. Introduction

Education is life's essential factor, and thus, it is important to ensure that every child receives equal learning opportunities. Education must be accessible not only to ordinary children but also to those with special needs. Technology-based learning is widely available, including educational applications for children (Mon and Subaramaniam, 2020). They range from accessing school syllabus to learning extracurricular knowledge such as moral values (Jian, Mon and Subaramaniam, 2020). Thus, educational entertainment or edutainment has become one of the popular approaches used in the teaching and learning environment. Edutainment applications usually involve rich media content and are only suitable for learners with sight. They are not suitable for visually impaired leaners. There are about 2.2 billion visually impaired or blind people globally (World Health Organisation (WHO), 2021), and vision impairment is one of the most serious issues with direct and indirect economic impacts. With the rapid growth of virtual learning tools, the accessibility to these tool-assisted environments remains lacking for the visually impaired.

The sense of touch applies forces, vibrations, or motions on the user. It has been widely used in investigations on both the sighted and visually impaired (Sreelakshmi and Subash, 2017). Haptic is typically used together with visual (sight) and audio (sound) media in edutainment applications for the visually impaired. An application that includes multiple senses such as visual, auditory, touch, and haptic is developed to provide multivariate data representation in multimodal virtual environment (Yasmin, 2019). The integration of visual presentation and audio feedback helps further exploration of the data and the haptic glyph, which enables users to feel the different shapes, sizes, and other physical properties such as friction.

Another interesting and useful media to enhance user experience is the olfactory media. It facilitates knowledge acquisition and content understanding for the user (Covaci, et al., 2018). However, there is no concrete research conducted to improve the users' experience using olfactory media for the visually impaired in the teaching and learning environment. Learners with visual impairment typically opt for non-technology assistive tools to learn shapes in an inclusive classroom, and thus, will not be engaging if visually impaired users were asked about existing edutainment application in their learning process. To the best of our knowledge, there is no research

Reference this paper: Mon, C. S., Yap, K. M., and Ahmad, A., 2021. Design, Development, and Evaluation of Haptic- and Olfactory-based Application for Visually Impaired Learners. *The Electronic Journal of e-Learning,* 19(6), pp. 614-628, available online at www.ejel.org

that explores or designs applications that use haptic, olfactory, and audio together for the visually impaired in a virtual learning environment. It is important to understand how and what to learn, as learning is essentially the dynamic modification of memory (Savage, 2018). What a user reads or sees alters their memory, which subsequently does the interpretation to input the data as knowledge. Olfaction is the sense of smell and involves specialized sensory cells in the nasal cavity and molecules in the sensory system to transmit signals to the olfactory bulb (Vokshoor and Meyers, 2013). There are two olfactory systems in humans; the primary one detects volatile chemicals, whereas the secondary one detects fluid chemicals. Smell memory in humans is strong in recalling previous situations or conditions when a particular smell was encountered.

As mentioned earlier, because of a significant proportion of population with visual impairment, it is important to provide equal opportunity in teaching and learning for the visually impaired. Virtual education or e-learning can assist learners in many ways and provide a number of advantages. However, there are many limitations for visually impaired learners to use e-learning or virtual learning applications. In the context of learning different shapes of fruits, visually impaired learners are unable to see the way sighted learners see the shapes by looking at the visual media via e-learning application. According to a study conducted by Mon, Yap and Ahmad (2019a), visually impaired users relied on olfactory sense in order to identify different shapes. However, there is no research on how the olfactory system can benefit the visually impaired.

Therefore, this research aims to design and develop a 3D-based olfactory, haptic–audio (3DOHA)-enabled virtual learning application for the visually impaired. When designing the application, user-centered design (UCD) was used as this approach primarily focuses on the requirements of the user, thereby producing highly usable and accessible products. UCD is used in a wide array of applications ranging from standalone mobile-based learning applications to applications for children with special needs. The current research was targeted toward an application as smart phones are widely used in education and has become an important tool to provide suitable contents that fosters collaboration between children and parents (Wardhana, et al., 2017).

Current available assistive applications for the visually impaired in learning and learning limitation of visually impaired learners in virtual edutainment environment are elaborated in the background section. Methodology section discusses designing the prototype, choices of haptic and odor devices, development of the prototype as well as questionnaire and participants. Results and discussion will then be discussed, followed by conclusion and future recommendation of the research. The block diagram of the structure of this paper is shown in Figure 1.

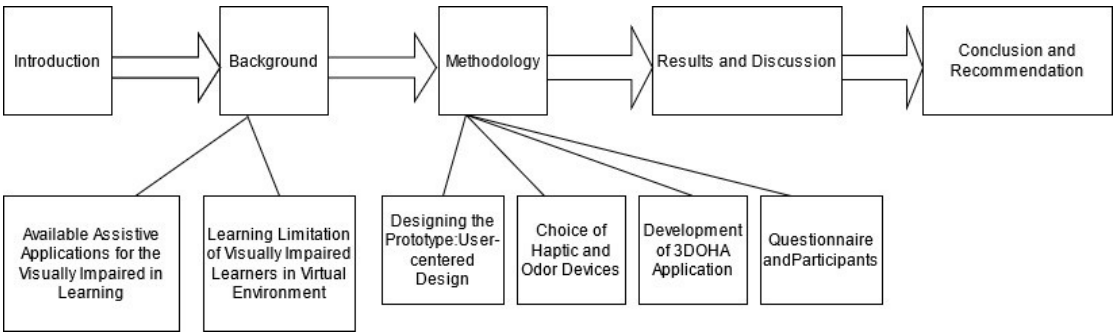

Figure 1: Block diagram of the structure of this paper

2. Background

2.1 Available Assistive Applications for the Visually Impaired in Learning

In accordance with the background study, assistive tools for visually impaired can be categorized into visual, tactile, and audio. Braille is one of the most popular tools and is widely used by the visually impaired. It is often used in conjunction with an audio feedback system. Visual assistive tools such as video magnifiers and screen magnifiers are also useful for individuals with insufficient vision. Acrobat short arm free standing video magnifier is one of the examples. This system is stable, easy to transport, and has connectivity to a portable monitor such as a computer monitor or television display (Nanopac, 2018). Tactile tools such as Braille books, keyboard, watches, and printers are also useful for visually impaired learners (American Council of the Blind, 2014). Furthermore, there are several computer and mobile applications with a screen reader to assist the visually

impaired in their learning environment. Screen readers automatically read text aloud and assist users in navigating the applications. JAWS is one of the examples of widely used popular screen readers (Jaws, 2020).

Non-technology assistive tools such as plastic, wooden blocks, paper, or cardboards are used for teaching shapes to visually impaired learners . These materials create 2D representations of shapes easily and effectively but can be time consuming. Materials such as sponge paper, embossing paper, thermoforming a shape into a plastic sheet, and gluing yarn onto a paper can be used to draw shapes with a felt tip pen. Teaching the shapes of different fruits, for example, can be done using tactile tools. However, the shapes of some fruits are similar, and thus, visually impaired users face difficulties while differentiating them.

Geoboards enables visually impaired learners to explore different types of geometric shapes in mathematical lessons (Gwyn, 2020). Geoboards are physical boards that use a number of nails or pins and rubber bands to outline shapes. They are interactive for both visually impaired learners and sighted classmates, encouraging learning together (Didax, 2020). Different visually impaired users use different kinds of tools depending on their level of sight. Some learners also opt for magnifying tools or software which can be used together with computer display screen. Some of the devices such as touch screens with voice over or Braille devices can also be used together with computer display.

Simple magnifying glass or powerful and flexing magnifier is popular among visually impaired users for reading books, magazines, and newspapers. Smaller devices are portable and suitable for reading small amount of text and larger devices are usually hands-free and are suitable for reading large amount of text or reading for long period of time. Video magnifier and scaled-up paper copies are also used by teachers in teaching visually impaired learners.

Assistive tools such as plastic, wooden shapes, papers, or cardboard cut and materials found in their environment are also widely used to teach the visually impaired. 3D printers are widely used to develop assistive tools for the visually impaired and they are great source for printing 3D shapes. Another way is to cut 2D and 3D shapes from paper box or cardboard as it is cheaper and easier to produce, albeit more time consuming to prepare.

2.2 Learning Limitation of Visually Impaired Learners in Virtual Environments

As stated in Article 24 of the United Nation's convention on the Rights of Persons with disabilities, it is vital to ensure inclusive education and lifelong learning for visually impaired learners (Braier, et al., 2014). Visual information is widely used in classrooms as it is accessible to most learners, but visually impaired learners require assistive tools to access the same information. In this environment, they are either supported by personal assistants or classmates in a traditional inclusive classroom setting. As a result, teachers or assistants need to spend more time explaining contents to allow their visually impaired peers or students to follow lessons.

Additionally, visually impaired or blind individuals are often sidelined by society in many ways. Learners with low vision or special needs require social and emotional support in order to ensure both academic and social success (Sacks, et al., 2011). According to them, visually impaired learners are more prone to being isolated and have less self-esteem and self-determination. In research conducted by Ishtiaq, et at. (2016), in an upper secondary school for the blind in Bahawalpur, 22 of 40 students were found to be depressed and 60% (22 out of 40) visually impaired experienced difficulties in their daily lives.

Nevertheless, visually impaired individuals are also frequently curious and eager to learn about the world around them, similar to any other sighted person. In this digital era, virtual learning or e-learning has been introduced and is dramatically advancing. E-learning approaches have benefited not only normal learners but also learners with different types of disabilities. However, there are a number of limitations for the visually impaired as these learning techniques only cater for sighted learners. Hence, it is important to redesign traditional approaches to cater for learners who are visually impaired by integrating information and communication technologies (Arrigo, 2005).

As the visually impaired can currently access the Internet, which was previously inaccessible, there is no doubt that e-learning can benefit visually impaired learners, but suitable methods and appropriate technologies should be chosen while designing e-learning platforms for them. Thus, an edutainment tool, such as YouTube, is not new and is one of the ways to encourage learning. However, because of the rich media involvement but no

engagement between the application and the user, the usage of virtual edutainment application among visually impaired users is very low (Mon, Yap and Ahmad, 2019b).

3. Methodology

3.1 Designing the Prototype: User-centered Design

UCD is chosen as the design methodology for this research to promote an understanding of the human subjects involved in the study and subsequently focus on their requirements as users (Norman and Draper, 1984). As an outcome of UCD, highly usable and accessible products can be produced for users. It imperative in this research to provide a user interface that closely relates to the users performing the task and ensure convenience in interaction, and thus, UCD is a good choice. The designing, prototyping, and evaluation phases were required to be repeated and results from each stage were used as the input or area for improvement for next stage as shown in Figure 2. The processes are incremental and thus better than the waterfall model (Sommerville, 2015).

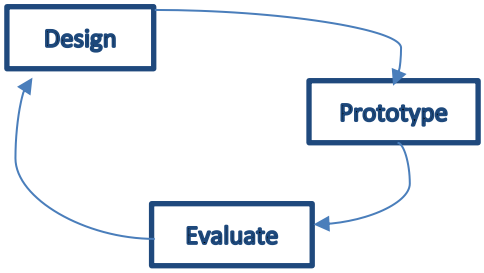

Figure 2: Iterative design process

The design of 3DOHA is considered carefully as the users of the system are visually impaired. Hence, the user interface of the application is not necessary to be attractive, but it should be easy to navigate for the users. The prototype that has been developed provides computer-based haptic-enabled 3D fruit objects with audio explanation and smell corresponding to the objects. These 3D objects can be touched using a haptic device. Haptic or tactile feedback technology creates a sense of touch by applying forces, vibrations, or motions to the users. The simulation is usually used in creating virtual objects in computer-based environment.

3.2 Choice of Haptic and Odor Devices

Haptic devices act as a medium between human and computer by generating force feedback in which motion is felt by users and perceived as haptic information (Liu, Li and Dai, 2017). Haptic devices are widely used in various fields such as, but not limited to, medicine, education, research, and training (Wong, et al., 2018). One of the well-known uses of haptic in the medical field is as a training tool for taking pulse and palpation (Kandee, Boonbrahm and Tantayotai, 2018). 3D systems, previously known as SensAble technologies, has developed a wide range of haptic devices, thereby becoming an option for researchers who do not want to develop their own haptic device (3DSystems, 2020a).

One of the popular haptic devices developed by 3DSystems is Touch, previously known as PHANToM OMNI (3DSystems, 2020b). This device generates force feedback that allows users to receive 3D information in a virtual environment. It is widely used in various research across many disciplines. A research that studied the association between color and tactile sensation used a haptic device from 3DSystems to provide virtual simulation to users (Slobodenyuk, et al., 2015). The study aimed to provide virtual haptic simulation through substances related to roughness and smoothness, hardness and softness, and other aspects. The Touch device by 3DSystems is shown in Figure 3.

Figure 3: Touch by 3DSystems (3DSystems, 2020a)

With Touch, users can feel the force feedback and 3D virtual objects by using a motor system provided by the Touch device. In addition, this device allows researchers to design and develop more advanced haptic programs together with the OpenHaptic toolkit in various fields. Touch X is another haptic device and an extension of Touch, developed by 3DSystems. This device is mostly used in advanced scientific or medical simulations as it provides more precise force feedback. A sample usage of Touch X in the medical field for surgical training is presented in Figure 4.

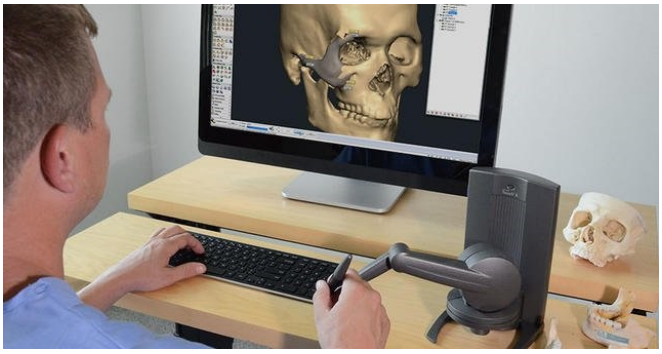

Figure 4: The use of Touch X in surgical training (3DSystems, 2020a)

Another premium haptic device, Sensable Phantom Premium provides the highest sense and force including motion and stiffness. These functionalities are suitable for high-end research as well as commercial applications. There are three ranges according to their motion and stiffness specifications: (i) Premium 1.0, (ii) Premium 1.5 and 1.5HF, and (ii) Premium 3.0 (3DSystems, 2020a). Figure 5 shows the design of the Premium haptic device used in rehabilitation, to design and develop a haptic Peg-Board exercise for the users (Xydas and Louca, 2007).

Figure 5: Phantom Premium Haptic Device (3DSystems, 2020a)

Another developer, Novint Technologies, designed and built various haptic and touch devices like 3DSystems and their main objective was for commercialization. The device shown in Figure 6 is the Novint Falcon which was the first 3D touch device developed by Novint Technologies for ordinary users (Amazon, 2007) .

Figure 6: Novint Falcon game controller (white) (Amazon, 2007)

Novinct Falcon provides the sense of touch in a virtual environment and is primarily used for video games as well as by professionals. The device enhances the quality of user experience for video game players. Furthermore, it is also used in professional applications or scientific research. An example of a scientific research application using Novint falcon is the eTouch Sciences Apps **"**A New Way to Interact with Math and Science Content" (Darrah, 2013).

Figure 7: The use of Novint Falcon in scientific application to study science, technology, engineering, and math (Darrah, 2013)

Another kind of haptic device is the glove type, which is typically used in virtual reality (VR) applications and research. This type of device is not widely and commercially used because of the high cost associated with it. Therefore, research institutes and universities are working to develop their own haptic glove devices (Nordrum, 2017a). The haptic glove device shown in Figure 8 was produced by HaptX Inc, formerly known as AxonVR, for VR applications (Nordrum, 2017b).

Figure 8: Haptic glove by HaptX Inc (Nordrum, 2017a)

The primary use of this device is for training in healthcare, defense sectors, design and manufacturing industries, and location-based entertainment such as VR theme parks. Its main target users are the corporate sectors and not individuals because of its high cost.

An odor-based device was also used in this research to develop an engaging virtual edutainment prototype for visually impaired learners. Odor generators are not widely used like air fresheners, which emit fragrance or scent. Odor generators are used in VR studies and generate a whole different level of odor experience with computer programming.

Krumins (2017) introduced a virtual nose, Vaqso, or a scent generator. This device is of the size of a large candy bar and can be inserted with up to three scent cartridges. It comes with an embedded small fan to enhance the smell and can be attached directly to the VR headset as shown in Figure 9.

Figure 9: Vaqso scent generator (Krumins, 2017)

Another odor device developed by Feelreal is shown in the figure 10. It allows users to create smells while wearing VR helmets (Malkovich, 2015). In this device, blowers, temperature generator, vibration motor, and microphone are inbuilt, and its essential power is supplied by a battery. The Bluetooth technology is used to connect the device to the helmet and is useful with any other applications that require scent generation.

