

Integrating technology in teaching and learning practices: students' competencies

Samuel T. Faloye , Victor Faniran 

The Independent Institute of Education, IIE Varsity College, Westville Durban, South Africa

ABSTRACT

Technology usage in teaching and learning is not a new pedagogical practice and the benefits of its adoption are noted in the literature. However, an area that is often neglected when integrating technology into teaching and learning is the competency level of the would-be learners or students. This study investigated student competency levels based on factors such as their prior exposure to computers and the availability of facilitating conditions such as human or technical support. The study adopted a descriptive approach and was quantitative in nature. Data was collected from 368 students by means of a questionnaire. Descriptive statistics were obtained through quantitative analysis and the computer-based assessment acceptance model (CBAAM) was adopted. The results showed that the provisioning of facilitating conditions in a technology-integrated academic environment positively influences student competency in the use of technology. Furthermore, results showed that prior exposure to computers significantly impacts student competency levels in such an environment.

Keywords: teaching and learning practices, technology integration, student competency

Categories: • *Applied Computing ~ Education, e-Learning*

Email:

Samuel T. Faloye – temitayofaloye@gmail.com (CORRESPONDING),
Victor Faniran – faniranvictor@gmail.com

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1 INTRODUCTION

The need to enhance teaching and learning efficiency has led to the emergence and adoption of different technological innovations. One such innovation is the Programmed Logic for Automated Teaching Operations (PLATO) developed at the University of Illinois. The PLATO project aimed to assist teachers to design and deliver module material. In 1974, the International Business Machine (IBM) Research Center also developed a computer program that is capable of teaching linguistic and scientific modules (Garrison, 2011). These innovations sparked interest in the use of technology in education and it has now become a global trend (Garrison, 2011).

In recent years, technology's interactive and dynamic offerings have changed the face of teaching and learning (Faloye et al., 2020; Garrison, 2011). Pedagogical practices have in-

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corporated various technological approaches (Faloye & Ajayi, 2021). Higher education institutions have introduced online registration, e-learning, blended learning and podcasting, etc. (Timotheou & Hennessy, 2021). E-learning enables online delivery of lectures and study material (Adikwu et al., 2017), facilitates communication between teachers and students and enables the latter to submit their work online (Naik et al., 2020). Several studies have shown that effective use of ICT enhances student learning at tertiary level (Faniran et al., 2020; Khlaif & Salha, 2022; Ramaila & Molwele, 2022). It supports interactive instruction and allows for bi-directional pedagogical activities. Teaching and learning can occur any time, any place in a collaborative and interactive manner (Ramaila & Molwele, 2022). The primary function of technology integration in educational institutions is its capacity for interactive learning through discussion, sharing and delivery of module material, communication, and multimedia (Mohebi, 2021). This led to many developed countries adopting technology for pedagogical purposes, with developing countries, including South Africa, now following suit. Indeed, technological innovations are now widespread across all levels of the education system, especially in higher education (Siddiqui et al., 2020).

While South African universities are embracing technology on an on-going basis, the challenge lies in the fact that many students lack competence to make the most of technological tools. The root cause is disadvantaged students' lack of exposure prior to entering university. Economic disparities have resulted in a marked digital divide, with most South African households unable to afford technological infrastructure (Jantjies, 2020; Makhado & Tshisikhawe, 2021). In some instances, the first time a student operates a computer is on gaining access to the university's local area network (Faloye et al., 2020). While universities have adopted numerous strategies to accommodate these 'digital immigrants', most involve a one-size-fits-all approach which is often inadequate to address individual students' challenges.

It is against this background that this study's research question was determined: What factors affect students' computer self-efficacy (or lack of), prior to joining the university? This study investigated student competency levels in the use of learning technologies and the causes of low competency levels. The following sections present a literature review, discuss the methodology employed, and present and discuss the study's results. This is followed by a conclusion and recommendations.

2 LITERATURE REVIEW

Technological integration in educational institutions has been defined differently by different authors (Khlaif & Salha, 2022; Yilmaz, 2021). However, the definitions all revolve around the use of technological tools for pedagogical purposes.

