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Research Article

The COVID-19 pandemic and student engagement in online learning: The moderating effect of technology self-efficacy

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This study examines the moderating effect of technology self-efficacy on the relationship between online learning and student engagement in a higher education setting. A survey was used to gather data from participants ($n = 425$) who were sampled from a population of registered students in a Technical University in Ghana. The data gathered were examined using hierarchical regression analysis. Results revealed that, technology self-efficacy strengthens 1) the positive relationship between online learning environment and student engagement; and 2) the positive relationship between instructional resources and student engagement. Secondly, the results revealed that the type of device used by students in the online learning environment has a positive and significant effect on student engagement. Conversely, findings of the current study show that while gender has a negative but significant effect on student engagement, age and academic discipline have insignificant effect on student engagement in the online learning setting. These findings among others lead the authors to propose ways that future studies could examine how technology self-efficacy, learning devices, instructional resources, institutional support systems and the online learning environment could be developed to enhance effective student engagement.

Keywords: Student engagement; Technology self-efficacy; Online learning; COVID-19; Learning resources

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1. Introduction

The SARS-CoV-2 (COVID-19) pandemic has created momentous challenges for educational intuitions with about 38,560,502 learners representing 2.4 percent of total learners worldwide in 10 countries still out of school due to countrywide school closures as of November 11, 2021. Not only did the COVID-19 pandemic alter the traditional and blended mode of learning to fully remote delivery (Prokes & Housel, 2021), it also stretched the resources of countries and educational institutions. Without doubt, the COVID-19 pandemic gave rise to the use of digital tools and technology-mediated learning processes in educational institutions (Camas et al., 2021; Dhawan, 2020). In Ghana, evidence show that before the COVID-19 pandemic, very few higher education institutions (HEIs) had appraised and adopted innovative teaching and learning practices as well

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as the use of technology-mediated learning systems (Larbi-Apau, 2020). Resultantly, some HEIs had to develop strategies to cope with the COVID-19 pandemic especially with proprietary or open-source learning management systems to ensure that teaching and learning occurred outside the traditional brick and mortar settings. Other HEIs also resorted to re-engineering policies and practices to cope with the challenges that came with the COVID-19 pandemic especially, concerning online teaching and learning (Larbi-Apau, 2020).

For some Technical universities, which are the context of the current study, the lack of virtual laboratories meant that students could not access laboratories while they were out of school. Furthermore, students who did not have access to learning devices such as computer laptops and smart phones could not access the online learning platforms. More worrying is the fact that some HEIs did not adequately prepare academics and students to cope with the disruptions through the use of social network sites and learning management systems for online teaching and learning. Other constraints include, inadequate organizational capacities to deploy innovative educational technologies and a lack of capacity to synchronize student learning, student databases, support systems and university-wide connectedness (Larbi-Apau et al., 2020). While various scholarly studies have focused on the effect of the COVID-19 pandemic on teaching and learning in HEIs, very few have examined the relationship between the preparedness of institutions to mitigate the effect of such disruptions on teaching and learning, the provision of instructional resources by HEIs and student engagement.

Previous studies have shown that, learning through online modes can only be effective when students are actively engaged in the process that lead to the development of their knowledge and skills (Christmann, 2017; Ding et al., 2018). Therefore, while technology serves as an integral part of teaching and learning processes in educational institutions (Wang et al., 2018), it has become important for HEIs to develop structures that enhance student engagement in online learning environments. Particularly, engagement could lead to quality student experiences (Lawson & Masyn, 2015; Howard et al., 2016), academic performance (Ding et al., 2018; Northey et al., 2018; Rashid & Asghar, 2016), desired learning outcomes (Manwaring et al., 2017), and intensity and quality of participation (Azevedo et al., 2012) in the online learning environment. Conversely, when online teaching and learning processes do not lead to quality student engagement, it could result in student disengagement and possible student dropout.

Prior literature has shown that the majority of students have challenges with the application of technology in the learning processes (Margaryan et al., 2011; Howard et al., 2016). Challenges with the application of technology could lead to further differences between teachers and students′ expectation of technology and disengagement in learning especially, those that concern students′ technology-related experiences (Alhabeeb & Rowley, 2018; Howard et al., 2016). Therefore, attempts to consider all students as knowledgeable in the application of learning technology could be problematic especially for teachers who are required to design learning modules (Howard et al., 2016; Philip & Garcia, 2013) and this was evident during the COVID-19 pandemic. Although a lot of studies have been conducted on students′ technology self-efficacy at the institutional level (Compeau & Higgins, 1995; Howard et al., 2016; Philip & Garcia, 2013), very few have sought to examine the moderating effect of technology self-efficacy on student engagement in online learning. Consequently, the aims of the current study are to examine the moderating effect of technology self-efficacy on: 1) the association between online learning environment and student engagement and; 2) the association between instructional resources and student engagement in the university.

The importance of examining the moderating effect of technology self-efficacy on the association between online learning environment and student engagement in a technical university in Ghana served as the researchers′ point of departure. The researchers′ choice of a Technical University in Ghana as the context of the current study is due to a dearth of research on online learning and technology application in the teaching and learning processes in Technical Universities. Accordingly, the current study was guided by two research questions (RQ):

1) What factors influence the perceptions of students about online learning environment, instructional resources and engagement in the university setting during COVID-19?

2) What is the moderating effect of technology self-efficacy on the association between a) online learning environment and student engagement and b) instructional resources and student engagement in the university?