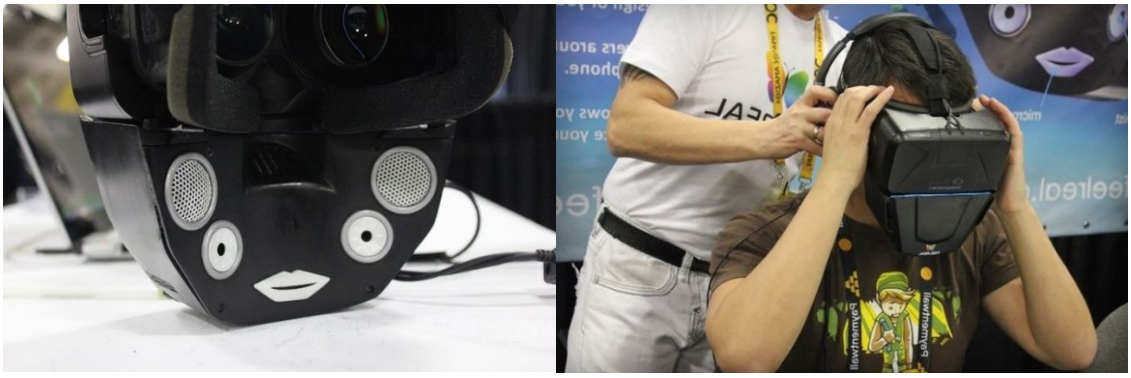

Figure 10: FeelReal odor generator fitted with VR helmet (Malkovich, 2015)

A desktop version of a scent generator was developed by ScentSciences and packed into a system that is about the size of a loaf of bread. The aroma generator is programmable to be used together with movies for an enhanced and enjoyable experience. It can hold up to 20 distinct smells and the cartridges can last up to 200 hours of use (McCollum, 2011). This device can also be used to generate smells; however, data have shown that wearing the device causes controversial feelings as it covers the entire face and air is supplied only through the vents. These effects engender fear and can cause asthma attacks. Nevertheless, novelty in the invention has attracted many fans. Figure 11 shows a model of this invention, Scentscape.

Figure 11: Scentscape odor generator (McCollum, 2011)

Another type of odor generator that can be used together with a mobile device is Cyrano developed by Vapor Communications. It is a battery-operated portable device and allows users to design their own personal scent for relaxation, empowerment, and personal wellness (Vapor Communications, 2016). The device is user-friendly and can be used together with different mobile applications. Figure 12 shows the invention alongside its accompanying application.

Figure 12: Cyrano and oNotes application (Vapor Communications, 2016)

Similar to Cyrano, a Scentee Machina was produced to be used together with a smartphone. This device can be switched on and off from any location and used with a timer. The type of smell and smell density are selectable, and an artificial intelligence algorithm has been incorporated to track usage history and favorite scents of its users. (Chalmers, 2014). Figure 13 shows a Scentee.

Figure 13: Scentee balloon attached to the earphone jack of a smartphone (Chalmers, 2014)

3.2.1 Development of 3DOHA Application

Touch by 3D system, a stylus-based haptic device, was used in this research. This device comes with an adapter, firewire cable, and is compatible with Windows or Mac operating systems. The device also provides true 3D

navigation and force feedback that can integrate the sense of touch to users. Users will be able to interact and feel the shapes of 3D data and touch is simulated when the cursor interacts with the 3D objects in a virtual environment.

3D objects were created using the Blender software in this project. Blender is a free and open-source software used to create 3D computer graphics. The 3D objects created in Blender are then imported into H3DAPI and modified using Python in order to be haptically enabled. The following describes the segment of code used to transfer 3D objects into haptically enabled 3D objects.

To transform 3D objects into haptically enabled 3D objects, there are a few steps to be followed, and they are enumerated below.

Step 1: Create 3D object with extension of stl, obj, 3ds, dae, abc, fbx, bvh, ply, svg, x3d file type. Next, use blender to import the file.
Step 2: Do rotation, enlargement, and other adjustments in Blender. Next, export the object with .x3d file type.
Step 3: Remove Transform tag code and camplight code from the x3d file.
Step 4: Add the code for Spring effect, box position, background color, etc.

The 3D objects will be paired with an audio when audio files are also integrated into the Python code. Add the code to link the 3D objects with the Python code.

The application allows visually impaired users to learn shapes in a virtual environment. Users will feel the virtual information from the haptically enabled 3D shapes by using the haptic device and receive the corresponding scent for 3D shapes via the olfactory device. An odor or olfactory generator is developed using a basic framework of the Vortex Activ smell-dispensing system but re-assembled using the Arduino Nano board. The odor generator consists of four fans that can be programmed to emit an aroma at specified times. The aroma is supplied from a small removable and replaceable circular cartridge. The appearance of Vortex Activ can be seen in Figure 14.

Figure 14: Vortex Activ device with refills aroma

The Arduino Nano board is programmed using Python and there are four 5v DC fans on the Vortex Activ. There are four control pins, one assigned to each fan. Upon request, the control pin will activate one of the four fans. The communication between the vortex device, 3D shapes, and haptic device were programmed using Python, and the application can be operated using Python 2.7.15. Users will be able to choose a character between “1” to “4” and the individual fan will be controlled by the chosen character.

The same steps will be used to activate Fan 2, Fan 3, and Fan 4, respectively. Arduino version 1.8.3 is installed in the workstation and Arduino executable files together with necessary library files will be bundled in the same folder. This application also generates the names of 3D shapes via audio speaker when users touch the corresponding 3D shapes. The control instructions are written in Python and will call an audio file when users touch the 3D object using the stylus haptic device. It also passes the character “1” to “4” to the pin to activate the respective fans in the olfactory device.

In this research, H3D API, an open-source, cross-platform, scene-graph API for graphic rendering was used together with OpenHaptic for haptic rendering (SenseGraphics, 2019). H3D API is written in C++ and can be used in multiple platforms such as Windows XP, Linux, and Mac OS X. By combining X3D, C++ and the scripting language Python, H3D provides a rapid development process. H3D API uses Python, X3D for high-level interface

and C++ for raw access to the API. The advantage of using C++ is to create highly efficient code when writing haptic rendering algorithms or by using OpenGL.

However, it has a relatively slow development time, and finding bugs can often be a time-consuming process. While designing using H3D API, it is important to take note of two components, fields and notes. SenseGraphic recommends utilizing encapsulation by using fields and scene-graph nodes for reusability and a good application design. Field is an event-handling mechanism and is arranged into a directed graph (called the field network), where events are passed from one field to another. It is a data container where data properties are stored and manipulated. Nodes are containers and managers of fields and filed networks. Figure 15 depicts overall process follow of the proposed prototype.

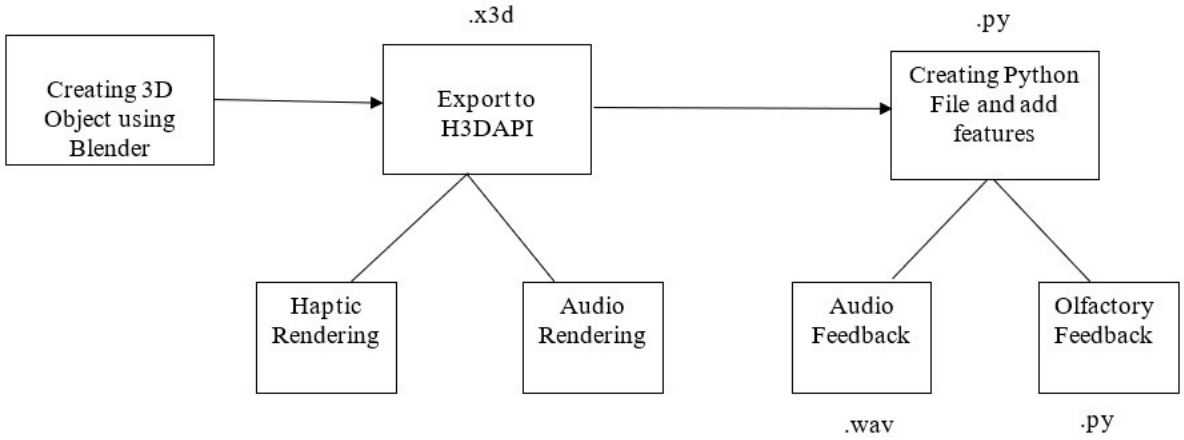

Figure 15: Overall Process Flow of Proposed Prototype.

Screenshots of the application's interface is as shown in the following Figures 16 (a), (b), (c), (d).

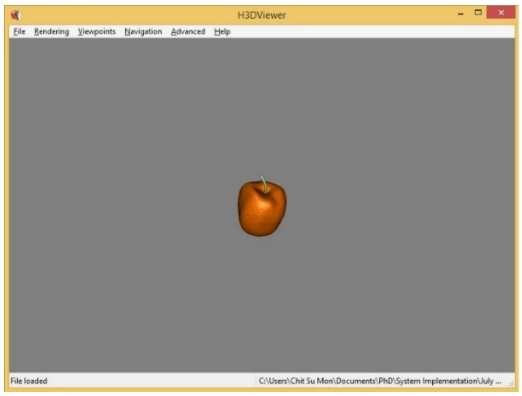

Figure 16 a. 3D object of an apple

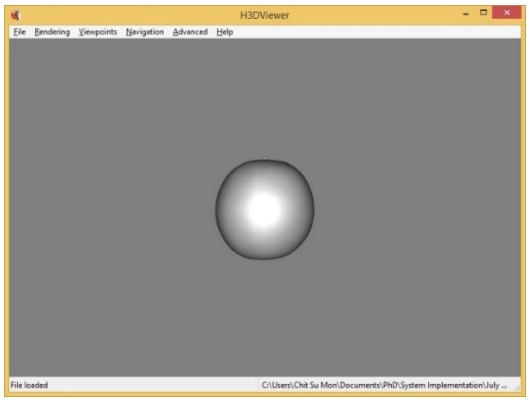

Figure 16 b. 3D object of an orange

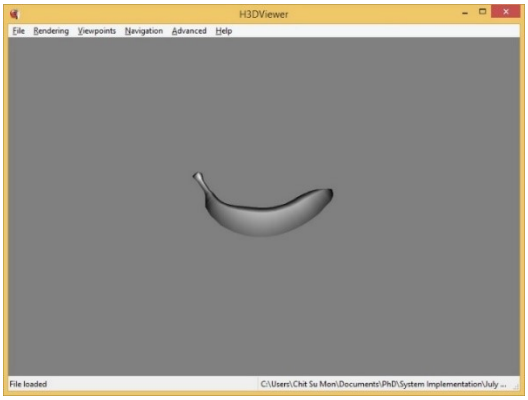

Figure 16 c. 3D object of a banana

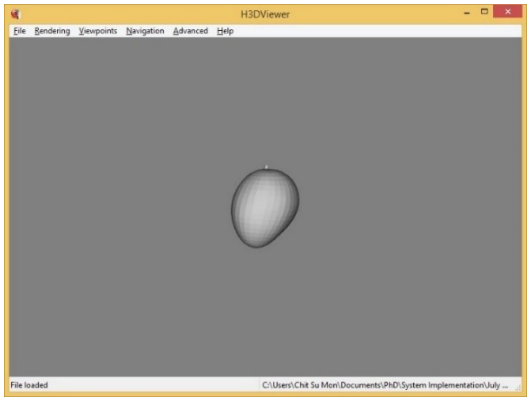

Figure 16 d. 3D object of a mango

Figure 17 depicts the overview of the application's framework in which haptic, audio, and olfactory can be used together in a virtual edutainment environment for visually impaired users. With this system, users can access 3D objects via a PC connected to haptic and olfactory sensors and headphones of choice. The haptic device will be used to access the 3D objects and the corresponding scent will be dispensed from the olfactory device. Corresponding sounds will also be generated from the PC whereby users can listen to the sounds either through a speaker or preferred microphone. This proposed framework is expected to enhance the visually impaired users' learning experience in the virtual learning environment by providing a fun and engaging experience, thereby boosting their interest in using the application on a frequent basis.

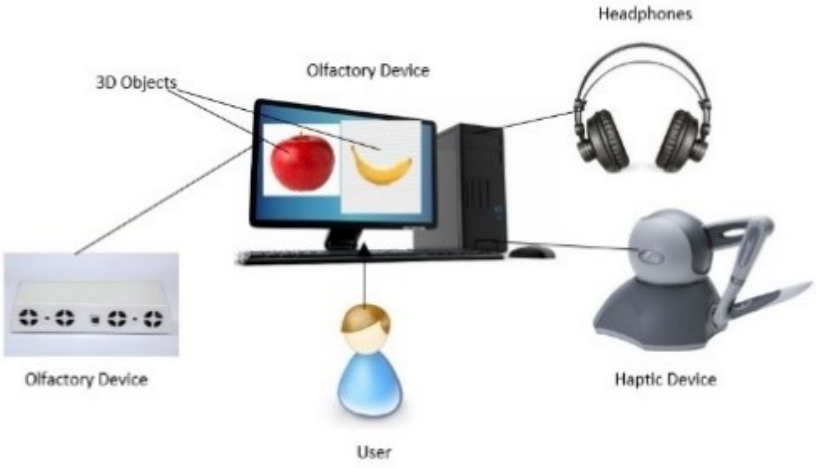

Figure 17: Proposed framework for virtual edutainment environment using haptic, audio, and olfactory Sensors

3.3 Questionnaire and Participants

The evaluation of the prototype was conducted at the Malaysian Association for the Blind (MAB) at Off Jalan Tun Sambanthan 4, Kuala Lumpur, starting with a pilot testing. In this testing, 10 participants were involved to express the usability of the 3DOHA application as well as how well visually impaired users can correctly identify 3D objects using all haptic, olfactory, and auditory senses in a virtual learning environment. The background of the research and the process were explained to the visually impaired participants prior to the actual testing. Once they were ready to begin the experiment, they were given a haptic device to touch the shapes of the different types of fruits. The corresponding smells were dispensed while the users were touching the shapes. The users were then asked questions from the questionnaire, and the tester filled up the answers according to the users' responses. The questionnaire adopted in this pilot testing is based on USE (Lund, 2001) corresponding to the objective to evaluate the prototype using usefulness, satisfaction, ease of use, and ease of learning. The questionnaire was designed with a 7-point Likert rating scale and participants were asked to rate their agreement to the statements, ranging from "1" as *strongly disagree* to "7" as *strongly agree*. This type of questionnaire was used as, according to (Lund, 2001), users primarily evaluate products according to three constructs, usefulness, satisfaction, and the ease of use, although there is evidence of other common dimensions. However, in this research, USE most effectively served the interfaces involved.

4. Results and discussion

Among the 10 participants, five were visually impaired teachers above 25 years old and another five were blindfolded students between the age of 19 and 25 years old. There were four female and six male participants. At this stage of prototype development, it is important to collect focused feedback on the functionality; thus adult users with academic background were approached. According to Lazar, Feng and Hochheiser (2017), it is a common approach to use blindfold sighted users as proxy users when target participants are not freely or readily available. It is not always to use proxy users for this reason; however, it is acceptable to use them when specific application or tool is being developed and is undergoing multiple iterations before a proof-of-concept is

completed. As this research uses both proxy users and actual visually impaired user, it is reasonable to accept the findings obtained from this experiment.

The vision level of these participants is shown in Figure 18.

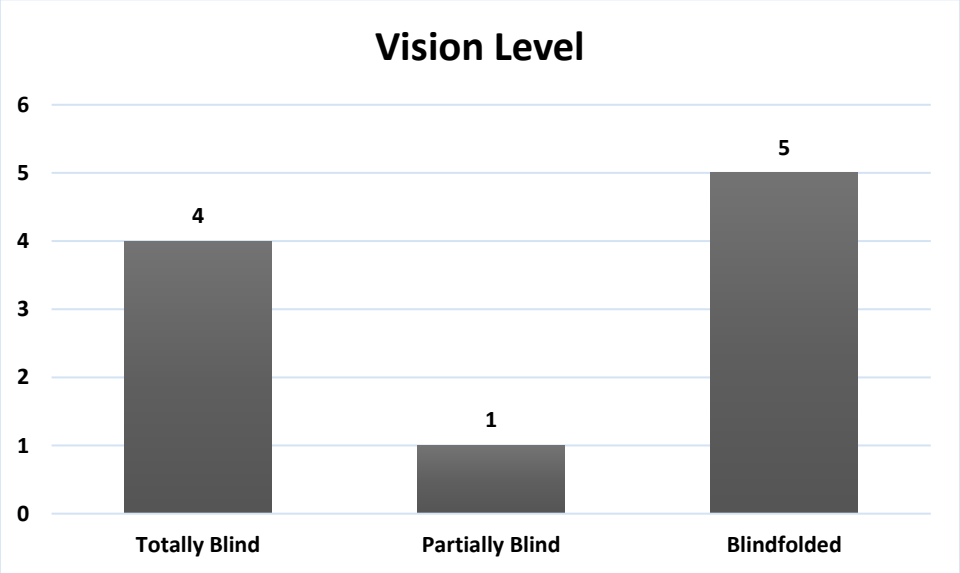

Figure 18: Vision level of participants

Majority of the participants use computer very frequently for various reasons such as surfing the Internet, requirement of their job, for learning new things, as well as for leisure. However, they have no prior knowledge on the haptic device and they have not used similar devices before. Figure 19 depicts the purpose of computer usage by participants. All the participants use computer for learning as well as Internet activities.