Technology integration has gained traction in educational institutions due to its numerous advantages. Studies show that the use of technology for teaching and learning activities teaches students' basic computer skills (Tanik Önal, 2021; Wang, 2021; West & Malatji, 2021). The ability to create and manipulate data improves their chances of finding a job. However, Njiku et al. (2019) noted that that some academic institutions are reluctant to change their

teaching and learning approach due to a lack of infrastructure and awareness. For instance, the systems currently used to assess student performance in some universities are still based on traditional methods instead of more modern computer-based assessment (CBA), which involves online assessment. Technology-enhanced environments offer a better platform for learning than traditional learning environments and are a more effective way of teaching, learning and assessment. However, students that are not familiar with the use of technology could be at a disadvantage when it comes to CBA (Tosuntaş et al., 2019).

It has also been observed that the use of technology in the classroom saves time as teachers can upload module material online, especially when there are many students in a class (Dexter & Richardson, 2019). It can also be harnessed for one-on-one teaching of students who are lagging behind and lecturers can post additional material on learning sites such as Moodle to enhance students' understanding. Furthermore, Ankiewicz (2020) observed that technology enables teachers to cater to students' diverse needs. This is important as students come from different academic backgrounds and have different learning styles and approaches.

Chisango and Marongwe (2021) also found that, through self-directed learning, students develop confidence and are empowered to take decisions relating to their studies. Similarly, Backfisch et al. (2021) found that students enjoy using technology, especially to search for information and to carry out learning tasks, and that the technology usage develops the digital skills students need for the workplace and to participate in the digital world. Furthermore, around 78% of the students that participated in Jones and Bridges' (2016) study reported that the use of computer-based writing tools such as Grammarly and Hemingway Editor enhanced their writing skills.

Berezki and Kárpáti (2021) conducted a study that incorporated web-based programs in Mathematics courses at the Massachusetts Institute of Technology and found that student performance improved. They concluded that technology boosts student performance in science subjects. Furthermore, the use of technology promotes self-directed learning (SDL), with students assuming primary responsibility for learning activities such as planning, implementing ideas, and evaluation of their efforts without educators' assistance (Bernacki et al., 2020; Ratheeswari, 2018).

However, Sarker et al. (2019) cautioned that educational technologies are not "magic tools" to boost students' academic performance. They highlighted the need to investigate the actual use of the technologies integrated into educational systems as students might use them for leisure or personal use rather than academic activities, with negative effects on their academic performance. Hanshaw et al. (2022) concurred and added that students tend to focus on chatting and visiting social networks. Tanik Önal (2021) conducted a survey to identify the activities that students engage in using technological devices. Around 60% of the respondents indicated that most of their time was spent "engaging in leisure activities" particularly on social networks and on financial websites (e.g., forex). Studies have found that spending an excessive amount of time on the Internet can cause psychological distress such as anxiety, insomnia, social seclusion and depression which in turn negatively affects academic achievement (Banoğlu & Gümüş, 2022; Kroesch et al., 2022).

Hanshaw et al. (2022) found that the amount of time students devote to academic work while using a computer and the Internet varies. They concluded that the total amount of time an individual devotes to the use of technology is a function of their motives for such use. According to Faloye and Ajayi (2021), some students devote less than 10% of their total time on the Internet to academic work, with 90% spent on personal tasks, leisure and entertainment. Hanshaw et al. (2022) reported that students spend a total of 19 hours per week on computer, of which around five was spent on academic work. It can thus be concluded that technology integration does not guarantee improved academic performance especially if time meant for study is spent on non-academic online activities. However, if technology is utilised appropriately by students, it will enhance teaching and learning efficiency and better academic performance will be achieved.

3 METHODOLOGY

A descriptive design approach was implemented to achieve the objective of this study. A descriptive design seeks to describe the characteristics of an observed phenomenon (Bhattacharjee, 2012). The primary aim of a descriptive study is to give a detailed description of the crucial factors surrounding the phenomenon of interest. In the context of this study, the descriptive design offered the researchers clear insight into the factors that contribute towards students' competencies in the use of educational technology.

The target population for this study was first year university students of a higher educational institution in South Africa, with a total population of around 9,000 students. First year students were selected as the literature showed that the impact of digital exclusion is most evident among this grouping. In addition, a pilot study conducted earlier in the study found that this cohort of students struggles to use technologies, particularly those from disadvantaged backgrounds.