1.1. Study Context

The context of higher education in Ghana represents one that is diverse ð often categorized into public, regional and private universities. As of 2019, there were 10 public universities, 81 private tertiary institutions offering degree programmes, one regionally owned university, 8 technical universities, 2 polytechnics and 7 professional universities (National Accreditation Board [NAB], 2019). This study was conducted in a Technical University in Ghana with a population of 3,193 students. The rationale for choosing the technical university colleges was due to the following: (1) the laboratory and hands-on base of teaching and learning which often involves less online learning modes; (2) the seeming challenges Technical universities face in deploying technology-mediated learning systems and state of the art virtual laboratories for teaching and learning purposes and; (3) the challenges many Technical Universities face in adopting online learning technology to support teaching and learning and the effect it could have on institutions as witnessed during the COVID-19 pandemic. As part of measures to enhance continuous learning and to avoid disruptions in the teaching and learning processes, the university put in place an action plan that aimed at promoting online learning. First was the development of training manuals for the training of lecturers and relevant support for staff in the use of social network sites - Zoom, Google suite as well an online learning platform ð Moodle. Second was the actual training of lecturers in the use of Zoom and Moodle for effective online learning. In addition to the use of Moodle and Zoom, lecturers were also encouraged to set up WhatsApp platforms for their class. However, not all students were able to join the online sessions due unstable internet connectivity and in some cases lack of money to by internet data. There were students who did not have Computers or mobile phones to support their learning. This meant that such student had to borrow either mobile phones or laptops from their colleagues or family members.

1.2. Theoretical Underpinning

The current study was underpinned by two main theories ð social cognitive theory and constructivism. First, social cognitive theory (Bandura, 1997) explains the concept of self-efficacy that is essential for the development of individual judgment, and ability to perform a course of action through behavioral, cognitive and other personal factors in an environment. The beliefs of individuals about their efficacy can be developed and reinforced in four principal ways: mastery experiences; modelling; social persuasion; and physiological states (Wood & Bandura, 1989). Although various studies have been carried out on the factors that enhance digital learning environment in higher education setting, there is dearth of research into what factors explain the moderating effect of technology self-efficacy on student engagement.

Second, constructivism - that is a theory of learning explains the active and interpretative process of how individuals make meaning of activities in their environment (Oliver & Herrington, 2003). Other formulation suggest that constructivism is based on the assumption that students construct their knowledge and experience learning as active process rather and not a passive process (O′Connor, 2020). Therefore, the active participation of learners in an online learning environment is student-centric because, it incorporates elements such as technology application, pedagogy, institutional provisions including learning resources and interaction. This further demonstrates the continuous shift of teaching pedagogies from a teacher-centred to learner-centred approach (Soetanto & MacDonald, 2017). Resultantly, the aim of online learning systems should be to enhance students′ learning experience in an educational setting (Christmann, 2017; Ituma, 2011). To examine how constructivism serves to enhance the learning experiences of students in an online learning environment, this study focused on student engagement as concept

that intersects with the learning environment, technology and institutional support systems. Student engagement is a complex and multifaceted concept with meta-construct that explains how students achieve their learning goals or outcomes through interaction with their learning environment (Kahu, 2013).

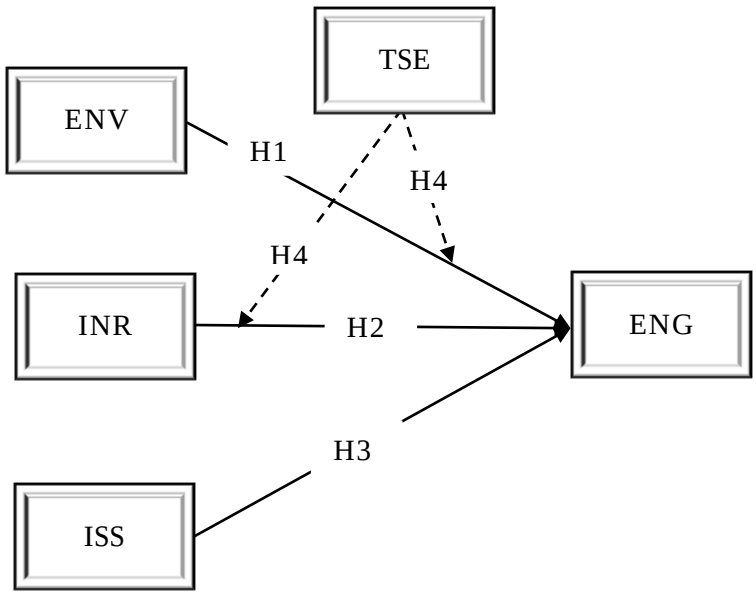
Four elements underpin engagement: 1) The behavioural perspective that explains students′ behaviour in relation to institutional policies and practice as well as effective teaching practice; 2) the psychological perspective, that explains engagement as an individual internal and psycho-social process; 3) the socio-cultural perspective, which defines the role of the socio-political context and; 4) the holistic perspective, that integrates the different facets of engagement (Kahu, 2013, p.758). A summary of literature on student engagement, technology self-efficacy and the online learning environment are presented in Table 1.

A cursory look at the findings of the different studies in table 1 show that there is a relationship between student engagement, technology self-efficacy and online learning. For instance Cassidy and Eachus (2002) show that there are significant positive correlations between computer self-efficacy and computer experience and familiarity with computer software packages. Similarly, the study by Pellas (2014) revealed that computer self-efficacy, metacognitive self-regulation and self-esteem in online courses were positively correlated with student's cognitive and emotional engagement factors. On their part, Srisupawong et al. (2018) showed that perceptions of a classroom-learning environment with autonomy, meaningfulness, and involvement are positively associated with strong computer self-efficacy.

1.3. The Conceptual Framework and Hypothesis

The conceptual framework is derived from the social cognitive theory and constructivism. First, Figure 1 shows the relationship between online learning environment, instructional resources, and institutional support systems during the COVID-19 pandemic. Secondly, figure 1 illustrates the moderating effect of technology self-efficacy on: 1) the relationship between online learning environment and student engagement and; 2) the relationship between instructional resources and student engagement in the university.