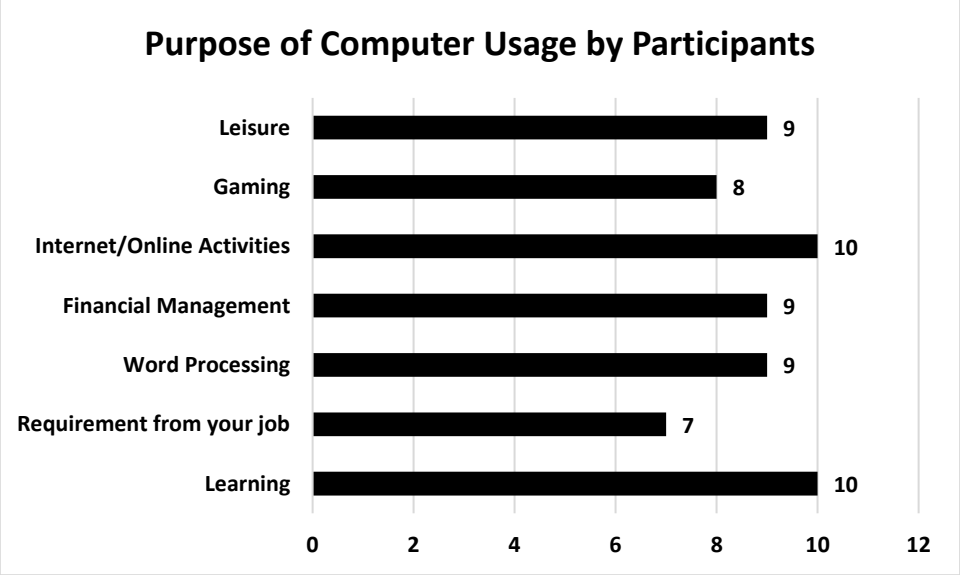

Figure 19: Purpose of computer usage by participants

The breakdown of results from all the participants in the 7-point Likert scale questionnaire is shown in Table 1.

Table 1: Breakdown of results from all participants

	Gender	Age (in years)	Vision Level	Blindness Since	Occupation	Usage of Computer	Usefulness	Ease of Use	Ease of Learning	Satisfaction
Participant 1	Female	>25	Totally blind	Progressive loss	Teacher	Very frequently	6	5.67	6.17	6.67
Participant 2	Female	>25	Totally blind	Birth	Teacher	Very frequently	6.29	5.44	6.5	6
Participant 3	Male	>25	Totally blind	Birth	Teacher	Frequently	5.86	5.11	5.67	6.17
Participant 4	Male	>25	Totally blind	Progressive loss	Teacher	Very frequently	5.57	5.33	4.83	6
Participant 5	Male	>25	Partially blind	Sudden loss	Teacher	Very frequently	2.57	2.89	5.33	4.33
Participant 6	Male	19-25	Blindfolded	Blindfolded	Student	Very frequently	6.86	5.89	6.83	7
Participant 7	Female	19-25	Blindfolded	Blindfolded	Student	Very frequently	6.86	6.56	7	7
Participant 8	Male	19-25	Blindfolded	Blindfolded	Student	Very frequently	6.71	7	7	7
Participant 9	Female	19-25	Blindfolded	Blindfolded	Student	Very frequently	6.14	6.44	6.67	6.17
Participant 10	Male	19-25	Blindfolded	Blindfolded	Student	Very frequently	6.29	5.67	6.17	6.17

Majority of the participants rated high for usefulness and most agreed that the proposed application will be more effective in the learning experience and encouraging in a virtual environment. In addition, the participants agreed that the 3DOHA application is useful in learning and would use the application frequently in learning. They also find this application easy and simple to use as well as easy in learning to use the application. Among all the participants, 80% mentioned that the application is fun to use and 50% *very strongly agree* that they need to have the application. Furthermore, 90% of them rated *strongly agree* and *very strongly agree* to recommend the application to their fellow friends.

The average rating and standard deviation according to each of the three constructs are encapsulated in Table 2. The rating of each construct was above average, which indicates that the application is satisfactory for users to use, easy to use, easy to learn, and useful for them in their learning activities.

Table 2: Average, standard deviation, maximum, and minimum of the rating

	Usefulness	Ease of Use	Ease of Learning	Satisfaction
Average	5.92	5.60	6.22	6.25
Standard Deviation	1.25	1.12	0.74	0.80
Maximum	6.86	7	7	7
Minimum	2.57	2.89	4.83	4.33

5. Conclusion and future recommendation

This research designed and developed a 3D-based haptic-, audio-, and olfactory-enabled edutainment application for visually impaired learners. Haptic and audio have been used together in many assisted applications, with the proven ability to help users with visual impairments. Additionally, there are several haptic-related applications available, but not all are designed for the visually impaired. UCD approach was also used to design the current prototype. Choice of haptic device was made carefully and a stylus-based haptic device from Geomagic (3Dsystems) was used in this research. Vortex Activ smell-dispensing system was used as the basic apparatus. The odor generator has four fans that can be programmed to emit an aroma at specified times. The types of aromas come in the form of a small circular cartridge, which is removable and replaceable. 3D shapes were generated using the Blender software and the control instructions were written in Python. It can call respective audio files as well as dispense corresponding smells when users touch the 3D object. To evaluate the prototype, usability testing was conducted to obtain user's feedback, and out of the maximum possible rating of 7, the participants rated 5.92 for usefulness, 5.6 for ease of use, 6.22 for ease of learning, and 6.25 for satisfaction. Majority of the participants agreed that the application is useful in learning and encourages them to carry out learning activities in a virtual environment. Furthermore, they also agreed that the application is simple and easy to use and requires minimum steps to accomplish the tasks. However, some of them needed a

technical person to assist them in using the application. This could be because of them not having been exposed to a haptic device before. Nevertheless, they learned to use the application very quickly and remembered how to use the application easily in subsequent attempts. The majority of participants agreed that the application is fun to use, and they would recommend the current application to their fellow friends. There is more evidence that e-learning can benefit visually impaired learners, but suitable methods and appropriate technologies should be chosen when designing e-learning platforms for them. Using this prototype, visually impaired learners can embark on a journey of continuous learning with the aid of e-learning.

This research is based on Malaysian context as the research was conducted at the MAB. Thus, infrastructure related support can be different from other developing and undeveloped countries. The challenge was in identifying visually impaired subjects between the age of 9 and 14 years. Owing to the pandemic situation in Malaysia, the schools were not opened, and thus, we had some difficulties in identifying the subjects that forced us to have limited samples. Once this pandemic is over, we will look for a larger sample of subjects in the said age range. Additionally, a comparative study of visually impaired adults can be carried out between the subjects in Malaysia and other countries to determine the effectiveness of the proposed system. Besides, this research can be enhanced for those who are deaf, blind, and mute learners to achieve the desired learning outcomes in virtual learning environment.

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Technology Integration in Higher Education: The use of Website Design Pedagogy to Promote Quality Teaching and Learning

Joyce West and Makwalete Johanna Malatji
University of Pretoria, Faculty of Education, Department of Early Childhood Education, South Africa
joyce.west@up.ac.za
makwalete.malatji@up.ac.za

Abstract: The integration of technology within higher education, specifically teacher education, has become vital in preparing pre-service teacher for the 21st-century classroom. Literature shows that the integration of technology allows students to engage deeply with content and promote authentic learning. Over two years, pre-service teachers who enrolled for a language education module at a university in South Africa were tasked with designing their own websites using Google Sites – an online, free, collaborative, web-based application that forms part of Google's G Suite. As part of the website design assignment, they had to include a blog, informative text and a YouTube video explaining a language-teaching-related topic. The study was conducted from an interpretivist paradigm and an embedded mixed-methods research design. The technological pedagogical content knowledge model served as the theoretical framework. Data collected from 214 pre-service teachers revealed that the use of website design pedagogy promoted the integration of different types of knowledge domains, authentic learning and proximal development. The pre-service teachers furthermore reported that the use of website design pedagogy better prepared them for the 21st-century classroom. Challenges that the students experienced included inadequate access to the internet and problems with recording and uploading videos. This study advocates for authentic learning and scaffolding and therefore recommends that higher education institutions integrate technology holistically by adhering to the principles of the technological pedagogical content knowledge model.

Keywords: authentic learning; Google Sites; higher education; pre-service teachers; teaching and learning; technological pedagogical content knowledge (TPACK) model; technology integration; zone of proximal development (ZPD)

1. Introduction

The 21st century is known for rapid technological advances and is associated with the implication of the so-called fourth industrial revolution. The fourth industrial revolution has and is "revolutionising how we conceptualise and act towards teaching and learning" (Skhephe, Caga and Boadzo, 2020, p.43). Blinder (2006) anticipated the implications of the fourth industrial revolution and recommended upskilling the use of technology and equipping teachers to navigate all information and communications technology, which includes computers, assistive devices, applications and software. Pre-service teachers therefore need to be encouraged to acquire 21st-century knowledge and skills, such as technology literacy and the integration of technology within teaching and learning (Ejikeme and Okpala, 2017).

Various researchers (e.g., Calvo and Villarreal, 2018; Du Toit and Verhoef, 2018; Green, Jones and Burke, 2017) argue that pre-service teachers' technology literacy skills and the integration of technology during teaching and learning within higher education have been insufficiently addressed and researched. Thus, the rationale behind this study was to determine how the use of Google Sites, an online, web-based application of Google's G Suite, can be used within higher education to promote quality teaching and learning. The interactive online platform was selected for this study because of its user-friendly nature and because it allows pre-service teachers to work collaboratively on the design of a website. The main research question was formulated as follows: How can the use of website design as pedagogy promote quality teaching and learning in higher education? According to Nwana (2008), for the effective incorporation of technology in higher education, research should be done to determine the challenges that affect pre-service teachers' teaching and learning. The study therefore also investigated the pre-service teachers' experiences of and challenges in designing websites using Google Sites as platform.

2. Technology literacy

Technology literacy refers to the ability to use technological skills and tools during learning (Ejikeme and Okpala, 2017). The United States Department of Education (1996, p.7) defines technology literacy as "computer skills and the ability to use computers and other technology to improve learning, productivity and performance". Thammasaeng, Pupat and Phetchaboon (2016) define a technologically literate person as someone who has the

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ability to use computers, communication tools and social networks appropriately and can define, access, manage, evaluate, integrate, create and present information using technological applications. However, the term "technology literacy" is not limited to devices, such as computers, but rather "the application of scientific knowledge for practical purposes" (Ejikeme and Okpala, 2017, p.1164). Technology literacy is also associated with digital literacy, online learning and e-learning (Hassan and Mansor, 2009). There is a global shift towards online and e-learning, which can be observed through the improvement or replacement of traditional learning modes, such as classroom experiences, textbook study, CD-ROM and traditional computer-based training (Calvo and Villarreal, 2018; Skhephe, Caga and Boadzo, 2020). Traditional classroom experiences and direct instruction are continuously being replaced by online education. The integration of technology within teaching and learning, also known as "blended and hybrid learning", also emphasises the shift towards online learning also known as e-learning.

3. Integration of technology into teaching and learning

Depending on how technology was used, existing research describes the overwhelmingly positive results and benefits of technology integration into higher education (Du Toit and Verhoef, 2018; Waghid and Waghid, 2016). According to Okpala and Ejikeme (2017), pre-service teachers' potential is unlocked by the integration of technology within teaching and learning. The benefits of technology integration into education include enhancing and promoting quality teaching and learning (Waghid and Waghid, 2016), the stimulation of social interaction and critical thinking, the cultivation of excitement, and the enhancement of collaboration among students (Wankle, 2011). Technology integration has also been associated with students gaining ownership, being creative and becoming problem solvers in the fourth industrial revolution (Gardner, 2014; Skhephe, Caga and Boadzo, 2020; Wankle, 2011). Also, technology integration can contribute to developing skills that would allow learners to access the global economy and improve their lives by unlocking the ever-changing world and to becoming game changers in society (Kiilu and Muema, 2012; Skhephe, Caga and Boadzo, 2020). Moreover, the Horizon Report of the New Media Consortium (cited in Adams Becker et al., 2017) suggests that the integration of technology helps to improve the internationalisation of higher education.

Although various benefits have been reported, various challenges and concerns have also been raised with regard to the integration of technology during teaching and learning within higher education. Challenges have been raised regarding cost-effectiveness, access and equity (Wainer et al., 2008), which also address the achievement gap. The achievement gap refers to a discrepancy in the "academic performance between student groups, defined by socioeconomic status, race, ethnicity, or gender" (Adams Becker et al., 2017). Other challenges that have been reported include increased plagiarism, the loss of concentration (attention, mindfulness and focus), the uncertainty regarding the role of the lecturer and a lack of resources (necessary devices, applications and internet availability) (Adams Becker et al., 2017).

The training of lecturers with regard to the integration of technology in teacher education programmes and curricula is another matter of concern (Georgina and Olson, 2008; Kiilu and Muema, 2012; Skhephe, Caga and Boadzo, 2020). Concerns about the training of lecturers stem from unrealistic expectations and mistaken assumptions about learning enhancement through technology integration (Du Toit and Verhoef, 2018). A critical document review of articles on technology-integrated learning from 2005 to 2010 by Kirkwood and Price (2014, p.26) concludes that there are expectations that "introducing technology would, by itself, bring about changes in teaching/learning practices". Du Toit and Verhoef (2018), Flavin (2017) and Kirkwood and Price (2014) all argue that this is a mistaken assumption. Adams Becker et al. (2017) also raise concerns about technology literacy being viewed by some lecturers as an isolated technological skill.

In this study, careful consideration took place regarding both the benefits and the reported challenges concerning technology integration. Du Toit and Verhoef (2018) encourage higher education role players to discover a more holistic and embodied understanding of technology in higher education by critically engaging with questions about the use and integration of technology in higher education. A holistic view and embodied understanding of technology in higher education refer to the acknowledgment of pre-service teachers as embodied beings (Du Toit and Verhoef, 2018). Clark and Chalmers (1998) agree and explains that if pre-service teachers are viewed as embodied beings then one will not view technology as only tools to be integrated, but that the technological tools are implemented and integrated in a holistic way that aligns with who we are. To gain a more holistic view and embodied understanding of technology in higher education as part of teacher

preparation, this study viewed technology integration through the lens of the technological pedagogical content knowledge (TPACK) model as a theoretical framework.

4. Theoretical framework of the study: TPACK

The TPACK model comprises of distinctive kinds of knowledge domains in which instructors have to become proficient to effectively integrate innovative technology in teaching and learning processes. (Koehler et al., 2014). Koehler et al. (2014) shows that the TPACK theory is used by researchers and teachers to describe the competences student and in-service teachers should develop in order to integrate technology within education and to understand and advance teachers' integration of technology in teaching and learning. The TPACK model is based on the notion of pedagogical content knowledge (PCK), which refers to the ability to combine content knowledge in a specific domain or school subject with pedagogical approaches to foster student learning (Saubern et al., 2019).

The TPACK framework has been used in various studies to describe teachers' knowledge (Chai, Koh and Tsai, 2010) and to understand the interplay of three unique domains of knowledge necessary for teaching, namely content, pedagogy and technology (Moe and Polin, 2016). In higher education, it is important to consider the different types of knowledge that pre-service teachers need to acquire for them to be prepared for the 21st-century classroom. The integration of technology into teacher education exposes pre-service teachers to new technological skills and assists them in becoming technologically literate. Therefore, a theoretical framework is needed to acknowledge the interaction that takes place between pre-service teachers' technological knowledge and content knowledge, as well as how they are going to apply their knowledge in their classrooms (i.e., pedagogical knowledge) (Koehler and Mishra, 2009). The TPACK model that was used in this study acknowledges a variety of knowledge and skills that a teacher needs. Moreover, the theory was found to be successful in teaching pre-service teachers how to integrate technology in their classrooms (Harvey and Caro, 2017).

Shulman (1987) pointed out that the TPACK framework builds on explanations of pedagogical content knowledge (PCK) to describe how teachers' understanding of educational technologies and of PCK interact with each other to produce teachers that can teach effectively with technology. Thus, pre-service teachers in this paper were equipped with TPACK in order to equip them with the necessary knowledge and skills to use technology within the literacy classroom. The TPACK model has been developed over time, with complete explanations found in the work of Koehler and Mishra (2009) and Mishra and Koehler (2006). The TPACK comprises of three fundamental components: technological Knowledge (TK), content knowledge (CK) and pedagogical knowledge (PK). Another important aspect of the TPACK model is the interactions among the different types of knowledge, for example technological content knowledge (TCK), technological pedagogical knowledge (TPK) and pedagogical content knowledge (PCK). The essence of the TPACK model is, therefore, the interaction of diverse types of knowledge required by a teacher for the effective integration of technology during teaching and learning. The TPACK model and the way the different types of knowledge are integrated are depicted in Figure 1.