This study employed probability sampling techniques because it helps in eliminating sampling bias by giving every student in the target population an equal chance of being selected (Bhattacharjee, 2012). More specifically, a cluster probability sampling technique and a simple random sampling technique were applied in this study. After the clusters were identified and gathered, a sample was drawn from each cluster by using the simple random sampling method. In accordance with Krejcie and Morgan's (1970) sampling table, the sample required was approximately 368. Thus, the combination of all the drawn samples (368 in total) constituted the final sample for the study.

Since this was a quantitative study, data was collected by means of a semi-structured questionnaire. In this study, self-administered questionnaires were given out by hand to the respondents. Before the questionnaires were given out, questionnaire pre-testing was carried out to assess the quality of the questions in the questionnaires.

The first page of the questionnaire described the aim of the research and set out the instructions, and the researchers' contact details. The questionnaire contained 40 questions and employed a five-point Likert scale. The questions were divided into 10 sections. Section A

contained questions on the participants' demographic details, including age, gender, ethnicity, and qualifications. The remainder of the sections contained questions based on the study's constructs. Participants were requested to read the instructions and complete the questionnaire which typically required 10-15 minutes of their time. The data was captured using Microsoft Excel and exported to the Statistical Package for the Social Sciences (SPSS) for cleaning and analysis.

4 CONCEPTUAL FRAMEWORK

This study revolved around the use of educational technologies. However, student achievement after capitalising on technologies depends on certain factors. Table 1 sets out theories that predict acceptance and use of technologies that were used in previous studies. None of these models offers sufficient constructs and variables to investigate student computer self-efficacy. For instance, higher education institutions require students to use learning management systems, computers, the Internet and other technological resources; therefore, investigating their skills in this regard is crucial. Hence, researchers have developed conceptual models that combine constructs and variables from other information systems models. Alki (2020) extended the Technology Acceptance Model (TAM) (Marangunić & Granić, 2015) by adding computer anxiety and computer attitude to investigate students' acceptance of computer-based assessment (CBA).

Table 1: Technology acceptance theories.

	Model	Constructs	Description
Sarver (1983)	Theory of reasoned action	- Attitude - Subject norms	The theory posits that individual behaviour is a function of behavioural intentions that are, in turn, a function of attitudes and subjective norms.
Ajzen (1991)	Theory of planned behaviour	- Attitude - Subject norms - Perceived behavioural control	The theory of planned behaviour is an extension of the theory of reasoned action. The theory posits that an individual's behaviour is driven by behaviour intentions, where behaviour intentions are a function of three determinants: an individual's attitude toward behaviour, subjective norms and perceived behavioural control.

Continued on next page

Table 1 – continued from previous page

	Model	Constructs	Description
Marangunic and Granić (2015)	Technology Acceptance Model	<ul style="list-style-type: none"> - Perceived usefulness - Perceived ease of use 	The Technology Acceptance Model (TAM) is an information systems theory that models how users come to accept and use a technology.
Murray (2009)	Diffusion of innovation theory	<ul style="list-style-type: none"> - Relative advantage - Compatibility - Trialability - Observability - Complexity 	Diffusion research revolves around the conditions which increase or decrease the likelihood that members of a given social system will adopt a new idea, product, or practice.
Chang (2012)	Unified theory of acceptance and use of technology (UTAUT)	<ul style="list-style-type: none"> - Performance expectancy - Effort expectancy - The ease of use - Social factors - Facilitating conditions - Attitude - Behavioural intentions 	The unified theory of acceptance and use of technology model aims to explain user intentions to use an information system and subsequent usage behaviour.

Following an extensive review of the literature, the Computer Based Assessment Acceptance Model (CBAAM) developed by Terzis and Economides (2011) was employed for this study. It was selected because it contains constructs that were deemed relevant in investigating the technological skills required to use available technological resources. The CBAAM was based on three models of technology adoption and usage, namely, the Technology Acceptance Model (TAM), unified theory of acceptance and use of technology (UTAUT) and the theory of planned behaviour (TPB). Seven constructs were derived from these three models, namely, social influence; facilitating conditions; computer self-efficacy; perceived ease-of-use; perceived usefulness; perceived playfulness and behavioural intention. Terzis and Economides (2011) added two constructs known as goal expectancy and content to form the CBAAM causal model to explain the constructs that affect the intention to use computer-based assessment. Thus, as shown in **Figure 1**, the CBAAM model has nine constructs.