Figure 1
The student engagement framework



Note. ENG- Student engagement; TSE ð Technology self-efficacy; ENV ð Online learning environment and; INR ð Instructional resources; ISS- Institutional support systems and interventions.

Table 1
Literature summary table for student engagement, technology self-efficacy and online learning environment

Author/Year of pub.	*Study setting*	*Theoretical underpinning*	*Methods (Approach)*	*Findings*
Durndell and Haag (2002)	Higher Education	Integrated theories	Quantitative approach	Male students demonstrated positive attitudes towards the internet; stronger computer self-efficacy; lower computer anxiety and; longer use of the Internet than females.
Cassidy and Eachus (2002)	Higher Education	Social cognitive theory	Quantitative approach	There are significant positive correlations between computer self-efficacy and computer experience and familiarity with computer software packages.
Pellas (2014)	Higher Education	Motivation and students' engagement	Quantitative approach	Computer self-efficacy, metacognitive self-regulation and self-esteem in online courses were positively correlated with student's cognitive and emotional engagement factor.
Howard, Ma and Yang (2016)	High School Students	Technology use and experiences	Quantitative approach	There are different patterns among school engagement and computer-efficacy factors as well as between students with positive and negative engagement with digital technologies.
Rashid and Asghar (2016)	Higher Education	Casual theory	Quantitative approach	The use of technology has a direct positive relationship with students' engagement and self-directed learning.
Li and Baker (2018)	Higher Education	Engagement	Quantitative approach	The same engagement variable could be oppositely associated with achievement of different subgroups for both behavioral and cognitive engagement.
Srisupawong et al. (2018)	Higher Education	Self-efficacy	Quantitative approach	Perceptions of a classroom-learning environment with autonomy, meaningfulness, and involvement were positively associated with strong computer self-efficacy.
Theobald, Windsor and Forster (2018)	Higher Education	Social constructivism	Qualitative approach	Students have the capacity to lead and engage in a community of learning and to take ownership and responsibility where scaffolding is provided.
Wu and Cheng (2019)	Higher Education	Theory of attention and meta-attention and gender differences	Quantitative approach	Higher media-multitasking self-efficacy is associated with higher executive and orienting problems for females, and higher alerting problems for males.

1.3.1. Student engagement

Prior scholarly studies on engagement has revealed two main dimensions - in-class (or academic) engagement and out-of-class engagement that are essential in explaining the individual and contextual factors in relation to the engagement discourse (Kuh, 2009). Concerning the academic dimension, Rahimi et al. (2015) argue that effective students′ engagement takes place when learners construct their personal learning environment (PLE) through communication between facilitators and students. This assertion demonstrates the importance of the relationship between student engagement and the learning environment. Lawson and Masyn (2015) emphasized latent profile analysis factors - context, motivation (sense of belonging or self-assessed competency beliefs), engagement, and outcome as essential components of students′ engagement. For the current study, student engagement was conceptualized by way of three main micro-environment factors: cognitive, behavioral and relational. Northey et al. (2018, p.322) show that sstudent interaction and participation in learning activities are important for engagement and academic outcomes while perceived engagement in the learning process has a positive mediating control on general academic outcomes.

1.3.2. Student engagement

Technology learning environment is characterized by different systems such as Learning Management System (LMS), Course Management System (CMS), Virtual Learning Environment (VLE) or even a Knowledge Management System (KMS) that all serve as platforms for teaching and learning activities (Moore et al., 2011). This study identifies two strands of the online learning environment ð the shared learning environment and the personal learning environment (PLE). Concerning the shared learning environment, the advantages of engagement in online learning environments include; providing learners with increased autonomy, collaboration, creativity (Jesson et al., 2018) and flexibility in the learning process. Jesson et al. (2018) conceptualize the digital learning environment by using digital devices, interaction, shared pedagogy and increased collaboration to explicate effective learning practices. Using the term virtual learning environments (VLE) (Orey & Rosa, 2018) argue that the learning environment could be considered as a democratic educational setting that supports that advancement of collaborative learning and interactions between learners and teachers. In a previous study, Skinner and Pitzer (2012) argue that the contextual factors, also referred to as the engagement facilitators explain the environmental factors that support the development of the knowledge and skills of students. Similarly, Manwaring et al. (2017) explain that the environmental factors consist of learning activity, class size and the mode of delivery (online or face-to-face). The development of the personal learning environment has evolved to include critical roles such as: students as producers of content, students as socializers, and students as decision makers in the online learning environment (Rahimi et al., 2015). The concept of PLE could also be linked to what Premlatha and Geetha (2015) refer to as adaptive e-learning environment that consist of personal motivators, learning objectives and learning style. For the current study, the online learning environment is conceptualized as the general learning environment and the personal learning environment.

H_1: There is a positive relationship between online learning environment and student engagement.

1.3.3. Instructional resources

Instructional resources consist of learning technologies such as Canvas, Facebook, Piazza, Skype in the Classroom, Blackboard learn, Top Hat, YouTube, Twitter, Pinterest, Learning Management Systems and Moodle. However, the importance of instructional resources goes beyond the provision of technologies required for teaching and learning to include the effectiveness of the devices in engaging students and providing them with important learning experiences (Ferguson, 2012). Prior study by Gupta and Pandey (2018) show that students′ engagement in an online learning environment is positively influenced by online learning resources that are intellectually

and academically stimulating. Conversely, the lack of learning resources could affect online teaching and learning. For instance, Mutisya and Makokha, (2016) show that academics who taught through online learning modes identified heavy workload, lack of internet connectivity and poor remuneration for developing online learning content as some of the factors that affect online learning in Kenyan Universities. Furthermore, inadequate laboratories and a lack of computers and laptops (Mutisya & Makokha, 2016) could also affect online teaching and learning. The application of learning resources could alter the learning practices and patterns in a technology-mediated learning environment (L·pez-P®rez et al., 2011). The COVID-19 pandemic brought about spontaneous reactions from some leaders of HEIs particularly because of resource and technical challenges.