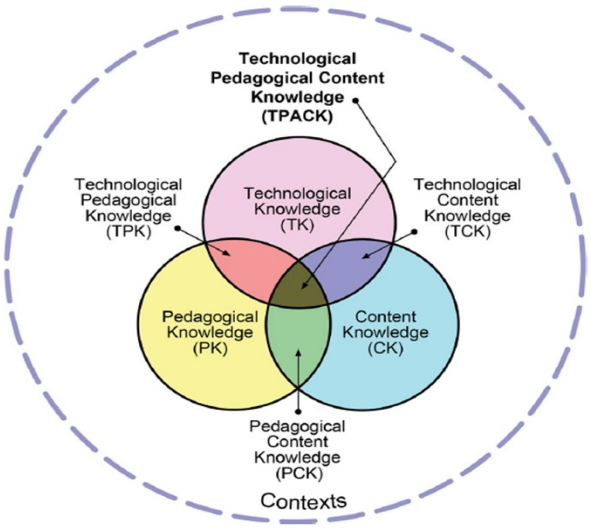

Figure 1: TPACK framework (Koehler and Mishra, 2009; Mishra and Koehler, 2006)

5. Integrating the TPACK model with Google Sites

Developing technology literacy and confidence in integrating technology is a key factor in achieving TPACK integration (Tai, 2015). Flavin (2017) therefore explains that teacher education and training programmes should deliberately infuse the use of technology throughout the programme to make a significant impact on pre-service teachers' learning. Tai (2015) articulates that technology-rich teaching experiences assist teachers in developing their TPACK. Allen and Seaman (2010) point out that pre-service teachers at higher education institutions should take at least one online course or be exposed to technology integration during teaching and learning to help prepare them for the 21st-century classroom.For pre-service teachers to effectively integrate technology during teaching and learning, Lambert and Gong (2010) suggest that they receive training on how to connect different knowledge domains (i.e., TCK, TPK and PCK) and skills when teaching. Pre-service teachers in this study were therefore trained on how to design a website which involves TCK, TPK and PCK.

Pre-service teachers' CK was developed by providing them with instruction on language education in the Foundation Phase (children of 5 to 9 years of age). The language education module consisted of 10 learning units that addressed various topics related to language teaching, such as the science of reading, reading theories and multilingualism within the South African classroom. The pre-service teachers' PK was developed by providing them with exposure to practical and pedagogical aspects of teaching a language. PK in this study therefore refers to different teaching strategies, approaches, methods, techniques and resources. The CK and PK were presented in an integrated manner (i.e., PCK) for the pre-service teachers to understand how theory and practice inform each other. g (2015) explains that PCK reflects the connections between subject matter and instructional strategies. Benavot (2015) and Lye (2013) emphasise that teaching and learning are endorsed when pedagogy is adapted to meet the content and skills of varying subject areas, such as languages.

Furthermore, the pre-service teachers' TK was developed by providing them with training on how to use Google Sites to create their own language education websites. Google Sites is an interactive and collaborative website design application that has been optimised for businesses, academic and social networking purposes. Online platforms, such as Google Sites, allow pre-service teachers to collaborate online and provide them with the opportunity to develop their technology literacy by engaging deeply with the content (Ejikeme and Okpala, 2017).

As part of the summative assessment of the module, the pre-service teachers had to create a website using Google Sites that contained information on language education and language development theories, as well as a blog and a YouTube video in which they discussed linguistic diversity and multilingual classroom dynamics. The integration of TK and CK (TCK), as well as TK and PK (TPK), is therefore also evident in this study. TCK in this study therefore refers to how the pre-service teachers used their TK to present their CK (cf. Benavot, 2015), and TPK refers to how technological tools can promote teaching and learning and how the teaching process itself may change an outcome by using specific tools (Boschman, McKenney and Voogt, 2015). Since the TPACK model does not privilege one knowledge area over the other, but rather advocates for the mediation of different knowledge domains (Moe and Polin, 2016), one can argue that TPACK contributes to authentic learning.

6. Authentic learning in the study

Authentic learning refers to a wide variety of educational and instructional techniques that are focused on connecting what students are taught in school to real-world issues, problems and applications (Dolapcioglu and Doğanay, 2020). Lombardi (2007) states that authentic learning requires learners to make connections to existing knowledge and deeply explore new knowledge in context. Creating authentic learning activities or experiences for pre-service teachers requires the integration of technology to achieve authentic teaching and learning (Archambault, Debruler and Freidhoff, 2014; Bjekic, Krneta and Milosevic, 2010; Latham and Carr, 2012). Pre-service teachers gain authentic learning through complex tasks that they have investigated over a sustained period, requiring a significant investment of time and intellectual resources (Johnson, 2012). Additionally, for authentic learning to occur, "learners must be engaged in an inventive and realistic task that provides opportunities for complex collaborative activities" (Herrington and Oliver, 2010: 1). Authentic learning therefore requires learning opportunities that pre-service teachers can benefit from and that will be worthwhile once they heave higher education (Herrington and Oliver, 2010). Johnson (2012) argues that there is no singular criterion for authentic learning; instead, it is a collection of characteristics. Furthermore, Herrington (2006), Herrington and Oliver (2010) as well as Johnson (2012) believes that authentic learning can be promoted through

the use of technology integration. During this study, pre-service teachers created their own websites with the aim of experiencing authentic learning.

6.1 Zone of proximal development in the study

Shulman (1986) and Mishra and Koehler (2006), authors of the TPACK model, emphasise the importance of educational learning theories such as constructivism and the social learning theory as integral to the TPACK construct. One such theory is Vygotsky's (1978) theory of the zone of proximal development (ZPD). In short, the ZPD refers to the difference between what a learner can do without support and what he or she can achieve with guidance and encouragement from a skilled partner (Fani and Ghaemi, 2011). The ZPD furthermore highlights the development of knowledge and skills through scaffolding, modelling, coaching and authentic learning. The ZPD is therefore anchored in the notion that the development of knowledge and skills is supported by scaffolding from more knowledgeable people, peers or learning tools. Teacher education has also shown that "successful implementation of the TPACK is achieved through scaffolding its use in practice, through learning by designing" (Moe and Polin, 2016, p.78). Various researchers, for example Vygotsky (1978) and Iszatt-White, Kempster, and Carroll (2017), support the view that knowledge is co-constructed and that individuals learn from others during experiences. Johnson (2012) argues that pre-service teachers should help others connect new experiences to existing knowledge in order to understand how technology can support teaching and learning. Informed by the ZPD, the pre-service teachers had to work in groups to support one another and to perform tasks beyond their current level of capabilities.

7. Research methodology and design

This study investigated the use of website design pedagogy as a way to promote quality teaching and learning in higher education through an interpretivist lens by adopting an embedded mixed-method research design. The embedded mixed-method design provided two sets of data, where one set played a supportive, secondary role (Behmanesh et al., 2020). The embedded mixed-method design served as a means of unifying a primary qualitative dataset with a secondary quantitative dataset. The qualitative and quantitative data were collected simultaneously using an online questionnaire. Over two years (2019 and 2020), 586 second-year pre-service teachers who had been enrolled for a language education module as part of the curriculum of their Bachelor of Education (BEd) degree at a university in South Africa were asked to voluntarily complete an online questionnaire. A total of 214 pre-service teachers voluntarily participated. The questionnaire was informed by the TPACK model and consisted of 20 reflective questions. In the questionnaire, 13 questions were open-ended, and the remaining seven were closed-ended. For this paper, the data was only analysed qualitatively. Data analysis was conducted using Atlas.ti, a qualitative software program. The data were thematically analysed by identifying codes, categories and, lastly, themes.

8. Findings and discussion

The findings of this study are based on 214 voluntary, anonymous responses by second-year pre-service teachers to an online open-ended questionnaire. In 2019, 142 (57% response rate) pre-service teachers responded to the questionnaire. In 2020, 72 (32% response rate) pre-service teachers responded. Within the data, we identified four themes. Having conducted extensive data analysis with Atlas.ti, it was evident that the four themes were connected by describing how the use of Google Sites could promote quality teaching and learning in higher education.

The first theme explains how the design of websites using the Google Sites application as part of Google's G Suite provides the pre-service teachers with the opportunity to integrate different types of knowledge (CK, PK and TK) as emphasised by the TPACK model. The second theme addresses the importance of integrating different types of knowledge to better prepare pre-service teachers for the 21st-century classroom. The third theme describes how the use of Google Sites promotes quality teaching and learning, owing to its adherence to the principles of authentic learning. The fourth theme focuses on how the use of Google Sites helps pre-service teachers to reach their ZPD as theorised by Vygotsky (1978). In the following sections, the four themes are discussed. Next to the quotations from the pre-service teachers' responses, the number of the document and the quotation from the Atlas.ti report are placed in brackets.

8.1 The design of websites to integrate and develop different types of knowledge

The first theme of this study addresses how the design of language education websites using Google Sites resulted in the integration and development of different types of knowledge. The findings indicate that the pre-

service teachers developed technological, pedagogical and content knowledge during the assignment. The integration of different types of knowledge aligns with the TPACK model, since it acknowledges a variety of knowledge and skills that a teacher needs for teaching learners in the 21st century (Harvey and Caro, 2017). Moreover, Harvey and Caro (2017) state that the TPACK model has also been found successful in teaching pre-service teachers how to integrate technology in classrooms.

8.1.1. Technological knowledge

After completing the assignment, the pre-service teachers were asked to reflect on their experience and the challenges they had encountered. From the data, it was evident that the pre-service teachers had gained TK but had also experienced various technological challenges. TK refers to the specific technology tools (computer, phones, games, the internet and Google applications) that can be used to promote teaching and learning and how the teaching process itself may change the outcome of using specific tools (Boschman, McKenney and Voogt, 2015).

When the pre-service teachers were asked whether the assignment had challenged their TK, 85.7% of them responded with a "yes". From 160 responses, it was evident that they had experienced various technological challenges that related to the design of websites, the use of the Google Sites application and the recording, editing and uploading of videos onto YouTube and Google Sites. Some of the pre-service teachers also reported having difficulties with the availability of devices and internet connectivity.

Many of the students explained that they had struggled with "*creating the website*" (e.g., 6:37, 8:11 and 8:23), "*setting up the website*" (8:10) and "*the design of the website*" (8:45). One pre-service teacher said that it was difficult "*working with a program that I haven't worked with before*" (8:8). Other pre-service teachers explained that they had "*struggled the most with learning how everything works to create a website"* (8:24), "*learning to understand the tool*" (6:48) and "*mostly the technical things like typing and putting everything together*" (12:34). Other pre-service teachers experienced problems with "*making the website look presentable*" (8:3), the "*formatting of the website*" (8:25) and "*creating a website page that was aesthetically pleasing*" (8:27). One pre-service teacher explained that "*finding the right backgrounds and themes to make the site perfect*" (8:55) was a challenge, while another pre-service teacher wrote, "*CHANGING THE FONT!! Everything I learnt quite easily, but the font got the better of me! (haha)*" (8:36).

Some of the pre-service teachers struggled with the Google Sites application because "*the site was very limiting. You could not choose multiple colours or fonts*" (12:1) and because there was a "*lack of design strategies and options in Google Sites*" (12:27). One pre-service teacher explained, "*[You] cannot customize your own page, changing one page changes the entire website*" (12:161). Moreover, some pre-service teachers did not know "*how to publish the site*" (8:7) and one pre-service teacher said that they had struggled with "*making our website public*" (8:9). Other challenges related to the Google Sites application included "*inserting links and adding sliding panes*" (8:20), "*linking the different pages together*" (8:32), "*adding tabs to my specific page so that I did not have all my information on 1 page*" (8:44), "*uploading the cover photo*" (6:31) and "*inserting pictures and videos*" (8:21). One pre-service teacher elaborated that "*I find that I struggled to personalize the page* (12:14) and another said that "*the video made it difficult because we had to embed it on the webpage*" (12:55).

Other technological challenges related to the recording, editing and uploading of a video onto YouTube and Google Sites, as one pre-service teacher wrote, "*when it came to video oh my word*". The pre-service teachers explained that they had "*struggled a long time to try and find the perfect app for the video*" (6:7) and that it was challenging "*to upload the YouTube video*" (e.g., 8:4, 8:14, 8:16 and 8:30) and "*editing a video*" (8:13). One pre-service teacher said that "*editing my visuals for my YouTube video*" (8:38) was the greatest challenge, whereas another pre-service teacher explained that "*finding an appropriate app for video making and editing the video*" (8:50) was the biggest challenge.

Although all pre-service teachers had free access to computers and the internet (e.g., Wi-Fi) in 2019, some of the pre-service teachers still experienced technological challenges with regard to internet connectivity. One pre-service teacher explained that "*the website assignment needed data and some of us don't live on campus where there's wifi*" (18:44). In 2020, due to Covid-19-related circumstances, pre-service teachers did not have access to the computer laboratories or the campus internet of the university, which led to 10 out of the 241 pre-service teachers reporting experiencing challenges with internet connectivity and the availability of computers. One pre-service teacher said that "*connecting to the internet*" (8:39) or "*connectivity issues*" (8:41) made it difficult

to design their websites. Another one said, "*I did not enjoy working on Google Sites … [because it] required [a] very strong internet connection*" (12:149).

From these quotations, it is evident that some of the technological challenges the pre-service teachers experienced related to their own TK and literacy skills, whereas some of the challenges were due to the Google Site application itself or the availability of devices and internet connectivity. From the data, it was also evident that although the pre-service teachers had experienced various challenges, their TK had increased significantly as well. Within the data, 84 responses were linked with various TK that the pre-service teachers had gained from this assignment. For example, one pre-service teacher said, "*I learned a lot, technology wise [sic]*" (17:10) and another, "*I learnt new things, like how to make a website*" (17:14). Some of the pre-service teachers explained that they now knew how to "*create a website*" and "*decorate the website*" (17:50) and "*where to get free pictures*" (17:20). The majority of the pre-service teachers explained that they had "*enjoyed making the website*" (17:31) because they were now "*able to use technology more effectively*" (17:37). One student explained that *"the thought of being technologically savvy*" (17:137) had made the assignment enjoyable and worthwhile. Another student said that the assignment had encouraged him or her "*to be computer literate*" (18:23). Another pre-service teacher elaborated that they were able to use different types of media "*to make the website happen and that has developed a lot of skills that we already have and taught us new ones … [which] helped us structure work that would otherwise be boring in a fun way*" (18:8).

From the pre-service teachers' responses, it was evident that even though the design of a language education website using Google Sites was challenging, they had enjoyed it and gained more TK and skills. Although the pre-service teachers had gained TK, it was evident from the data that they had also gained CK and PK.

8.1.2 Content knowledge and pedagogical knowledge

CK in this study refers to the content that the pre-service teachers were exposed to and had to engage with during the language education module. PK refers to the practical and pedagogical aspects of teaching a language. When the pre-service teachers were asked whether the assignment had increased their CK, 90% of them responded with a "yes". When they were asked whether the assignment had increased their PK, 89% of them responded with "yes". After that, the pre-service teachers were asked to elaborate on the CK and PK they believed they had gained. From the pre-service teachers' responses, it was evident that they had learnt about the "*theories on how to teach language*" (23:1) and that "*learners' mother tongue must be taken into consideration in the classroom and it is important that teachers keep enough resources in the classroom for learners to strengthen their mother tongue"* (23:2). One pre-service teacher also said, "*It provided me with a more holistic view on teaching a language*" (23:5). Others said they had learnt about "*creating an inclusive classroom*" (23:6) and that they now had "*a clear awareness of language difficulties that teachers face in the South African classroom context*" (23:10). One pre-service teacher said that the assignment had taught her about how "*cultural diversity plays an important role in teaching language and how different methods can work together to teach languages in an effective manner"* (23:26). Pre-service teachers also said that they were "*more knowledgeable about the different reading methods and how to use them in the teaching environment*" (23:14) and that the assignment had equipped them with "*the steps you need to take to teach language successfully*" (23:17). *"I now know what aspects to focus on when teaching language*" (23:29), another pre-service teacher added.

Since the assignment required the pre-service teachers to research language teaching, to write a blog and to record a video for their website, the pre-service teachers benefited greatly from the assignment. The pre-service teachers explained that they were "*able to do a lot of research on the teaching of languages in the Foundation Phase … and therefore gained new insight into the teaching of a language*" (23:18). Another pre-service teacher felt that her "*knowledge was broadened by having to … research factors about teaching languages*" (23:24). One pre-service teacher elaborated, "*It made me aware that teaching languages is important and it made me more open-minded about how to teach language and that there are many theorists that talk about teaching languages*" (23:28).