This study is focused on the facilitating conditions (FC) and computer self-efficacy (CSE) constructs of the CBAAM model as important factors influencing perceived ease-of-use and ultimately intention to use computer-based assessment. The data captured through the questionnaire forms part of a larger study that considers more of the constructs of the CBAAM model, but these are not discussed in this paper.

Facilitating conditions (FCs) refer to the conditions that a user believes are available to enhance their use of technology (Terzis & Economides, 2011). In the context of this study, this construct was employed to investigate if students felt that the necessary resources and support (staff or technical) were available to them when using technological resources.

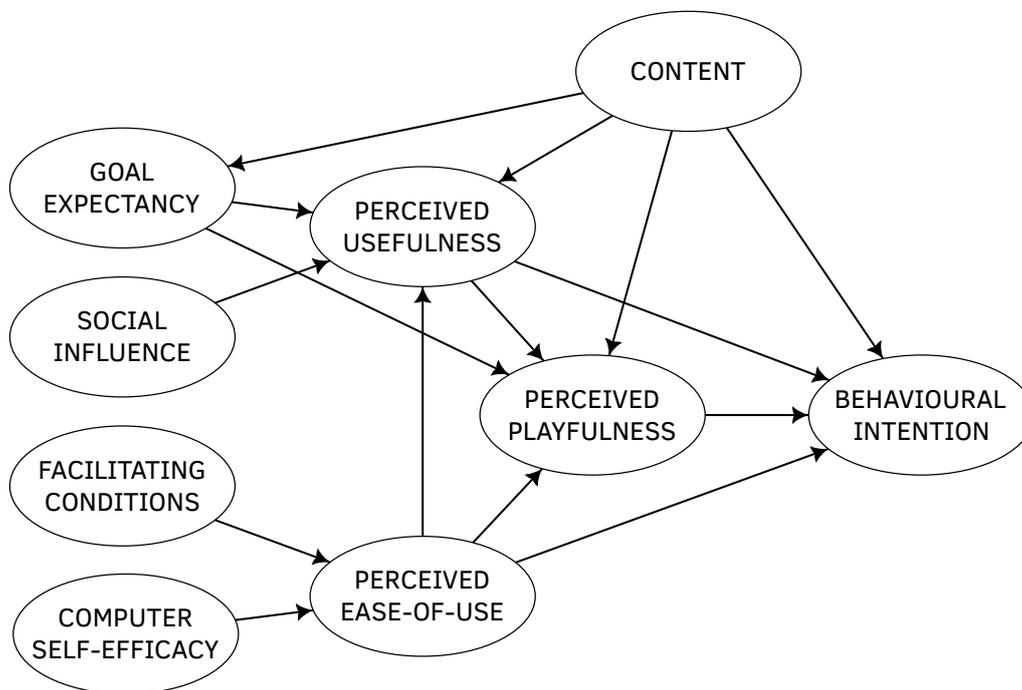


Figure 1: The CBAAM causal model^a

^a(Terzis & Economides, 2011, p. 1034)

Computer self-efficacy (CSE) measures how an individual perceives their capabilities and competencies with regard to the efficient use of computers (Compeau et al., 1999). In the context of this study, it was used to examine if students felt that they could use computers as well as other computing devices on their own or with assistance.

5 ANALYSIS AND DISCUSSION

Inferential and descriptive analysis were employed to generate statistics and make informed inferences. The Cronbach alpha test was used to check the questionnaire's data (the questions) for internal consistency and reliability. For a questionnaire's data to be considered reliable, the reliability coefficient (Cronbach alpha) based on the inter-item relationship (between all the questions) must be greater than 0.7 (Bhattacharjee, 2012). The most important items in the questionnaire that are relevant to this paper are the five items (questions) under the facilitating conditions construct and the six (6) items (questions) under the computer self-efficacy construct. As shown in **Table 2**, the reliability coefficient obtained among the 5 facilitating condition questions (items) was 0.877 (> 0.7) while the reliability coefficient among the 6 computer self-efficacy questions (items) was 0.824 (> 0.7), thereby confirming

Table 2: Scale reliability

Constructs	Cronbach's alpha	Number of items
Facilitating conditions	0.877	5
Computer self-efficacy	0.824	6

the reliability of the questionnaire data used in this study.