Consequently, this study hypothesises that:

H_2: There is a positive relationship between instructional resources and student engagement.

1.3.4. Institutional support systems

The response of leaders of HEIs to deploy interventions that address the immediate needs of students during the pandemic demonstrates the importance of institutional structures, policies and administrative willpower to respond to emergencies. Porter et al. (2014) posit that structure, strategy and support constitute essential factors for developing technology-mediated learning framework in educational institutions. Particularly, institutional structure (Porter et al., 2014) serves as the context that supports learning and this include policy on technology usage, teaching and learning philosophy, governance and assessment of students′ performance. The support factor explains the technical and pedagogical support as well as institutional incentives to promote online learning (Graham, 2018). While the three-factor framework provides relevant information on the adoption of a structure for technology-mediated learning, it does not provide information on classroom factors that are particularly important for the teaching and learning processes. Consequently, this study postulates that:

H3: There is a positive relationship between Institutional support systems and student engagement.

1.3.5. Technology self-efficacy

Technology self-efficacy in the context of our study is very important due to the challenges students face in developing their cognitive abilities using technology in their learning processes. Terms such as computer efficacy (Howard et al., 2016) or technology self-efficacy have been used in different studies to describe individual judgment in the application of technology in learning. For the purpose of this study, the term technology self-efficacy is used due to the broad scope of technology usage and its application with other tools in the online learning environment. While technological advances continue to alter the way individuals communicate, socialise and learn (Owusu-Agyeman & Larbi-Siaw, 2017; Reyna et al., 2018), it has become necessary to examine how technology self-efficacy moderates student engagement and the learning environment in a higher education setting. High end technology usage also depend on the instructional resources that are made available to students (Larbi-Siaw & Owusu-Agyeman, 2017; Porter et al., 2014) as well as the development of a convenient environment that support the exchange of knowledge (Ding et al., 2018; L·pez-P®rez et al., 2011). Focusing on a different mix, Lin and Wang (2012) posit that a link between task-technology fit, perceived usefulness of technology and continued intention to use serve as motivation for the adoption of technology in a technology-mediated learning environment. The current study postulates that the stronger the Technology self-efficacy, the stronger the relationship between the online learning environment and student engagement. Secondly, the stronger the technology self-efficacy, the stronger the relationship between instructional resources and student engagement. Drawing from the literature, this study hypothesizes the following:

H4a: Technology self-efficacy moderates the relationship between the online learning environment and student engagement.

H4b: Technology self-efficacy moderates the relationship between instructional resources and student engagement.

Resultantly, the strength of positive relationship between a) online learning environment and b) Instructional resources and student engagement is greater when technology self-efficacy is high.

2. Method

A quantitative research approach was used to gather and analyze empirical data from students in a Technical University in Ghana. The research methodology used in this study is consistent with the prior procedures used in conducting quantitative research in a higher education setting. For instance, Henrie et al. (2015) have argued that the measures used in technology-mediated learning environment should be adaptable to the unique challenges of the students and the context studied.

2.1. Participants

The population of the current study context were 3,193 students who were enrolled in different programmes in four academic schools in a Technical University in Ghana. The mode of teaching and learning was through online learning mode. Using a probability sampling method (simple random sampling), the researchers gathered data from 437 students. Out of the 800 questionnaires distributed to level 200 and 300 students, 437 were retrieved representing 54.60%. Also, the number of valid survey responses was 425 and this represented a valid response rate of 53.13%. Demographic characteristics of the participants were presented in Table 2.

Table 2
Demographic characteristics of participants

	Number of participants	*Percentage of participants (%)*
Gender		
Male	195	45.88
Female	230	54.12
School		
School of Applied Sciences and Technology	127	29.88
School of Applied Arts	58	13.64
School of Engineering	120	28.24
School of Business and Management Studies	120	28.24

In terms of the distribution of participants by the devices they use, the number of participants who indicated that they use mobile phone for their learning was 323 which represent 76% of participants. Conversely, 78 participants (18.35%) and 24 (5.65%) participants indicated that they used Computer laptops and Tablets for learning online.

2.2. Instruments

The independent variables in the study are the online learning environment, instructional resources, and institutional support systems and interventions. Student engagement served as the dependent variable while technology self-efficacy served as the moderating variable.

2.2.1 Student engagement measures

Student engagement with technology refers to the involvement of students in technology-mediated process of learning (Howard et al., 2016). The engagement construct was derived from the Higher Education Student Engagement Scale (HESES) (Zhoc, 2019). The construct consisted of 12 items: online engagement consisted of four items; cognitive engagement scale consisted of four items and; social engagement with peers scale consisted of four items. Sample items were, òI

regularly use web-based resources and information designed specifically for the courseó and òI find my courses intellectually stimulatingó ($\alpha = 0.905$).

2.2.2. Technology self-efficacy measures

Self-efficacy that is the moderating variable in this study is the core of Bandura′s socio-cognitive theory that emphasizes the observational role of learning and social experience in the development of human personality. The technology self-efficacy construct consisted of five items. Three items were derived from the Computer / technology self-efficacy construct by Manwaring et al (2017) and the other two from the Computer / Internet self-efficacy construct by Hung et al. (2010). Sample item was, òI am capable of using the internet to find information I need.ó ($\alpha = 0.882$).

2.2.3 Institutional support systems and interventions

The institutional support systems and interventions construct (five items) was derived from the institutional presence construct by Shin and Chan (2004). Sample item was, òI believe that student support staff are willing to help me if I have technical problems while taking the course.ó ($\alpha = 0.912$).

2.2.4 Instructional resources

The instructional resources construct comprised of six items. Five of items were obtained from Alhabeeb and Rowley′s (2018) e-learning systems and Online learning resources construct while the last item was developed from the literature. Sample item was, òI receive frequent communication regarding new learning materials online.ó ($\alpha = 0.909$).