8.1.3 The importance of integrating different types of knowledge to better prepare students teachers for the 21st-century classroom

During the analysis, it became clear that the integration of different types of knowledge benefited the students to be better prepared for the 21st-century classroom. When the pre-service teachers were asked whether they felt more equipped for the 21st-century classroom on a scale of 1 (not equipped at all) to 5 (very equipped) after

completing the assignment, the majority (81%) of the students felt that they were more prepared. The responses of the pre-service teachers are depicted in Figure 2.

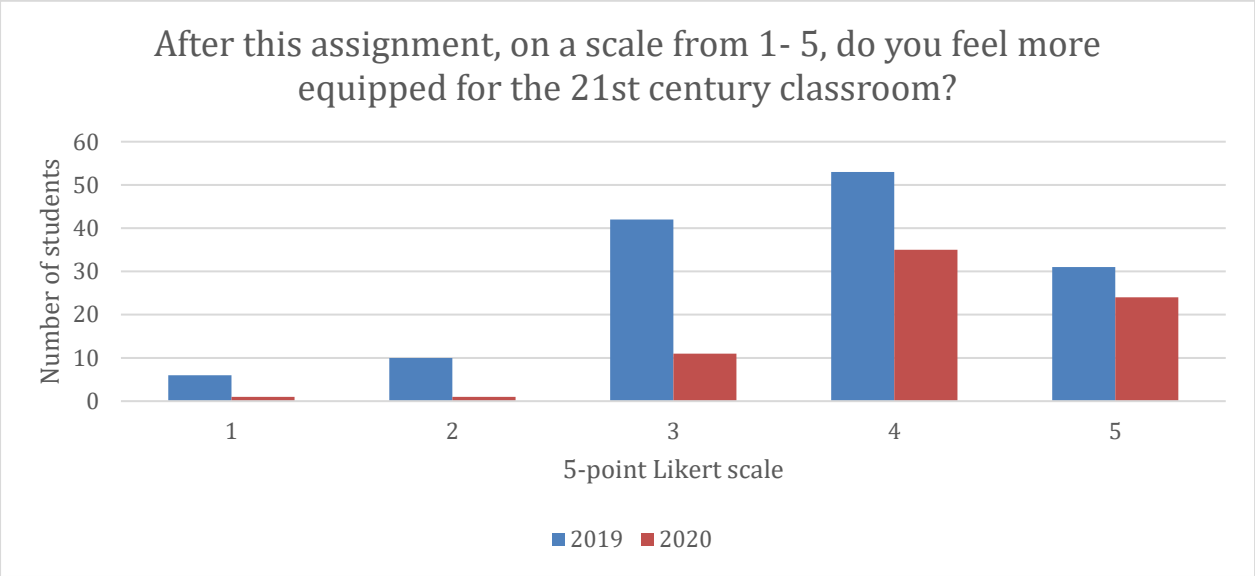

Figure 2: Pre-service teachers' responses to being equipped for the 21st century

The pre-service teachers were also asked, on a scale from 1 (not equipped at all) to 5 (very well equipped), whether they felt more equipped to integrate content, technology and teaching approaches when teaching learners in the Foundation Phase. The data showed that the majority (75.4%) of the pre-service teachers felt more equipped to integrate different types of knowledge (i.e., TK, CK and PK). This is because the TPACK shows that the mastery of technology skills and confidence in using technology when teaching is the key factor that pre-service teachers should acquire at higher institutions (Flavin, 2017). Furthermore, Lambert and Gong (2010) suggest that preservice teachers need training on how to connect the skills in teaching (PK), content (CK) and technology (TK). When the pre-service teachers were asked why they enjoyed the assignment, they explained that the assignment "*prepares us for the future when we are teachers ourselves*" (18:4), "*prepares us for the technologically advanced classrooms and students*" (18:16) and "*this type of assignment was the best because it opened us up to more things and what teaching foundation phase or any other phase might be like in the 21st century" (18:17).* From the pre-service teachers' responses to this question, it is evident that the integration of different types of knowledge has promoted their ability to teach a language in a technologically advanced classroom.

The pre-service teachers were asked to elaborate on how they would use technology when teaching a language. They listed various technological applications and explained that they would use technology when teaching a language by doing the following: "*By playing sound tracks with the correct pronunciation of [sic] the learners to understand better*" (24:1), "*Google Sites and power-point [sic] to make it more fun*" (24:2), playing "*educational games*" (24:5), "*providing educational songs and games*" (24:7), finding "*resources*" (24:7), "*using different website for resources and ideas*" (24:8) and integrating "*songs, videos and blogs when teaching language*" (24:13). Some of the pre-service teachers explained that they would create their "*own website where children will get easy access to the information they'll need*" (24:16) and that "*technology can be used to illustrate what is being said by the teacher by the show of pictures that gives meaning*" (24:19).

One pre-service teacher explained that this assignment had taught him or her how to "*aid my teaching*" (24:9). Another pre-service teacher said, "*I will use multiple tools with technology as technology is never ending and a lot of resources and tools are available*" (24:10). Another pre-service teacher added, "*I will use the translate app to help learners if they are not studying in their mother language. Or I will use language games for instance Kahoot, there [sic] will be asked click on the word that is spell [sic] correctly*" (24:23). Most of the technological applications the pre-service teachers listed were used when designing their own websites, which shows how the integration of TK, CK and PK within the assignment better prepared them for the 21st century by equipping them with the necessary knowledge of and skills in how to use technology effectively. Wankle (2011) points out that the essence of the TPACK model is the interaction of different types of knowledge needed by a teacher for the

effective integration of technology when teaching. Another prominent theme that was identified in the data was how the integration of different types of knowledge with the Google Sites assignment promoted authentic learning.

8.1.4 The use of website design pedagogy promotes authentic learning

Creating authentic learning activities or experiences for pre-service teachers in the higher education environment continues to be a priority, as it is important for pre-service teachers to understand how to integrate technology to achieve authentic learning (Archambault et al., 2014; Bjekic et al., 2010; Latham and Carr, 2012). The data of this study showed that the use of website design pedagogy promoted authentic learning because, as one pre-service teacher explained, "*it is relevant to our everyday life experiences*" (18:18). Authentic learning was promoted by having the pre-service teachers experience a sense of ownership, allowing them to express themselves and to research a topic of their choice. The use of Google Sites also stimulated and promoted their critical and creative thinking – aspects associated with authentic learning. Owing to the pre-service teachers having to work in groups, collaborative learning, another characteristic of authentic learning, was evident too.

That the assignment promoted authentic learning was evident in 184 responses where the pre-service teachers explained that they had experienced a sense of ownership when "*seeing the end product and knowing that I created that*" (17:23), being "*able to be proud of the work and being able to say we have created a website*" (17:67) and "*the whole concept of having a website with your name on it*" (17:106). In 37 responses, the pre-service teachers used the words "my own", for example "*getting to create **my own** website*" (17:133, 135), "*designing **my own** web page*" (17:131) and "*I was able to apply **my own** thoughts based on the research I did*" (18:20). A sense of ownership was also evident in one pre-service teacher stating "*being able to put a touch of **myself** in something that people will read made it great*" (17:28). The use of words such as "my own" and "myself" demonstrates how the assignment promoted ownership, which can be associated with authentic learning.

The assignment also promoted authentic learning by allowing the pre-service teachers to express themselves. There were 53 responses associated with pre-service teachers elaborating on being able to express themselves freely. Some of the pre-service teachers said, for example, that they enjoyed the assignment because "*I could raise my voice as a teacher*" (17:48), they had "*more freedom*" (18:1) and it made them feel like they were "*some published blogger or researcher*" (17:57). One pre-service teacher explained it as follows: "*I enjoyed compiling everything about the assignment. Seeing everything come together beautifully was amazing. The introduction about myself made me feel important and knowing that someone out there will read my work*" (17:53). One pre-service teacher said, "*I felt like I expressed myself more constructively. You got to meet me, and put a face to the name when reading my work"* (20:9). Another one remarked, *"I never knew where to post or how to and this has taught me how to creatively express myself"* (22:23).

Another 54 responses demonstrated how the assignment promoted critical and creative thinking, which could also be associated with authentic learning. One pre-service teacher said, "*YES YES YES it is a fun way to get hold of your creative side and making something that is yours*" (31:4). Another one noted that "*this [assignment] gave you a bit more creative freedom*" (18:21). Other pre-service teachers wrote that the assignment allowed them "*to be creative and it is more about my experiences and not just content-based*" (17:21) and "*to use my creativity*" (17:39). One pre-service teacher stated, "*I enjoyed doing something that required me to be creative*" (17:132). Another pre-service teacher said, "*I prefer this type of assignment because it makes you think creatively and critically*" (18:2). According to the pre-service teachers, the assignment "*develops critical thinking*" (20:10) and "*improved my research skills*" (22:10), which align with the principles of authentic learning.

Group collaboration as part of this assignment also promoted authentic learning, as the pre-service teachers explained that they had benefited from working in groups. One of the pre-service teachers said, "*I really did not know how to do subpages at first; however, with the assistance of my group members I was able to do it*" (12:102). Another pre-service teacher elaborated as follows: "*I found creating the website very challenging because it was my first time creating a website. At first, I also did not know how to post my work on the website but I got help from my group members who were more knowledgeable than I*" (12:150). Other pre-service teachers emphasised that "*with the assistance of my group members I was able to do it"* (17:62) and "*working as a group because we helped each other"* (17:74).

The data make it evident that the design of educational websites using the Google Sites application (i.e., language teaching) adheres to the principles of authentic learning since it develops a sense of ownership and allows for the expression of thoughts and ideas about the teaching of languages and the stimulation of critical and creative thinking. Since the design of websites also requires the application and integration of different types of knowledge, it can be viewed as promoting authentic learning as well and aligns with the principles of the TPACK model. Lastly, creating websites is a complex activity that results in the creation of a tangible product that can be used in real life and focuses on a specific audience (other teachers), which are all characteristics of authentic learning (Herrington, 2006). Since the assignment integrated different types of knowledge that better prepare pre-service teachers for the 21st-century classroom and promote authentic learning, the principles of Vygotsky's ZPD are evident too.

8.2 The use of website design pedagogy helps pre-service teachers to reach their zone of proximal development

Various researchers (i.e., Iszatt-White and Kempter, 2013; Moe and Polin, 2016; Vygotsky, 1978) support the opinion that knowledge is co-constructed and that individuals learn from others during group work. Consequently, in this study, pre-service teachers were grouped with their peers to learn from one another and support struggling students. From the data, it was evident that the assignment challenged the pre-service teachers, as 85.7% of the students explained that they had no prior knowledge of Google Sites or the design of websites. They were then asked to show on a scale of 1 (not at all) to 5 (extremely) how challenging they had found the assignment. Their responses showed that over two years, 172 (80.3%) of the pre-service teachers had found the assignment challenging. Figure 3 is a depiction of the pre-service teachers' responses.

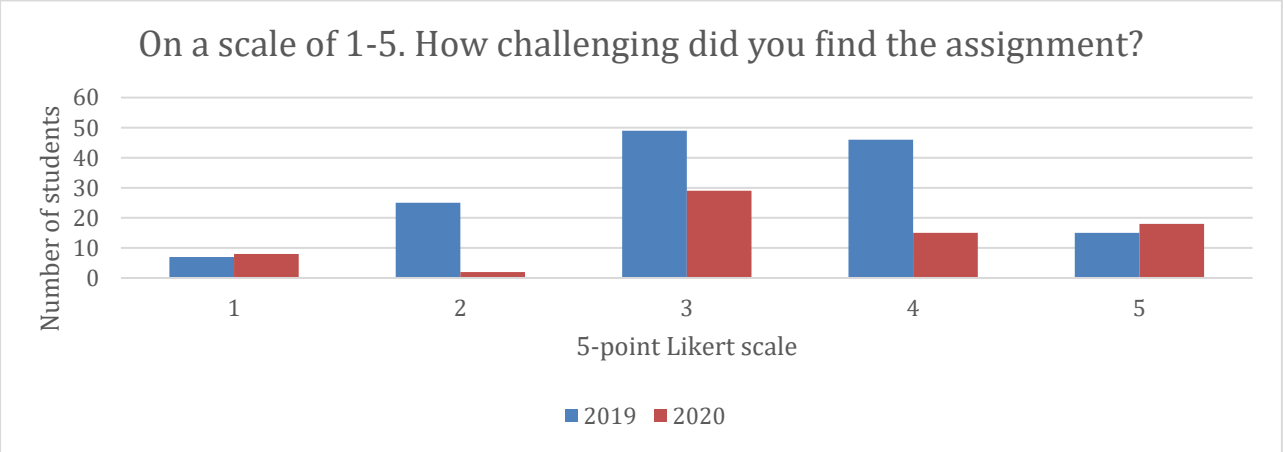

Figure 3: Pre-service teachers' responses to how challenging they had found the assignment

Even though the majority of the pre-service teachers had found the assignment challenging, 84.6% of the pre-service teachers indicated on a scale of 1 (not at all) to 5 (very much) that they had enjoyed creating their own websites as part of the assignment. The figure below depicts the distribution of the pre-service teachers' responses.

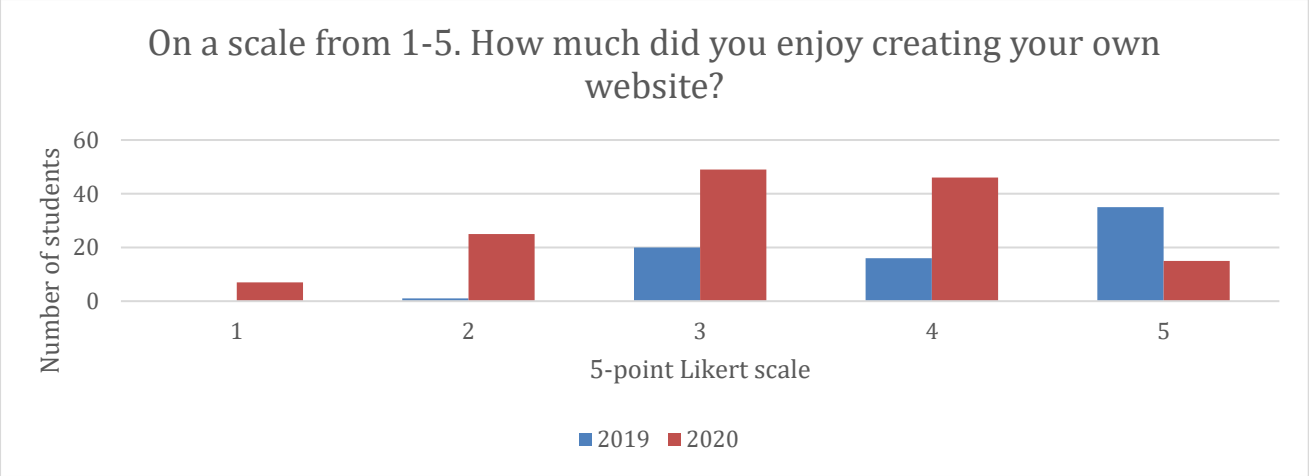

Figure 4: Pre-service teachers' level of enjoyment

The principles of ZPD were evident in responses where the pre-service teachers explained that "*the growth and ability to pull through at the end*" (17:45) had made the assignment worthwhile and that it "*felt good to do something new that I had not been aware I was capable of. It was a [sic] great to see the final product after completion*" (17:60). One pre-service teacher said that the assignment "*pushes our boundaries*" (18:40), which aligns with Vygotsky's ZPD that scaffolding from peers and experienced people assists individuals in performing tasks beyond their level of capabilities. Another pre-service teacher declared, "*Everything I did for the assignment was new knowledge*" (29:3). Moreover, the assignment was "*challenging and rewarding*" (19:4) by having the pre-service teachers perform "*out of our comfort zones*" (19:23).

The ZPD is anchored in the notion that the development of skills and conceptual knowledge is supported by scaffolding from more knowledgeable people, peers or learning tools (Vygotsky, 1978). Scaffolding in this study refers to the training and guidance as well as the instructions and information that the pre-service teachers have received throughout the semester. The pre-service teachers were asked to indicate on a scale of 1 (not at all) to 5 (very well) how they had experienced the training and guidance they had received throughout the assignment. The majority of the pre-service teachers (88%) indicated that they found the instructions clear and the guidance sufficient. From their responses, it is evident that the success of an assignment where pre-service teachers are challenged to integrate different types of knowledge and use online platforms, such as Google Sites, with which they are not familiar, requires guidance and clear instructions.

From Figures 2, 3 and 4, it is evident that the findings of this study align with Vygotsky's explanation that the ZPD provides a way of thinking about how individuals develop skills and knowledge through scaffolding, modelling, coaching and authentic learning support to guide the transfer of knowledge and skills to others (cf. Chai, Koh and Tsai, 2010). As the pre-service teachers were challenged by the assignment, but still enjoyed the assignment, gained TK, CK and PK and felt better prepared for the 21st-century classroom, it can be concluded that the assignment had contributed to the pre-service teachers reaching their ZPD.