Based on a normality test conducted on the questionnaire data, the data gathered from all the questionnaires were not normally distributed; therefore, a chi-squared (non-parametric) test was used to ascertain whether there was a significant relationship between the variables investigated. In a chi-squared test, a p-value greater than 0.05 indicates no significant relationship between the variables under consideration, while one of less than 0.05 points to a significant relationship.

Computer self-efficacy was determined by measuring student competence in the use of computers, while facilitating conditions were all conditions that supported students to use e-learning platforms. Computer self-efficacy was used to gain insights into students' computer skills, and competence levels with regards to the e-learning platform. Facilitating conditions were used to determine whether students had the resources required to use these platforms. We considered computers as they are the most common devices used by students to conduct learning tasks. In addition, most e-learning platforms such as Moodle are accessed through desktops or personal computers due to their large screen sizes.

As shown in **Figure 2**, more than half the participants (N = 368) demonstrated high proficiency in the use of the e-learning platform (Learn) provided by the institution. This could be attributed to their exposure to computers prior to entering university (see **Figure 3**). According to Compeau et al. (2015), access to computers before entering university brings about strong affinity and confidence among students, which in turn leads to high competency levels. Technologies such as computers, the Internet and Blackboard have become an integral component of classrooms from primary to tertiary level (Timotheou & Hennessy, 2021). This has resulted in students developing technological skills from an early age. Furthermore, due to the pervasiveness of mobile technologies, many students are exposed to sophisticated technologies prior to entering university and thus develop the skills required to use them.

A few participants demonstrated low competency in the use of computers. These students were unable to perform several learning tasks on a computer. Further observation revealed that this group of students was only exposed to technologies in their first year at university. This is in line with previous studies that found that prior access to technology impacts students' computer self-efficacy (Ankiewicz, 2020; Faloye & Ajayi, 2021). Young adults tend to develop an affinity with technology through continuous usage which, in turn, increases their competency level.

As shown in **Figure 4**, most of the students stated that they were competent in the use of computers. Also, a significant percentage of participants who had access to a computer

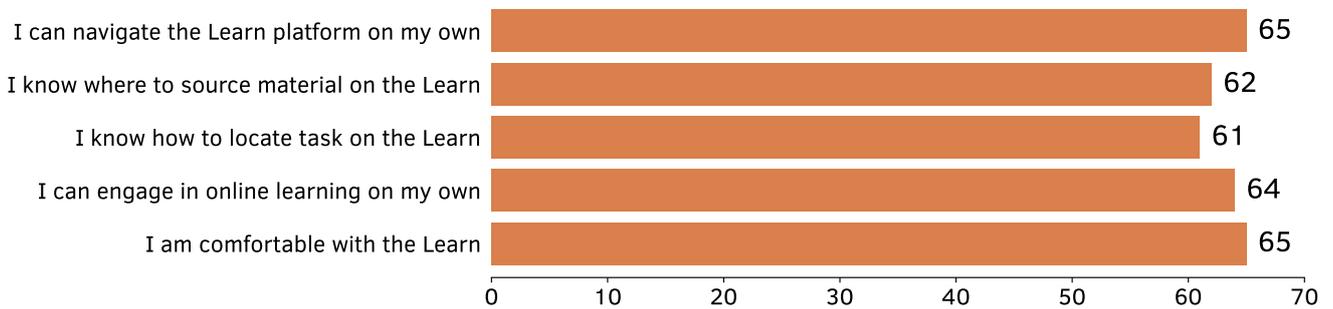


Figure 2: Student competency level with the e-learning platform (Learn)

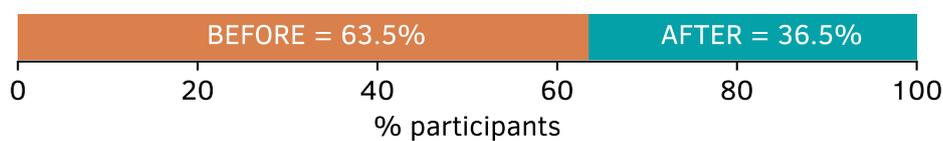


Figure 3: Prior computer exposure - *before* or *after* joining the university

prior to entering university indicated that it was easy to learn to operate a computer and that technology was easy to use. However, most of the participants without prior access to computers reported that it was not easy to learn to use a computer. This could be attributed to unfamiliarity and computer anxiety. Students, particularly African students with no prior exposure to technology are likely to exhibit computer anxiety which may impact computer self-efficacy (Chisango & Marongwe, 2021). Computer anxiety refers to being fearful of using a computer and related technologies. Students that suffer from such anxiety are likely to find it difficult to use a computer and will often avoid computer-related tasks. Therefore, computer anxiety is a crucial factor that affects students' computer self-efficacy.