2.2.5 Online learning environment measure

The online learning environment construct consisted of four items. All the four items were obtained from the environment-structuring construct by Barnard et al. (2009). Sample item was, òI usually find a comfortable place to study for my online courses.ó ($\alpha = 0.819$).

2.2.6. Control variables

The control variables for this study were made up of age, gender, programme of study and type of device. Age was categorized based on nine descriptions. For the purposes of the regression analyses, indicator variables (dummy codes) were created with reference categories as follows: gender (females); age (23-27); academic school (SASTS) and; type of learning device (mobile phone). Pearson et al. (2003) show that age and gender have a direct influence on an individual′s computer efficacy. All the constructs in the study were gauged using a 5-point Likert scale where 1 represented ăstrongly disagreeʹ and 5 represented ăstrongly agreeʹ.

2.3. Procedure

A paper-based survey was administered in February and the first week of March 2021 at the university during the contact sessions of students. Although the data was collected at a time when students had moved from the online learning to the blended mode, the focus of the study was to gather the experiences of students during the full-scale online learning period. Therefore, students were explicitly informed to answer the items based on their experiences during the peak of the COVID-19 pandemic when they were learning via the online learning mode. The researchers relied on the support of different course lecturers and school administrators to assist with the lecture schedule of participants who attended the mandatory face-to-face sessions of their courses. Particularly, the researchers requested for between 40 to 50 minutes after each class to distribute the questionnaire where they also had the opportunity to explain the items to the participants who required additional clarification. In line with the institutional COVID-19 protocols the students were informed to maintain their seats akin to the seating arrangements during their lecturer sessions. Students used between 35 to 45 minutes to provide their responses. Prior to completing the questionnaire, participants were made to consent to their participation in the study. The data

that was gathered from the survey was analysed using statistical methods and software - Statistical Package for the Social Sciences (SPSS) version 27. In accordance with the rules of ethical consideration, the researchers sought institutional approval to conduct the current research. Additionally, the rationale of the study, potential risks and benefits as well as the right of participants to withdraw from the study were clearly stated on the instrument.

2.4. Data Analysis

The first step was to examine the data for univariate or multivariate outliers using Mahalanobis distance and box plots. The results showed that the data was normally distributed and that, there were no univariate or multivariate outliers. The researchers then proceeded to conduct confirmatory factor analysis (CFA) specifically to: 1) evaluate the structure of the measurement models; 2) to explain the association between the predictor variable ð ENG and the four outcome variables ð INR, ISS, TSE and ENV and; 3: to reveal whether the predictor variable and the outcome variables are empirically distinct variables in the sample we used. To perform the CFA, the maximum likelihood estimation method was chosen to determine the parameters of the data distribution. In particular, the study relied on results of the chi-square statistics and fit indices using the root mean standard error of approximation (RMSEA), comparative fit index (CFI), Tucker Lewis index (TLI) and normed fit index (NFI) to assess the model (Anderson & Gerbing, 1988). The model demonstrated an acceptable model fit: $\mathcal{X}^2$ = 3336.065(584); CFI = 0.972; TLI = 0.958; NFI = 0.965; and RMSEA = .05. Importantly, the standardized factor loadings exceeded the threshold of 0.50 (Hair et al., 2014) and was significant at 0.05 as shown in Table 3.

The assessment of measurement model of the current study consisted of Cronbach′s Alpha (À), composite reliability, average variance extracted (AVE) and the Fornell-Larcker criterion. In particular, Cronbach′s alpha and composite reliability were calculated to show internal consistency among the constructs whereas AVE was used to gauge convergent validity. Prior study suggest that in order to obtain satisfactory convergent validity, the estimated parameters between the latent variables and the indicators should be at least 0.50 (Hair et al., 2014). The study used the Fornell-Larcker criterion to examine discriminant validity. For the study to obtain an estimate of the reliability based on the inter correlation of the observed indicator variables, Cronbach′s alpha was used to evaluate internal consistency reliability while composite reliability was used to assess the internal reliability of the variables including the different outer loading.

As shown in Table 3, all Cronbach Alpha coefficients and composite reliability demonstrated values above the threshold of 0.7 (CR=>0.76, À=>0.77) as recommended by Hair et al. (2014). Furthermore, in other to obtain a confirmation of convergent validity the AVEs were computed as displayed in Table 3. Significantly, the AVEs demonstrated values above the 0.5 threshold (Hair et al. 2014) with the AVE of each of the latent constructs higher than squared correlation of the latent variable. Moreover, each construct shares more variance with its related indicators than with any other construct (Hair et al. 2014). As explained earlier, the Fornell-Larcker criterion (Fornell & Larcker 1981) was used to evaluate discriminant validity (to show the extent to which the constructs are distinct from each other based on empirical standards). As shown in Table 4 below, the square root of the AVEs of each construct revealed a value that is greater than its highest correlation with any of the other constructs.

Table 4 shows the correlation matrix with the mean, standard deviation and the square root of AVEs. Results revealed that TSE (M=3.72, SD=0.81) demonstrated the highest mean values while ISS (M=3.42, SD=0.93) demonstrated the least mean values. The study evaluated the strength of the relationships between the five variables using Pearson product-moment correlation coefficient. Results revealed that ENG is strongly associated with INR ($r = 0.73, p < 0.01$), ISS ($r = 0.60$, $p < 0.01$) and ENV ($r = 0.59, p < 0.01$). Similarly, the results demonstrated that TSE is strongly