9 Conclusion

In this study, we explored how the design of websites as a pedagogy in higher education could promote quality teaching and learning. Pre-service teachers were tasked, in groups, with designing their own language education websites using Google Sites that consisted of various types of media, such as videos, blogs and images. After completing the assignment, the pre-service teachers provided us with feedback by voluntarily completing an open-ended questionnaire. The main objective of the questionnaire was to investigate the pre-service teachers' experiences and challenges and to identify the possible benefits of designing language education websites.

Based on our findings, we argue that the use of website design technology to design educational websites allows for the integration of different types of knowledge (CK, PK and TK), which aligns with the principles of the TPACK model (cf. Abbitt, 2011). Moreover, integrating different types of knowledge helps to prepare pre-service teachers for the 21st-century classroom, as they are exposed to technology in a meaningful and integrated way.

Pre-service teachers therefore not only develop technical skills but also knowledge on how to use technology to teach a language, i.e., TPACK.

A key finding of the study was that the use of website design pedagogy promoted quality teaching and learning owing to its adherence to the principles of authentic learning, such as promoting a sense of ownership, allowing students to express themselves and promoting creative and critical thinking as well as collaboration. It was also evident that the use of website design pedagogy helped pre-service teachers to reach their ZPD, as theorised by Vygotsky, as they were challenged to learn and develop new skills with the necessary assistance provided by their lecturers in the form of training workshops, guideline documents and frequent interaction. Overall, we found that the design of language education websites using Google Sites was a successful and effective way to improve the quality of teaching and learning that took place in higher education. The integration of the TPACK model, Vygotsky's ZPD theory and the use of the Google Sites application equipped pre-service teachers with authentic learning that better prepared them to teach in the 21st-century classroom.

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Finally in the Spotlight: How Contemporary Learning Theory is Saving Education Online During COVID

Paula Charbonneau-Gowdy, Jaime Pizarro and Danisa Salinas
Universidad Andres Bello, Santiago, Chile
paula.charbonneau@unab.cl
jaime.pizarro@unab.cl
danisa.salinas@unab.cl

Abstract: A surge of literature documenting myriad challenges being faced online during the COVID pandemic strongly suggests that e-learning scholarship has fallen short of conveying an understanding of how to build highly effective e-learning spaces. Recent stories from practitioners abound with reports of absenteeism, cameras and microphones turned off, inaction in forums and a general reticence on the part of learners to engage online. Where have we missed the mark in our efforts to have contemporary e-learning theory affect online practice? Scholarship is indicating that the root of the disconnect often lies in the conventional instructional designs being used in these spaces and the teaching, learning and assessment practices they support. In response to such issues, we conducted a qualitative action research initiative to apply an instructional design (ID) model, based on *contemporary* learning theories and *goals*, in a teacher education program in Chile. The study took place in 2020 over 2 academic semesters. In this study, we focussed on the impact of these changes on a small group of first-year Pre-service Teachers (PSTs, *n=17*), experiencing online learning for the first time. Pre and post interviews, an open-ended questionnaire, field notes from self-assessment portfolios and observations of the digital environment were used to collect data. We also draw on two other data sources in the same context: 1) an earlier report of this initiative that focussed on the Teacher Educators (TEs) in the same program (*n=4*), and 2) survey data collected in a preparatory stage of the action research on the experiences of the greater university student body (*n=1,054*). Evidence revealed that initially learners' epistemological views were heavily influenced by the teacher-centric and content-driven pedagogies of earlier schooling. Yet, results also showed that the contemporary learning design framework had positive implications for many students' social, cognitive, and metacognitive competencies. Clear signs of more active investment in social interactive learning online on the part of the PSTs and of flexible, self-directed behaviours were evidenced. The results of this study provide an empirically based practical solution for connecting current learning theory to practice in online contexts, solutions that could endure even once the challenges of the pandemic crisis are behind us.

Keywords: instructional design model; online learning; higher education, COVID-19 pandemic; contemporary learning theories

1. Introduction

Few would argue that the chaos and disruption caused globally in many areas of society by the pandemic have been especially felt in the field of education. With more than 1.3 billion students out of school worldwide in the early stages of the pandemic (Seels 2020), teachers and their institutions in most countries have been scrambling to ensure that formal learning continues. The quality of that learning is another matter. Indeed, according to media reports and judging from the outpouring of recent scholarship, there have been serious challenges (Deihl, 2020, Scull et al. 2020; Flores and Gago, 2020). E-learning scholars have long predicted the potential conversion of a large part of conventional education to online spaces. Yet, despite this forewarning, the transition that abruptly began in 2020 both to synchronous and asynchronous learning has been met with skepticism by some (Moralista and Oducado, 2020; Judd et al. 2020), and resignation or mere compliance by others (Ribiero, 2020). Neither reactions are indicative of the conditions for offering opportunities for quality learning. Not surprisingly, Joshi et al. (2020) have claimed the instructional achievement of online learning to be debatable.

Of course, reservations vis-à-vis online learning and its effectiveness did not arise only of late. Scholars in the last twenty years have documented similar signs of resistance, both passive and active, to technology-supported learning well before and up to the time the pandemic struck. In a recent meta-analysis of the literature on online learning, Castro and Tumibay (2021, p.1) uncovered insights from the analysis of thirty studies that might suggest the roots of this resistance. The researchers found three themes that can explain the tensions related to online learning: 1) *comparisons* drawn between online learning and traditional face-to-face settings; 2) factors related to online learning *delivery;* and 3) factors pertaining to *institutional adoption* of online learning. In terms of *comparisons*, debates on the advantages of online versus face-to-face learning have abated somewhat in scholarship, at least prior to the pandemic. Indeed, a large body of research in the last 10 years has extolled the benefits of online learning over conventional learning, especially in higher education settings (Garrison and

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Kanuka (2004); Charbonneau-Gowdy, 2018). In relation to the *adoption* of online learning, here too there has been movement. Statistics in the last decade are clearly indicating a significant increase of online distance learning being incorporated in higher education (HE) institutions (Allen et al. 2016), a fact that can be equated to its growing acceptance.

Ironically, with the global move to online learning in 2020, both comparison and adoption arguments have become mute points. Naidu (2020, p. 425) notes that criticism of the veracity of online learning compared to conventional classroom learning no longer matters. So too, with senior management in most institutions deciding to go fully online to remain viable, a question of institutional support is redundant. On the other hand, from the abundance of research documenting the educational challenges in the new evolving reality and the many stories being told (UNESCO, 2021), uncertainty and confusion around the *delivery* of online learning is at the very heart of the issues being faced, and the hesitancy being felt. *Delivery*, like the contexts in which it operates is a complex construct that mirrors complex conditions – pedagogical, technological, social, cultural and economic, just to name a few.

How can we respond to questions about *delivery* challenges in view of the *'forced'* move to online learning during the pandemic? How can we enhance a more universal and active uptake of understanding and knowledge from e-learning scholarship that we have built thus far for ensuring *delivery* of *effective* learning online? These questions become particularly relevant considering the possible future of education post pandemic. In recent World Economic Forum reports (Whiting, 2021, Schleicher, 2021), those examining the future of education suggest that there is no turning back. In a survey of 27,500 adults in 29 countries when asked about their visions of higher education being conducted in their country in five years, 72% expressed the belief that online learning will be as prevalent as in-person learning, if not more. Given the continuing salient role online learning will apparently play in higher education, what concrete, practical, and indeed critical, steps can we take to connect theory to practice more effectively than we have done in the past? Even reviewing the deluge of studies appearing in e-learning scholarship during the transition to online learning due to COVID, there appears a paucity of empirical evidence to support a systematic, theoretically based design framework that could address the most salient issues that these studies are documenting about online contexts.

Increasingly, grounded research into applying ID models based on contemporary e-learning theories into practice is being considered our best hope for transforming online education, both teaching and learning. It is through aligning this modality of education with a constructivist, learner-centred, cooperative pedagogy in practice, that learners are offered rich opportunities for deep learning (Garrison and Cleveland-Innes, 2015, Picciano, 2017). Calls for these kinds of initiatives have been growing steadily in scholarship (Pange and Pange, 2011; Branch and Dousay, 2015; Margaryan, Bianco and Littlejohn, 2015; Medina, 2018) and more so than ever during the pandemic. Momentum has been gathering to respond (Adinda and Mohib, 2020).

In searching ways to find answers to these issues and reflections, our goal was to put in place action research in which we applied a made-to-measure contemporary theory-based instructional design framework to a pedagogy program in Chile. The program, like many others globally, was forced to move online abruptly due to the pandemic. In an earlier study we reported on the impact of this change on Teacher Educators (TEs) in the program (Charbonneau-Gowdy, Pizarro and Salinas, 2021). In this earlier 10-month study, we focussed on 4 TEs' experiences as they adopted the new contemporary theory-based design in their practices online. The results of the study showed the TEs' long-held teacher-centric identities and approaches sometimes interfered in this trajectory. Yet, their heightened critical awareness of the ineffectiveness of traditional teaching paradigms in online settings combined with their grounded efforts and perseverance, resulted in the TEs moving progressively away from teacher controlled to learner-driven practices in the new online setting. Their bold steps to connect theory to their approaches and practice showed parallel changes to their identities as online instructors, evidenced by increased confidence, courage, creativity, and resilience. There was also evidence of the TEs assuming 21st century teacher roles as trusted learning guides and facilitators of strong learning communities (Riverin and Stacey, 2008).

In the present study conducted in the same context, we focus on the PST learners and on their learning. An important preparatory step to the action research involved collecting data from the larger university body of students in the institution on their reactions and learning experiences in the sudden move to online learning. The emerging findings from this stage in the process helped precipitate the action research initiative in the pedagogy program.

With this impetus and our goal in mind, the following questions were used to guide the study:

1. What are the perceptions of a small group of PSTs in Chile of a sudden move to online learning due to the pandemic?
2. How has this move impacted their attitudes towards and engagement in learning?
3. What influence, if any, does applying a contemporary e-learning design model based on sociocultural theory and goals *in the teaching practices* of the online program have on their present and future identities as learners and on their investment in learning?

In the next section, we describe the theoretical framework and literature that supported the instructional design model we collaboratively built with instructors and applied in the online program. We then explain our methodology including details about the context, research design and data collection. A discussion of the analysis and findings follow and we end the paper with acknowledging the limitations of the study and suggesting its implications for future research.

2. Theoretical Framework and Literature Review

The increasing visibility that contemporary learning theories, especially those based on sociocultural perspectives rooted in Vygotskian principles (Vygotsky, 1981) and 21st century goals (Voogt et al., 2013), have gained in education scholarship over the last two decades, is encouraging. These theories and goals are being recognized for their value in: a) placing learners and their agency at the centre of learning processes; b) acknowledging that learning is a complex, social interactive phenomenon; c) involving learners in communities that collaborate on co-constructing knowledge based on their own contexts and experience; and d) having important implications for learners' competencies, and their highly dynamic identities, and their engagement in learning.

2.1 Impediments to contemporary theories in online learning

Growing numbers of scholars in e-learning contexts over the last decade have been preoccupied by these social-based theories and goals. Scholars like Yuan and Kim, 2014, have shown the upsides of applying these theories in practice in online spaces – increased learner satisfaction and completion rates, as well as the downsides if they are ignored – feelings of isolation, lack of active engagement and attrition. Indeed, some e-learning scholars argue that the failure of scholarship to turn mindsets in *traditional* learning contexts towards embracing these theories and goals, could be overcome in *virtual* settings (Garrison and Kanuka, 2004; Garrison and Vaughan, 2013, Charbonneau-Gowdy and Herrera, 2019; Prinsloo, 2016). Yet, such aspirations for both traditional and online contexts have been slow to materialize (Brown and Charlier, 2013). As a result, at least in online settings, a focus on self-paced, autonomous learning in isolation, information-based content and teaching, as well as traditional assessment practices, are often the default. A significant body of emerging research and examples being documented during the COVID pandemic, are a case in point. The lack of social interaction, constructivist learning and community building that are reflected in the practices in the contexts of many of these reports can help explain some of the major challenges: disengaged and anxious learners, high levels of attrition and disappointing learning results (Flores and Gago, 2020). In our view, the key shortcoming of much of this albeit valuable scholarship is that it stops short of providing empirical evidence of changes and the application of theory-based pedagogical practices that could help reverse such issues.

One way to explain the lack of uptake of contemporary theories and goals in online learning on the part of practitioners could be by the paucity of empirical evidence that provides *concrete examples* of these theories *in practice.* As Yuan and Kim (2014, p. 221) point out what is needed is "a set of guidelines…but also the steps to reaching the goal". Examples of such efforts have been emerging gradually in a cross-section of fields and contexts (Garrison and Vaughan, 2013; Margaryan, Bianco and Littlejohn, 2015; Philipsen et al., 2019), albeit in blended learning scenarios. According to Charbonneau-Gowdy and Herrera (2019), these emerging examples of putting theory into practice are proving to lead to multiple benefits - increased learner engagement, self-directed learning and regulation skills, creativity, and critical thinking.

The slow uptake of contemporary learning theory and goal-based online practice could also be placed on the lack of realistic ID-based models to guide this transition. By ID, we reference a systematic approach to analyze, design, develop, implement and evaluate instruction, i.e. both learning and teaching (Seels and Richey, 1994; Branch and Dousay, 2015). Smith et al. (2016) argue that without these clear guiding design frameworks, instructors' *practices* in online learning settings fail to promote agency, social interaction, social cognitive

presence, and identity empowerment underlining contemporary theories and goals. Instead, as pointed out above, practitioners often fall back to conventional instructional designs ingrained in their practices in traditional classrooms. Indeed, Adinda and Mohib (2020) posit that the benefits of the various and expanding affordances offered by technology in theory are not automatic, but rather dependent on the essential epistemological conformity that exist in *designs, approaches* and *practices* in online spaces. In the context of the current study in which a pedagogy program was being offered online for the first time in virtual spaces, the confluence of the ID, approaches and practices to reflect contemporary theory in the virtual spaces held particular importance. Not only could the approaches and practices in the online spaces have a serious impact on the PSTs' pedagogical development, but also seriously influence their future profiles and effectiveness as aspiring professionals for the new educational aftermath of the pandemic, a future in which online learning could be the norm.

2.2 Current online learning theories and models

Scholars working to develop theories of online education derived from sociocultural principles and goals have offered a variety of perspectives and models. The Community of Inquiry (CoI) theory developed by Garrison, Anderson and Archer (2000) is closely tied to Lave and Wenger (1991) and Wenger's (1998) communities of practice and situated learning concepts. Based on this model, learning is a process that results from a deepening participation in a learning community. The CoI model supports IDs in which online learning takes place in active environments where instructors and students share ideas, opinions and ideas and where social presence is demonstrated through engagement in discussion boards or forums, blogs and videoconferencing. In the context of our study, a focus on building strong communities of learners (Riverin and Stacey, 2008) and active participation of PSTs and TEs were firmly built into the new direction for program courses.

Anderson's (2011) and Picciano (2017) offer further theory-based models for online education that had relevance to our study. Of interest in Anderson's (2011) model is the emphasis it places on both Net-based synchronous and asynchronous activities. The model draws attention to the richness of these environments for the development of social skills, collaborative learning of content and the establishment of personal connections among participants. One of the limitations of the model is that it does not consider the powerful affordances of videoconferencing for face-to-face sessions that existed in our study. Picciano's Multimodal Model for Online Education (2017, p.178), is based on the premise that "pedagogy drives approaches that will work best to support student learning". The model is built on a framework of seven intersecting components that comprise the essential opportunities for learning available in a quality online program - that is through *media content*, *reflection*, *collaboration*, *assessment*, *dialogue, self-directed learning* and *social/emotional support*. These opportunities underscore the aims of the design applied in our study which were: a) to build community; b) to influence the social/emotional makeup of student profiles, i.e. their identities; and c) to promote the collaborative development of 21st century skills.

2.3 Applying theory to practice

In considering ways to apply new design models that will connect theory to practice, Branch and Dousay (2015) suggest five well-established conceptual phases, so-called ADDIE, to guide the actualization process: *analyze, design, develop, implement,* and *evaluate*. The authors have used these guiding phases to evaluate the application of over 150 instructional designs for their relevance and effectiveness. It is important to point out that these phases should not be confused with a learning design in and of itself, but rather its implementation and evaluation. These 5 phases supported the development of the ID used in our study and its concrete application in the teaching and learning processes taking place online. It is worth noting that most newly developed IDs, as Branch and Dousay (2015, p.89) point out, are never applied or much less evaluated. It was the practical application and validation of the contemporary theory-based design developed in the context of our study, albeit a modified existing model, that we considered important to its future usefulness as a pragmatic tool for sustained use.