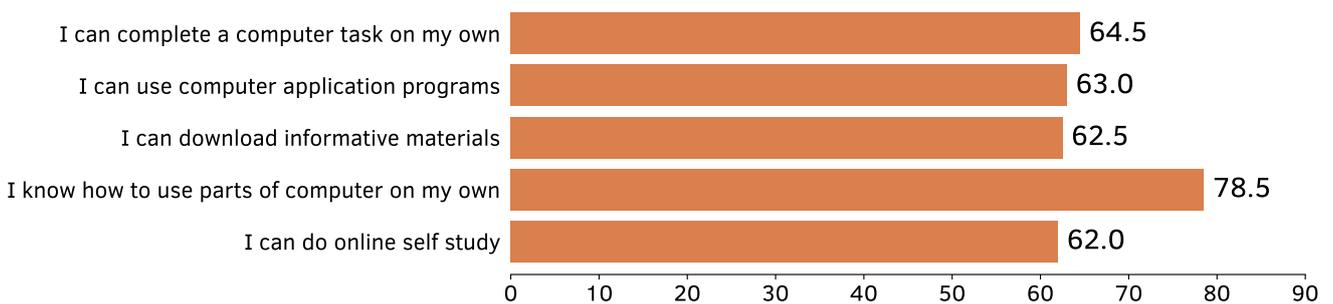


Figure 4: Student competency level with computers

It can thus be concluded that students who had access to a computer prior to entering university are likely to be more competent in their usage than those who only had access after joining the university. This is because they are more likely to have developed the skills

and confidence to use technologies. Time of access is therefore likely to impact students' computer self-efficacy. The result of a chi-squared test between the computer self-efficacy and facilitating conditions variables, shows that there is significant relationship ($p < 0.05$) between the computer self-efficacy of students and the facilitating conditions surrounding the students' use of e-learning platforms (see **Table 3**). Therefore, our results suggest that access to computers impacts students' competency level in the use of computers and e-learning platforms.

Table 3: Chi-squared test between CSE and FC

	Value	df	Asymptotic Significance (2-sided)
Pearson chi-square	44.608	3	0.000
Likelihood ratio	47.767	3	0.000
Linear-by-linear association	37.624	1	0.000

Of the total number of participants who indicated that they did not have access to a computer before entering university (36.5%, $N = 134$), about 48% ($N = 64$) demonstrated a reasonable competency level with a computer and e-learning platforms. This suggests that even if students do not have access to any form of technology before attending university, the technological facilities provided by the institution enable them to learn how to use and access technology and its resources, which in turn enhances their self-efficacy and performance. This result suggests that higher education institutions' efforts to bridge the access and skills gap among students through providing technological resources and training is helping to alleviate the digital divide and its impact on student learning.

6 CONCLUSION

The study offers improved understanding of the factors that should be considered when integrating technology in teaching and learning. Using the CBAAM, the study found that prior exposure to computers impacts student computer self-efficacy. It was also found that unfamiliarity with technologies caused computer anxiety which negatively impacted computer self-efficacy. Lastly, the results showed that students with no prior exposure to technologies in any form acquire technological skills and perform better due to academic institutions' efforts to bridge access and skill gaps.

As in other parts of the world, the COVID-19 pandemic led to South African higher education institutions resorting to online learning platforms. Some students have struggled to adapt to this transition due to numerous factors, including the fact that they have to navigate systems on their own. When students have to stay at home, they lack peer support, which many use to share information and knowledge on campus. Therefore, higher education institutions should formulate strategies to assist digitally disadvantaged students entering university. This could take the form of technology training, and on-going technical support.

7 FUTURE RESEARCH

The study only considered first-year students. It is recommended that future research on technology integration in teaching and learning focus on all students. Given the shift to virtual technologies and online learning due to the COVID-19 pandemic, it is also recommended that future research should investigate the impact of the digital divide on such integration.

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