Table 3

Confirmatory Factor Analysis results for student engagement

Paths	*Standardized factor loadings*	*Standard error*	*95% confidence intervals*	R^2 *values*	*CA (À)*	*CR*	*AVE*
ENGL1--->ENG	0.744	0.062	[0.866, 0.622]	0.554			
ENGL2--->ENG	0.844	0.056	[0.954, 0.734]	0.712			
ENGL3--->ENG	0.799	0.058	[0.913, 0.685]	0.638			
ENGL4--->ENG	0.674	0.056	[0.784, 0.564]	0.454			
ENGP1--->ENG	0.645	0.061	[0,765, 0.525]	0.416			
ENGP2--->ENG	0.755	0.058	[0.869, 0.641]	0.570			
ENGP3--->ENG	0.769	0.055	[0.877, 0.661]	0.591			
ENGP4--->ENG	0.674	0.058	[0.788, 0.560]	0.454			
CENG1--->ENG	0.739	0.055	[0.847, 0.631]	0.546	0.905	0.912	0.576
CENG2--->ENG	0.778	0.056	[0.888, 0.668]	0.605			
CENG3--->ENG	0.711	0.049	[0.807, 0.614]	0.506			
CENG4--->ENG	0.636	0.058	[0.750, 0.522]	0.404			
OENG1--->ENG	0.756	0.059	[0.872, 0.640]	0.572			
OENG2--->ENG	0.848	0.054	[0.954, 0.742]	0.719			
OENG3--->ENG	0.774	0.059	[0.890, 0.658]	0.599			
OENG4--->ENG	0.887	0.059	[0.990, 0.771]	0.787			
INSR1--->INR	0.757	0.061	[0.877, 0.637]	0.573			
INSR2--->INR	0.791	0.057	[0.902, 0.679]	0.626			
INSR3--->INR	0.790	0.056	[0.899, 0.680]	0.624	0.909	0.917	0.650
INSR4--->INR	0.859	0.061	[0.979, 0.680]	0.738			
INSR5--->INR	0.802	0.056	[0.912, 0.692]	0.643			
INSR6--->INR	0.833	0.061	[0.953, 0.713]	0.694			
INSS1--->ISS	0.734	0.060	[0.852, 0.616]	0.539			
INSS2--->ISS	0.792	0.055	[0.899, 0.684]	0.627			
INSS3--->ISS	0.857	0.061	[0.977, 0.737]	0.734	0.912	0.915	0.685
INSS4--->ISS	0.898	0.061	[0.998, 0.778]	0.806			
INSS5--->ISS	0.847	0.058	[0.961, 0.733]	0.717			
TESE1--->TSE	0.805	0.057	[0.917, 0.693]	0.648			
TESE2--->TSE	0.731	0.056	[0.841, 0.621]	0.534			
TESE3--->TSE	0.695	0.054	[0.801, 0.589]	0.483	0.882	0.890	0.621
TESE4--->TSE	0.892	0.060	[0.992, 0.774]	0.796			
TESE5--->TSE	0.801	0.060	[0.919, 0.683]	0.642			
ELEN1--->ENV	0.721	0.059	[0.837, 0.605]	0.520			
ELEN2--->ENV	0.888	0.056	[0.998, 0.778]	0.789	0.819	0.805	0.515
ELEN3--->ENV	0.895	0.055	[0.992, 0.787]	0.801			
ELEN4--->ENV	0.851	0.058	[0.964, 0.737]	0.724			

Note. Goodness-of-fits statistics: $\chi^2(584) = 3336.065, p = 0.001$; $RMSEA = .05$; $CFI = 0.972, TLI = 0.958$ *and* $NFI = 0.965$.
$* p < 0.001$. CA - Cronbach's Alpha; CR - Composite Reliability; AVE - Average Variance Extracted.

Table 4

Correlation Matrix with Mean, Standard Deviation and SQRT of AVE

	MEAN	*STDEV*	*SQRT(AVE)*	*ENG*	*INR*	*ISS*	*TSE*	*ENV*
ENG	3.616	0.894	0.759	1.000				
INR	3.583	0.791	0.806	.729**	1.000			
ISS	3.421	0.933	0.828	.604**	.547**	1.000		
TSE	3.724	0.811	0.788	.544**	.671**	.490**	1.000	
ENV	3.617	0.884	0.718	.585**	.633**	.463**	.640**	1.000

Note. Correlations are significant at the $p < 0.01$ level. ***$p < 0.001$; **p < 0.01; *$p < 0.05$.

associated with INR ($r = 0.67$, $p < 0.01$). What the results mean is that, 45% ($R^2 = 0.45$) of the variance in the participants' perception of their technology self-efficacy could be explained by their perception of the quality of instructional resources available to them especially during the COVID-19 period. Importantly, all the five variables (ENG, INR, ISS, TSE and ENV) demonstrated positive statistically significant relationships as shown in Table 4.

3. Results

A hierarchical regression analysis was performed to evaluate how the four-predictor variables (INR, ISS, TSE and ENV) explain student engagement in the university setting during COVID. The variables were entered in five steps: (a) the demographic variables; (b) independent variables INR, ISS, TSE and ENV; (c) moderating variable - TSE; (d) Interaction effect 1 - ENV&TSE and; (e) interaction effect 2 - INR&TSE.