In the context of the study, ensuring the validity and applicability of our design met three objectives: a) that the PSTs had an opportunity to build a collaborative framework to guide their present and future practice; 2) that sociocultural principles and 21st century goals were being applied in the online learning pedagogies; 3) that the PSTs would potentially benefit from these principles and goals. A recent study conducted by Margaryan, Bianco and Littlejohn, (2015) provided a framework (see Table 1) in our analysis of the value of our theory-based design in practice. In their study, the authors assessed and compared the ID quality of 76 Massive Open Online Courses (MOOCs). The ten-principle framework, of interest to our study, is built on key ID theories and models (Merrill, 2013; Margaryan, Bianco and Littlejohn, 2015, p.78-81). A systematic review of 22 contemporary instructional

theories confirmed support for the list of principles that make up the framework (Gardner, 2011a). It is worth noting that the majority of the MOOC courses analyzed by the authors using this framework "faired poorly" in aligning contemporary theory-based design to online practice. We found the framework and the key questions used in their analysis (See Table 1) applicable to our study and a way to assure the successful application of the sociocultural perspectives and 21st century goals we were attempting to apply. Their study also allowed us to draw inferences as to the causes of the challenges that the PSTs, and indeed their educators, were facing in our study and with this knowledge work towards design solutions.

Table 1: Framework for the evaluating instructional designs in practice online (Margaryan, Bianco and Littlejohn, 2015)

Guiding Principle	Description
Problem-centred	Learners learn skills in the context of real-world problems
Activation	Learners activate their existing knowledge and skills for developing new skills
Demonstrated	Learners learn when exposed to 'real' examples of new skills to be learned rather than information.
Application	Learners have opportunities to apply their new skills to solve problems.
Integration	Learners have opportunities to reflect on, discuss and defend their new skills
Collective Knowledge	Learners contribute to collective knowledge
Collaboration	Learners collaborate with others to build knowledge
Differentiation	Learners have options according to their individual needs
Authentic Resources	Learners are put in real world situations
Feedback	Leaners are given regular feedback

3. Methodology

3.1 Context and Participants

The action research study took place in 2020 with a group of 17 first year undergraduate students and their 4 full-time Chilean teacher educators in the context of an EFL 4-year teacher preparation program. Since the decision to move all programs to online learning in the institution had come at the beginning of the academic year, most PST students in the group had never met their TEs nor their fellow classmates face-to-face. The program included a variety of course subjects: Phonetics, Language in Use, Writing, Reading, Speaking and Listening.

Chile is one of only three members of the OECD in Latin America. The advancement of English is considered a priority of the government and many young people are lured to the English pedagogy program with attractive national scholarships. While the country is economically stable, the system of education is still evolving to meet higher educational standards reflective of developed countries - a goal which many suggest is and will be determined by the quality of its teachers. Most students, including the pre-service teachers in the institution are first generation university attendees and come from clearly divided socio-economic backgrounds. Due to this reality, disparities exist in terms of access to technological resources and internet and in terms of the cultural capital students bring to their study programs.

During 2020, the government imposed several periods of enforced lockdown. Citizens in the major cities were restricted in their movements during the day, most confined to their homes with outings permitted during specified periods and with government-issued passes. COVID case counts and deaths were relatively high for most of the year although as the second semester ended, the situation improved as record numbers were being vaccinated. The global pandemic crisis that hit the country and the angst it caused was compounded by the previous year when major violent student strikes and social unrest in a call for reform closed schools, universities, and many businesses for an extended period in the country, most particularly in the capital city. The general malaise and fear this period had caused among Chileans was still being strongly felt at the beginning of 2020 when the pandemic struck.

3.2 Research Design

The research design consisted of two main phases in which the five core ADDIE elements or steps of implementing instructional design were conducted. These two phases aligned with the two semesters in 2020 in the Chilean context. Table 2 provides an overview of the Research Design and the data collection process. The first phase, March to July 2020, served as a period of analysis. In a preparatory step to the study, we had distributed a survey to the wider undergraduate student body (n= 1,054) at the university to understand the

context and the experiences students were having with the abrupt move to online learning. Armed with the general findings from the analysis of the survey data, we then turned our attention to the experiences of a subset of the student body. Our lens was aimed at a small group of PSTs and the exposure to learning and teaching they were having in their first-year courses in the EFL Pedagogy program. We employed individual interviews, observations, a questionnaire, and field notes from online activity as the basis for further analysis of the PSTs' realities, needs and their learning context in this first phase/semester.

The second phase, August to December 2020, involved the design, development, and implementation of the new ID. In this phase, TEs and the lead researcher mediated the key elements of the design and its application. The various changes that were to be made to the design of their courses and their practices based on sociocultural theories and 21st century goals were discussed and agreed upon. Essentially, deep ID changes included: a) launching strategies for building learning communities to increase learner involvement in the synchronous sessions; b) providing increased opportunities and resources for student collaboration on both learning assignments/projects and assessment processes; c) using group project media and student generated material as course content; d) incorporating problem-based strategies in course forums to promote a student exchange of ideas and opinions; e) assigning mentor and teaching roles to students; f) building individual and group reflection opportunities into course plans; g) increasing choice and options for student decision making; and h) improving the quality and incidences of instructor-student and peer feedback.

Strategies and innovative ways intended to incorporate the newly adapted design were also negotiated among the instructor and the lead researcher. Importantly, these plans involved decision making about the evaluation of changes to learning both on an ongoing basis throughout the semester (formative) and at the end (summative). Over the second semester, the implementation of the new instructional design took place in each course. As with the first phase, an understanding of the perceptions and experiences of the PSTs were collected through individual interviews, observations, and field notes.

Adhering to strict ethical guidelines played an integral part in this design – informed consent, the use of pseudonyms and freedom on the part of students to abstain or withdraw from the action research process.

Table 2: Phases of the Study and Data Collection

Phases of the study	Type of Data	Description
Phase 1: Analysis March – July 2020	Interviews (online)	5 Recorded Zoom individual and group interviews with PSTs
	Field Notes	Results of 25-item survey of online experiences of greater student body (*n= 1,054*); PST's digital Self -Assessment Portfolios (*n=17)*
	Questionnaire	End-of -semester open-ended probe of PSTs' experiences in 1st semester (*n=17*)
	Observations	TE's observations of online classes; Digital activity in online forums and google drive
Phase 2: Design, Development, Implementation and Evaluation August – December 2020	Interviews (online)	9 Recorded end-of-semester Zoom individual and group interviews
	Field Notes	PST's digital end-of-year Self-Assessment Portfolios; attendance records (*n=17)*
	Observations	TE's observations of online classes; Digital activity in online forums and google drive

3.3 Data Collection and analysis

We situate our study within the qualitative paradigm. We recognize the epistemological advantages of researching within this methodological area for gathering a deeper understanding of the implications of change to educational settings and for uncovering participant voice (Denzin and Lincoln, 2005). Although tools available within this methodology, i.e. in-depth interviews, field notes, observations, were the primary source of data, we also employed a numbers-based, Likert-scale, survey typical of quantitative inquiries in the preparatory phase.

The triangulation of data gained from: a) the survey of the general student body (*n=1,054*) about their new online experiences, conducted in the preparatory stage of this study; b) the previous qualitative inquiry in the same context that centred on the experiences and perceptions of the TEs with the new ID (Charbonneau-Gowdy, Pizarro and Salinas, 2021); and c) data that emerged from the focus on PSTs in this present study, adds to the rigour and the validity and reliability of its findings. These combined data sources provide a fuller picture of the impact of the new ID-based approach and strong empirical evidence of what was taking place in the context of learning online in 2020 for learners in this HE institution.

A survey was distributed to the general university student body (*n=1,054)* during the first semester of 2020. The survey was intended to gain student perceptions of the move to online learning initially and after two semesters. The survey consisted of a 25-item Likert scale questionnaire. Topics addressed in the questionnaire included the following: reactions to the use of technology, online course content, peer and instructor interaction, instructional practices, and evaluation. Descriptive statistics were employed to analyze the data tabulated. The analysis of these statistics offered insight into the overall perceptions and experiences of the general student body in the transition to a fully distance learning modality.

As mentioned above in the description of the design (Table 2), the qualitative data tools used as data sources in both phases of the study included: mid and end-of-year interviews, a student questionnaire, observations of digital environments and field notes. Field notes consisted of i) digital activity online; ii) individual PSTs' expectation questionnaire (*n=17*); and iii) end-of-year self-assessment journals (n=17). The student questionnaire conducted after the first semester gathered feedback from student PSTs about their experiences online during the first cycle of the study whereas results from the second provided general information about their first year in the program.

The qualitative data was analyzed by the lead research with cross-referencing support from two of the TEs and using a combined inductive-deductive process (Miles, Huberman and Saldaña, 2014). After establishing a conceptual framework, a series of iterative steps were taken: a) inspecting the data sets to determine those data that could inform the research questions; b) multiple readings and considerations of the data sets; c) condensing and coding the data for key concepts and ideas that related to the theoretical framework and literature review; d) identifying and refining the salient or common themes from the coded data; e) re-forming a conceptual framework that could then be corroborated by the findings. Descriptive statistics were employed to analyze the data tabulated from the survey. This analysis provided an overall view of the general student body about their initial experiences online. These perceptions helped to corroborate the perspectives being voiced by the PSTs and offered insight to our analysis.

4. Analysis and Findings

The initial impetus for launching the study was a combination of a) observations and experiences that TEs were voicing about their online courses and b) the results of the first survey distributed to the larger student body. Early results from the survey indicated that students were reporting: a serious decrease in interactions with both teachers fellow peers; a deep decline in opportunities to engage in discussion in courses; feelings of increased loss of connection with teachers; lack of confidence in the ability to perform well on assessments and to learn.

Compounding these findings, were disturbing signs in the context of the pedagogy program that illustrated the severity of the situation: students' poor attendance records, lack of involvement in online synchronous sessions, inactivity and failure to comply with required assignments in the online asynchronous platforms, general despondency on the part of many students for online learning, and an over-dependency on TE's efforts for their learning. In discussions between TEs and the lead researcher held near the end of the first semester in 2020, it was decided that immediate action was needed. As one of the TE's shared: "[We are] forced to make changes and rethink our effectiveness….and to move beyond our comfort zones" (Charbonneau-Gowdy, Pizarro and Salinas, 2021). Rather than adding to the body of literature being reported at the time documenting similar issues due to the sudden move to online learning, the TEs and lead researcher shared a commitment to apply deep pedagogical changes to the program's ID and collect empirical evidence of the results. A key problem we were seeing at the time with much of the immense body of valuable research being generated in response to COVID's impact on educational contexts, was that it focussed generally on reports of challenges and yet producing a paucity of empirical evidence of ways to respond to these issues. Thus, with the support of macro and meso administration, critical to change (Charbonneau-Gowdy and Chavez, 2019), the newly adapted ID was

applied to first-year students' courses in our English pedagogy program during the second semester and results were documented.

Changes to instructional practices based on the new design were accompanied by changes uncovered in learners' online identities and their investments in learning over the duration of the study. By investment, we reference Norton (Darvin and Norton, 2016) who developed the construct to mean a commitment to learning based on learners' intentional choice and desire. Two themes emerged from the data sets that demonstrate the trajectory of these changes: learners' attitudes, behaviours and learning during the first semester and learners' attitudes, behaviours and learning in the second semester.

4.1 Learners' attitudes, behaviours and learning during the first semester

It was clearly observable from the blank screens, muted microphones and frequent empty chat and forum spaces in the first semester that the PSTs were experiencing feelings of reticence vis à vis learning online. It could be speculated that some of these issues were due to technical, connectivity or family contextual problems, as reported elsewhere (OECD, 2020; UNESCO, 2020; Ribiero, 2020; Flores and Gago, 2020). Yet, data from the various data sets in the pedagogy program, corroborated by quantitative data from our large university-wide survey, suggest a deeper explanation of the PSTs' visibly disengaged behaviours. Hesitancy to speak and engage in discussions were explained by some PSTs to be due to their fear of correction, to lack of confidence in exposing their written communication to peers in the online forums or to tensions that existed in class as teachers struggled to adapt to the new modality. Survey results of the larger student body reflected these concerns: 69.7% of students reported feeling very or somewhat more hesitant about speaking in online classes compared to 'regular' classrooms; 83.6% indicated they had fewer possibilities to speak; only 61.5% felt that their teachers attempted to encourage speaking; a low 28.6% reported being able to establish a connection with their professors.

A closer analysis of such attitudes and their corresponding behaviours indicates an absence of a strong community of learning in the online classrooms which is pivotal to learner engagement and completion rates (Yuan and Kim, 2014). Indeed, when asked what students missed most about in-person classes, one PST responded: "*The social interaction because it is what makes the classes more interesting, and you feel like part of a community*." (Questionnaire, July, 2020). Similarly, among the general student body, 74.4% indicated that they lacked contact with their fellow classmates and 87% interaction with their professors. When reflecting on the group of her peers in the online classroom, one PST poignantly remarked: *"I feel we're just minding our own business*." (Interview, July, 2020). These words provide an image of the students in the group attempting to learn in isolation contrary to social learning theories and thus missing out on the deep learning that occurs through interaction with others (Vygostky, 1981; Yuan and Kim, 2014).

Indeed, in the end-of-term interviews, many of the PSTs openly *expressed* dismay over their learning progress in the first semester. One PST poignantly observed: "*I don't feel like I've acquired much knowledge, I don't feel like I'm making any progress at the level of my English either*" (Interview, July 2020). This individual's disappointment in the lack of progress over the first semester was also repeated in the responses to the survey. 84 % of respondents reported that they felt that they had learned less. A surprising revelation from the data sets was an indication that some PST students, and others in the general student body (94%!) according to survey results, adopted more autonomous attitudes towards their learning. Perhaps isolation and/or additional time saved in the absence of commuting might explain this change in some students. After all, many institutional goals, at least in Chile, aspire to promote this trait in students. Yet, 21st century goals would suggest that working predominantly alone in isolation is counter to the kinds of skills education should be building. Instead, working in teams, sharing ideas and building knowledge are key prerequisites for the new workplace realities students will need to face. Not surprisingly, survey results of the larger student body, who also had indicated their feelings of isolation, showed that 83.5% felt a lack of confidence in their ability to perform well on assessments and even 68% questioned their ability to learn in the online program setting.

4.2 Learners' attitudes, behaviours and learning in the second semester

Phase 2 of the study was marked by a move to new ID-based practices. Analysis of the substantial data that emerged in this phase revealed salient and evolving deep changes to the PSTs identities and investment as evidenced by their attitudes, behaviours, and learning. In Table 3, we draw a conceptual model that concisely synthesizes the findings in this part of the study. In the table, the practical application of key principles of a contemporary learning ID (Margayan, 2015) in these roll-out changes are connected to changes revealed by the

PSTs. We support this analysis by providing some representative excerpts from the data. The table is followed by a more detailed description of this analysis.

Table 3: Tying changes in design practices to changes in learners and learning

Contemporary Theory Guiding Principles	Examples of Changes to Practice	Changes in attitudes, behaviours and learning
Problem-centred	Current issues from online media sources rather than pre-set textbook content used to provoke discussion among PSTs in synchronous classes	-Openness to novel ways and new ideas and broadened perspectives of effective learning practices: *Students said they liked having real things to read* [and discuss] *that were happening in the real world at the time.* (Interview with TE, Dec. 2020) - Trusting in community support and valuing learning from others: *I am grateful of every recommendation and every feedback…*(PST portfolio, Nov. 2020) - Increased responsibility for learning and sharing knowledge – e.g. groups of PSTs volunteer to teach theory to their peers in replace of TE lectures; also significant number of assignments submitted online - More active involvement in forums and sharing knowledge as shown by increased activity in forums - Obvious signs of deeper thinking (cognitive development): shown in formulating questions and opinions (cognitive development) in synchronous and asynchronous settings - Greater agency in the day-to-day activities in class, e.g. acceptance by some PSTs to allow their work to be used as teaching tools - Effective team players when involved in group projects shown in quality of end-of-year projects - Secure in one's learning and goal orientation: *My expectation was to finish the semester with good marks….and that is how I* ended (PST portfolio, Nov. 2020) - Confident and pride in one's achievements: *I gained confidence in myself and in my own skills.* (PST portfolio, Nov. 2020) - Increased interest in online synchronous classes – attendance rates rise to 85% whereas they fall alarmingly in other areas of the program - PSTs show less anxiety and nervousness during summative testing - Signs of more PSTs' active involvement in synchronous videoconferencing- all cameras open in one TE's final class.
Activation	PSTs share digitally recorded examples of their own language speaking issues in community forums to elicit feedback from peers	
Demonstrated	TEs model ideal practice instead of textbook theory in synchronous classes to promote Q&A and critical discussion	
Application	-Assessment becomes a group mediating process rather than individual one -Learning is measured by PSTs ability to draw on newly acquired knowledge to critically examen language for errors rather than reproduce theory	
Integration	-Learning as a self-reflective process is integrated through end-of-year digital learning portfolios; PSTs attest to their learning development and future learning aspirations. -Portfolios published in program community site to share with peers for their feedback.	
Collective Knowledge	-Individual student generated content, eg writing assignments, are used in a flipped classroom scenario by TEs in synchronous classes to support peer critical analysis and improvement. -Formative test rubrics are co-constructed by PSTs and TEs in a shared drive.	
Collaboration	Groups of PSTs assume teaching roles in presenting key topics of the course and implicate peers in collaborative learning activities during synchronous classes, replacing TE lectures	
Differentiation	Freedom of choice offered to PSTs when forming virtual groups and pairs in breakout rooms	
Authentic Resources	Opportunities provided to PSTs to attend faculty online webinars - experts share insights about "real" classroom issues, eg. learners with special needs	
Feedback	Increased feedback given by TEs on virtual formative and summative tests and learner-generated content.	

Changes in approach due to the alignment of the ID more closely to contemporary theory and goals were aimed first and foremost at providing opportunities for: a) building community, b) increased control i.e. agency, to the PSTs over learning content, activities, and importantly, assessment processes, c) promoting instances for social collaborative knowledge building through group work and d) having fun - an antidote to the pervasive stress as a result of the pandemic.

As noted above, the change process did not come easily to the 4 TEs as they attempted to migrate their courses to online modalities and to align their online pedagogical practices to contemporary theories (Charbonneau-Gowdy, Pizarro and Salinas, 2021). The transition was no less automatic for the PSTs. Many students, although not all, clung to the security of closed cameras for much of the second semester and opened them only in one of the TE's classes at the very end. On the other hand, data from several data sets revealed that the emerging shifts in pedagogical approach over the semester had a significant impact in other ways on learners. Many PSTs in the group displayed changes in their attitudes, behaviours, and ultimately their learning. In terms of *attitude,* several PSTs conveyed more positive feelings about the online classes. One student remarked: "*Personally, starting the second semester was difficult and I didn't have much desire, but I was motivated to learn little by little, since, at the end of the day, I really want to live [learn] from this and be an excellent professional."* (PST self-assessment portfolio, November 2020). In this excerpt, this PST acknowledges the difficulties he had in continuing to attend online classes at the outset of the second semester. At the same time, he recognizes that his increased investment levels, presumably due to the newly applied approaches and practices, allow him space for reflecting on his imagined identity – one that visualized himself in the future as an "excellent professional" teacher. We can speculate that as this student was given increased opportunities to invest more in the community of practice of the classroom and assume a more agentive role in his own learning and assessment process, he was able to produce 'new images of possibility and new ways of understanding' (Wenger, 2000). His testimonial reveals that these images and understandings are in relation to the world well beyond his engagement in acts in the immediate context of the online classroom (Norton, 2001) and speak to the long-term impact of the new ID practices. Another PST echoing similar positive sentiments, signalled not only a change of attitude but an awareness of the important role social interaction pedagogies played in his learning. In this student's end-of-semester self-assessment, he wrote: "*I can say that I'm grateful of every recomendation (sic) and every feedback that teachers and my classmates gave me, because without it I could never be able to improve my skills."* (PST learning portfolio, Nov. 2020)

An increase in responsible learning behaviours, reflective of changes in identity and investment in learning, were also evident. For example, although activity in the online forums improved slowly, in other assignments the PSTs became observably more involved. Volunteering to work in groups to teach course content in the videoconferencing sessions (with cameras open), giving constructive feedback to each other on the platform site and willingly sharing their work with those having difficulty, are a few examples. These examples speak to the agency and the accompanying responsibility several of the future teachers in the group were beginning to assume. These responsible behaviours went beyond their own immediate autonomous needs. Instead, they reflected a recognition of the value of shared knowledge.

Analysis of the data also revealed clear signs of changes in terms of learning – both cognitive and metacognitive. In an end-of-year self-assessment one PST reflecting back to her expectations at the beginning of the semester, recognizes progress in her learning trajectory through her words: "*My expectation for this semester was to finish with good marks and new knowledge. Not being nervous on a Speaking Test. And that [is] how I have ended this semester."* We speculate that the skills that this student has achieved and recognizes, demonstrated by her grades, new knowledge and confidence in speaking English are a testament to the instructional approaches the TEs mediated during the second semester. Clear instances like this of learning development, among others that surfaced in the data were not solely confined to increased skills in language teaching knowledge. There were also obvious signs of increased metacognition. Several PSTs evidenced this development in metacognition in both year-end self-assessment portfolios and interviews. For example, one PST shared:

> *For my second self-assessment I would like to give an overall view of this new and amazing semester. 2020 part 2 gave me so many life lessons that I am grateful for. I have learned so much during this term, not only about use of English, phonetics, listening, speaking, reading and writing but about myself, for example I became more aware of my learning process…* (End-of-year self- assessment, Nov. 2020)

We understand that the recognition this student has of her learning development, not just through her acquisition of skills but by a more advanced understanding of her personal cognitive processes, puts her in an ideal position for her trajectory as a professional educator.

Another example of this kind of metacognitive awareness can be seen in the following list shared by one particular PST as evidence of the changes she experienced over the semester:

> *Regarding to my relationship with my classmates, I had the chance to interact and get to know a little more a few of them and I am really happy about it, due to as a class we all should get along and support each other in this academic journey.*
>
> - I was way more participative in all my classes
> - I was more constant with my studies.
> - I was more motivated to learn as much as I could.
> - I gained confidence in myself and in my own skills.
> - I managed my time in a better manner.
> - I improved my grades in speaking.
> - I took delight in the learning pathway
>
> *In addition, this semester was more about get to know myself and [my] learning*. (PST, End-of-year self-assessment, Nov. 2020)

In these words, we see a testimony to the student's evolving understanding of some of the critical conditions she needs for her learning to take place: the need for a community of learners, participation, time management, enjoyment, confidence, motivation, and consistency. We believe that a connection can be drawn between her awareness of these essential conditions for learning and the list of new pedagogical practices installed in the second semester in the move to a more contemporary learning-based design.

4.3 Discussion

Returning to our research questions (RQ1, RQ2), the data reveal the dire situation in which a majority of students, like their teachers (Charbonneau-Gowdy, Pizarro and Salinas, 2021), found themselves in the sudden transition to distance online learning. Clearly, most students in this context suffered from a lack of community and interaction both with their peers and teachers. This scenario left many despairing of their abilities to succeed in their courses and in learning. At least for many in the group of PSTs in the study, their attitudes and investment in learning were strikingly impacted – characterized by an obvious lack of commitment, interest, and willingness to engage in their studies online.

In the analysis of the second semester and the impact on learners of the new ID put into practice, (RQ3) we have painted a more positive picture. The changes in many of the PSTs in terms of their identities and investment in learning are substantiated with evidence of changes in their attitudes, learning behaviours and learning. What our analysis vividly reveals is that the majority of the PSTs showed positive and encouraging growth in their identities as learners. This growth was made visible through signs of: increased commitment; critical thinking in forums and discussions; confidence in one's own knowledge and sharing it with others; being active team players; openness to new ways of seeing and doing; and visionaries in terms of their imagined identities as professionals. The analysis also revealed a significant progress in many of the PSTs' learning trajectories, evidenced by signs of deep learning and metacognitive development not only in their current formal online learning contexts, but in envisaging their future lives as professionals. Based on this evidence, it is clear that in this particular context the theory-based changes made to pedagogical practices made a profound difference to the instruction, i.e. both teaching and learning, that took place online.

This picture of course is not a complete one. The data sets also revealed that a few PSTs witnessed continual frustration with online learning, fears, and hesitancy to engage with others, an ongoing lack of motivation, and anxieties about their progress over the semester. Sadly, four of the original seventeen students in the first-year group withdrew from the program. Whether these individuals were unable to cope with the changes in learning online as opposed to learning in traditional spaces or with the myriad implications of the pandemic crisis, the reasons are not clear. The study of human activity is always complex.

Some might question the connections we draw here between the positive changes we did uncover in the PSTs' identities and their learning, and the new theory-based pedagogical practices installed in the 2nd phase of the

study, based on changes to the ID. One could argue after all, that these encouraging signs in the PSTs are simply a result of the maturity and growth of these individuals over the period of their first year. There may be some validity to this argument. Yet, from our emic position working within the program, the clearly visible changes revealed in the PSTs identities and investment in learning between the end of the first and end of the second semesters, lead us to question that argument. Also, words such as: "*this semester"* and *"2020 part 2"* and *"starting the second semester.. I was motivated little by little"*, that are cited in testimonials above, as well as others not reported here, helps give further credence to the conclusions we draw.

Another case in point relative to these conclusions pertains to further information collected from the larger student body. Space limitations here prevent us from providing details of the second university-wide student survey *(n= 1,137)* that was distributed across the institution at the end of at the end of 2020, which in Chile is the end of the academic year. But it is important to point out that students responding to the survey were not exposed to the specific ID changes that the first-year PSTs experienced in this action research study, nor any systematic changes to the ID being used by other faculty. Essentially in summarizing the results of this second survey, there is clear evidence that minimal change occurred in both student's experiences online, their lack of confidence in online learning and their disparaging attitudes towards their ability to learn compared to the results reported in the first survey. We see these results as a further testimony to the value of the initiative that was instigated in the pedagogy program in putting contemporary theory to work in online practice.

5. Conclusion

We realize that we are not alone in asking the question why it has taken so long for many in education to connect theory to 'real' practice (Bonk, 2020). The chorus of voices that have been echoing this message has grown increasingly louder as conventional learning approaches and spaces are being more rapidly influenced by the impact of technology on every part of our lives. The current COVID crisis has magnified these voices exponentially. Some see confusion and insurmountable challenges; others see opportunities for positive change (Diehl, 2020). Our study was aimed at the latter by taking concrete positive steps to respond to this call. The small size of the inquiry as well as the short timeline of the study can be considered limitations. Yet, we believe the strong findings offer a clearly applicable and realistic framework for addressing many of the roadblocks that scholars and many stakeholders in education at the macro, meso, micro levels have failed, at least until now, to overcome (Charbonneau-Gowdy and Chavez, 2019). The framework is built on clear steps: 1) mediate highly structured and contextualized instructional designs based on contemporary learning theories and 2) apply these structures to well defined instruction decisions, both learning and teaching practices in e-learning settings. Our study has shown that taking these steps has positive implications for learning and learners -the kinds of learning and learners many of us have been struggling to foster for quite some time. It will require an abundance of similar empirical study initiatives in a broad range of contexts to determine the viability and sustainability of this initial attempt at finally drawing theory into practice online. Education is being shaped by this pandemic crisis in ways that are still to be determined. Projections of an educational system more dependent on online learning seem assured. We can continue to focus on theory, *or* practice, but given the findings of this study and the cries for help from many stakeholders in the field, now seems the ideal moment to succeed finally in aligning both.

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Editorial for EJEL Volume 19 Issue 6

Dear readers of the EJEL,

2021 is nearly over and the EJEL team has worked diligently to provide you with the last issue of the year. A total of 13 articles makes up the issue, mainly focusing on the topics of learners' perceptions of digital learning tools (e.g., user satisfaction, convenience, and emotions), game-based learning and gamification, as well as the use of digital tools in the context of generative learning. In addition, the influence of cultural context on digital learning tools, the application of olfactory and haptic sensory stimuli, the use of instructional design models and cooperative learning are addressed in separate articles. Malaysia (3) and South Africa (2) are the most represented countries of origin of the authors, together with contributions from Chile, Egypt, Estonia, Hong Kong, Indonesia, Norway, Russian Federation, Singapore, United Arab Emirates and the USA.

The issue kicks off with a qualitative study on social media in the classroom. Wilson O. Otchie, Margus Pedaste, Emanuele Bardoneand Irene-Angelica Chounta from the University of Tartu, Estonia interviewed teachers about their use of social media in 7th to 10th grade. Their findings suggest that social media (and YouTube resources in particular) could be a useful pedagogical resource for learning, and teaching, but also note that challenges such as the distractive nature of social media use in class, and increased workload for staff should be carefully considered prior to adoption.

Hassan Bello and Nor Athiyah Abdullah of Universiti Sains Malaysia examine the extent to which quality factors of summative computer-based assessment influence user satisfaction. In addition to developing a synopsis of benefits of computer-based assessment, they apply the Delone and McLean information system success model to predict user satisfaction with computer-based assessment in a developing African country.

In the third paper, Lubna A. Hussein and Mohd Faiz Hilmi, also from Universiti Sains Malaysia investigate the acceptance factor for learning management systems. Based on an online questionnaire, and structural equation modeling, they conclude that student satisfaction is positively influenced by information quality, system quality, service quality and convenience.

The fourth paper addresses the need to integrate educational technology into the cultural context in which it is applied. Drawing on the theory of culturally relevant pedagogy, Jenny Eppard, Amir Kaviani, Michael Bowles, and Jason Johnson of Zayed University, United Arab Emirates describe the dependencies of successful educational technologies on culture through three case studies, each featuring an educator providing in-depth comments. Consideration of the findings from this study may enable the development of more accessible educational technologies.

In the fifth article, Kelvin Wan, Vivian King, and Kevin Chan, a team of authors from three Hong Kong universities employ a survey to examine the conditions for self-regulated game-based learning in formal learning contexts. Among the findings are that flow conditions, such as focus and challenge, are important to students. However, contrary to conventional expectations, students use game-based learning less for immersion than to achieve solid learning outcomes.

The authors Mona Kamal Ibrahim (Al Ain University, UAE and Helwan University, Egypt), Natalya Spitsyna (Far Eastern Federal University, Russian Federation) and Anastasia Isaeva (Tula State University, Russian Federation) investigate the student perceptions of the sudden transition to e-learning caused by COVID. Based on the results of questionnaires and learning tests, which were answered by students in the Russian Federation at the beginning and at the end of a 3-month period, the authors can prove that the acceptance, comfort, and usefulness of e-learning dropped significantly during the period. The learning outcomes, too, showed worse results especially for male participants.

The paper by the Norwegian author team Olav Dæhli, Bjørn Kristoffersen, Per Lauvås jr and Tomas Sandnes from the University of South-Eastern Norway and Kristiania University College presents LernER, a gamified web-based learning tool for database modeling. The supporting field study includes data from six courses covering four

academic years, during which the learning tool has been continuously improved, as evidenced by increased engagement as well as qualitative feedback from students.

In a comparative study, Aubrie Adams and Weimin Toh from California Polytechnic State University, USA, and Nanyang Technological University, Singapore, survey emotions during the learning process. For this paper, the media text, video and game were compared with respect to 13 emotions. Among the results, six of the tested emotion outcomes indicated positive differences between the text and video game conditions (in comparison to the video condition) for the emotions of joviality, self-assurance, attentiveness, surprise, hostility, and general positive emotions. It is concluded that text and games can evoke a higher emotional intensity than video.

Marelize Malan from University of Johannesburg, South Africa, discusses cooperative learning in online learning environments. Specifically, the assessment results of group work are compared with those of individual work, and it is found that group work receives better scores than individual work. Other findings of this mixed method study include the students' belief that the ability to collaborate is an essential one for their future professional practice.

The topic of gamification is taken up again in the paper by authors Putu Wuri Handayani, Satrio Raffani Raharjo and Panca Hadi Putra from Universitas Indonesia. The study examines the use of points, badges, and leaderboards in a learning management system. Among the positive results are the positive impact on active learning, student acceptance, and the increased participation in online classes stimulated by badges.

The next paper explores olfactory and haptic technologies that have been little used in educational settings so far. Chit Su Mon, Kian Meng Yap, and Azlina Ahmad from Sunway University, Malaysia and Universiti Kebangsaan, Malaysia envision the technologies as a means of supporting visually impaired learners. For the technical prototype examined in a pilot study, excellent scores were obtained for the surveyed parameters of Usefulness, Ease of Use, and Satisfaction, encouraging further research into these innovative technologies.

Joyce West and Makwalete Johanna Malatji of the University of Pretoria, South Africa, report on a study in which pre-service teachers were given the task of designing and implementing a website. The evaluations found that the task promoted the integration of different types of knowledge domains, authentic learning and proximal development, and the pre-service teachers indicated that they gained from the task. Overall, the study recommends higher education institutions to integrate technology into their curricula.

Last, but not least, Paula Charbonneau-Gowdy, who also serves as an associate editor of this journal, together with her colleagues Jaime Pizzaro and Danisa Salinas from Universidad Andres Bello, Chile, demonstrate how the application of a concurrent instructional design model for digitally supported learning activities improved the learning process during the COVID pandemic. The results of applying the instructional design model included positive effects on students' meta-skills, higher participation in collaborative online learning opportunities, and more self-directed engagement.

I hope that readers will enjoy reading these papers, that again document the diversity of the e-learning domain, show the opportunities, but also highlight that the e-learning community still has some homework to do, and the work continues. With this in mind, we would like to thank you for your support in 2021 and wish you a pleasant end to the year and a successful new year in 2022. We would be delighted if you would continue following the EJEL.

Journal Editors
Heinrich Söbke and Marija Cubric