Table 5 shows the results of the hierarchical regression analysis. In the first model, four control variables were entered. Results revealed that gender (à=-.475, p < .001) and type of device (à = .097, p < .01) were significantly related with ENG. The hierarchical regression analysis with ENG as the criterion variable in Model 1 revealed an overall R^2 of 0.081, F(4, 425) = 9.252, p=0.001. The results suggest that 8.10% of the variance in ENG is explained by the control variables ð gender and type of device. To test for H1, H2 and H3, INR, ENV and ISS were entered stepwise into Model 2. The stepwise inclusion resulted in a significant increment of R^2 .422, F(7, 424) = 43.483, p = .001, thereby, increasing the adjusted R^2 by 34.10% and demonstrating that 42.22% of the variance in ENG was explained by ISS, INR, and ENV. In explaining the results further, ISS (à=0. 562, p < .001), INR (à=0. 169, p < .01) and ENV (à=0. 149, p < .01) had a significant and positive effect on ENG. The moderator variable, TSE was entered in Model 3. The addition of TSE resulted in an R^2 .437, F(8, 424) = 40.386, p = .001 with a corresponding marginal increase in R^2 by 1.50%. The results further revealed that 43.70% of the variance in ENG was explained by the moderator variable TSE in model 3. The first set of interaction term ENV&TSE was entered in Model 4. The addition of ENV&TSE resulted in the R^2 .440, F(9, 424) = 36.252, p = .001. The result further confirmed hypothesis H4a: ($à_{ENV*TSE}$ = .052, p < .05). The last model consisted of the interaction effects of INR&TSE that also explains hypothesis H3b. The inclusion of the interaction effect - INR&TSE yielded the R^2 .449, F(10, 424) = 33.775, p = .001. The results therefore confirmed hypothesis H4b: ($à_{INR*TSE}$ = .156, p < .01).

In line with the aims of the current study and in order to explain the extent to which: 1) TSE moderates the relationship between the ENV and ENG; and 2) TSE moderates the relationship between the INR and ENG interaction plots as presented in Figures 2 and 3 were created. In particular, the study postulated that the strength of positive relationship between a) Online learning environment and b) Instructional resources and student engagement is greater when Technology self-efficacy is high. Previous study has shown that the process of explaining the interaction term in regression analysis is important because it leads to a better interpretation of the moderation effect in a model (Dawson, 2014). To avoid possible high multicollinearity with the interaction term, the variables were centered while the two interaction terms were created (Aiken & West, 1991). Figures 2 and 3 show the interaction plots for the two interaction terms.

Table 5
Results of multiple regression analysis for student engagement

	Model 1		*Model 2*		*Model 3*		*Model 4*		*Model 5*		
	SE	β	SE	β	SE	β	SE	β	SE	β	VIF
Intercept	0.103	2.940***	0.206	0.101	0.214	-0.124	0.349	0.289	0.377	-0.093	
Control variables											
Age (23-27)	0.087	0.025	0.069	0.007	0.069	0.013	0.069	0.006	0.068	0.013	1.004
Gender (Male)	0.092	-0.475***	0.075	-0.302***	0.074	-0.297***	0.075	-0.285***	0.075	-0.312***	1.116
School (SASTS)	0.100	-0.156	0.082	0.100	0.081	0.108	0.081	0.101	0.080	0.111	1.114
Type of Device (M.P)	0.102	0.097**	0.082	0.176*	0.082	0.225**	0.082	0.235**	0.082	0.23**	1.037
Independent variables											
ENV			0.050	0.149**	0.052	0.089	0.119	-0.071	0.169	0.387	1.869
INR			0.060	0.169**	0.065	0.087	0.065	0.090	0.201	0.588**	2.524
ISS			0.081	0.526***	0.079	0.525***	0.080	0.527***	0.079	0.517***	2.363
Moderating variable											
TSE					0.058	0.194**	0.117	0.041	0.126	0.170	2.198
Interaction effects											
ENV&TSE							0.035	0.052*	0.053	0.047	4.176
INR&TSE									0.059	0.156**	7.696
R		0.285		0.650		0.661		0.663		0.670	
R2		0.081		0.422		0.437		0.440		0.449	
ΔR2		0.081***		0.341***		0.015**		0.003		0.009**	
ΔF		9.295		43.483		40.386		36.252		33.775	

Note. ***p < 0.001; **p < 0.01; *p < 0.05; SE. – Standard error; B – Beta; VIF - Variance Inflation Factor; Dependent Variable: ENG

Figure 2
Technology self-efficacy as a moderator between online learning environment and student engagement

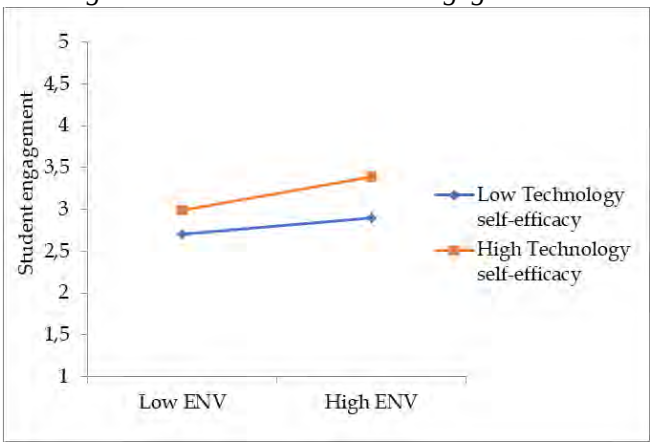


Figure 3
Technology self-efficacy as a moderator between institutional resources and student engagement

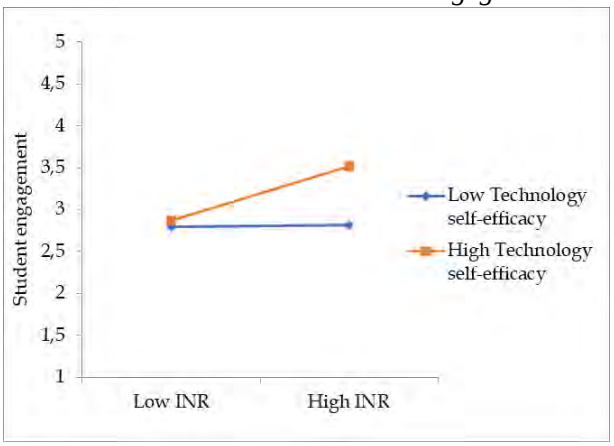


Figure 2 is interpreted as technology self-efficacy strengthens the positive relationship between online learning environment and student engagement. As can be understood from Figure 3, technology self-efficacy strengthens the positive relationship between instructional resources and student engagement.

An analysis of the simple slope effect showed a positive and significant relationship between Technology self-efficacy and student engagement when they perceive the quality of the online learning environment ($à_{ENV*TSE}$ = .052, t=2.964, p < .05) and Instructional resources ($à_{INR*TSE}$ =.156, t=2.621, p < .01) as high. A close observation of the slopes reveal that the relationship between a) online learning environment and student engagement and; b) Instructional resources and student engagement is greater when students perceive Technology self-efficacy as high.

4. Discussion

The findings of the current study show that online learning environment, instructional resources and institutional support systems enhance student engagement in the study setting. In line with the major aim of the current study, the results revealed that technology self-efficacy enhance the relationship between online learning and student engagement. These findings are consistent with prior studies that show there is a direct relationship between higher levels of computer self-efficacy and student engagement (Laird & Kuh, 2005) as well as students′ use of technology and student engagement (Rashid & Asghar, 2016). Conversely, if students do not have adequate knowledge of technology application in their learning, it could adversely affect their engagement with content, academics and peers. Linking the findings of the current study to theory, constructivism explains student engagement in the classroom or micro context as well as the institutional environment that serve to provide students with relevant knowledge and skills (Kahu, 2013). This position provides credence for the development of a learning environment, provision of online learning resources and the establishment if institutional support systems that enhance online teaching and learning. This is also consistent with L·pez-P®rez et al. (2011) who show that the combined effect of the various technology-mediated learning activities has a positive influence on the outcomes of student learning.

Result of the first hypothesis (H1) tested showed that a strong online learning environment enhances student engagement in higher education setting. This is in agreement with prior scholarly studies that show that Virtual Learning Environment (Orey & Rosa, 2018) and personal or adaptive online learning environment (Premlatha & Geetha, 2015) enhance student engagement. Learning among students is enhanced in online learning environment through contribution, participation and cohesion among students (Costley & Lange, 2018; Graham, 2018). Also, findings of the current study showed that there is a positive relationship between instructional resources

and student engagement therefore, confirming H2. This result support findings from previous study which show that student engagement in an online learning environment is positively influenced by online learning resources that are intellectually and academically stimulating (Gupta & Pandey, 2018). Similarly, Chen et al. (2010) indicate that there is a positive relationship between internet and web-based learning technologies and student engagement and learning outcomes. However, the outbreak of COVID-19 revealed the frailties of existing structures and resources especially in developing countries such as Ghana in supporting students who learn through online modes. While prior study has demonstrated that inadequate laboratories and the lack of computers and laptops and other learning devices continue to affect online learning in developing countries (Mutisya & Makokha, 2016), there is an urgent need for interventions at the institutional and national levels to enhance its uptake.

An analysis of the data also revealed that there is a positive relationship between institutional support systems and student engagement. This particular outcome confirmed H3 and it is consistent with Porter et al. (2014) who show that structure, strategy and support constitute essential factors for developing technology-mediated learning framework in educational institutions. In situations of unplanned disruptions such as COVID-19, the swift intervention of the university to deploy online learning to mitigate possible disruptions to learning is very important to sustaining academic activities. Therefore, institutional support systems that include technical and pedagogical support as well as institutional incentives that enhance the uptake of online learning (Graham, 2018) is very important now and after COVID-19. Conversely, a lack of adequate management support in the application of online learning adversely affect the delivery of online content (Alfelaij, 2016) and student engagement with content, academics and peers. Consequently, when educational providers offer support to students through the provision of IT infrastructure and institutional policies that promote innovative teaching and learning (Graham, 2018; Porter et al., 2014), students will be well prepared to face unforeseen academic disruptions.

The Findings of the current study found support for H4a and H4b. First, in relation to H4a, the study revealed that, technology self-efficacy strengthens the positive relationship between online learning environment and student engagement. Particularly, students′ experience concerning increased autonomy, collaboration and creativity (Jesson et al., 2018) in the online learning environment is partly dependent on technology self-efficacy. Therefore, through student tracking, online support, electronic communication and the provision of internet access in the learning environment (Orey & Rosa, 2018), students actively engage with their teachers, peers and content.

Second, in relation to H4b the findings show that technology self-efficacy strengthens the positive relationship between instructional resources and student engagement. What these results show is that technology self-efficacy is important to enhancing student engagement in an online learning environment and this was evident during the early stages of COVID-19 pandemic where students were obliged to take their lectures via online learning modes. The dimensions of technology self-efficacy consist of the strength, generalisability and magnitude (Compeau & Higgins, 1995) that are necessary for student engagement in a technology-mediated learning environment. However, technology proficiency is not the same in all countries because technology affordances are based on different situations. In some cases, students only get access to use computers when they visit computer laboratories in institutions. For instance, a study by Mutisya and Makokha (2016) revealed that 67% of students in public universities in Kenya were computer literates with a greater percentage indicating that they acquired knowledge of computer application when they were in secondary school. In Ghana, recent research by Adarkwah (2021) revealed that a lack of access to internet and electricity are some of the challenges to the uptake of online learning.

Concerning the control variables, the result revealed that the type of device (Mobile Phone) used by students in online learning environments has a positive and significant effect on student engagement. This finding is significant to technology usage in higher education because it reveals, 1) how learning devices serve as tools that enhance student learning and engagement and, 2) how

HEIs could prioritize the learning devices used by students in online learning to enhance engagement. Previous study by Wang et al. (2018) showed that technology serves as an integral part of teaching and learning processes and student engagement in higher education. Also, the results demonstrated that gender (female) has negative but significant effect on student engagement. However, age (23-27) and school (SASTS), demonstrated insignificant effect on student engagement.

4.1. Educational Implications

While HEIs begin to think and plan towards post COVID-19 and the creation of robust structures and systems that will withstand possible future disruptions, it has become important for managers of HEIs to put in place policies and practices that will address the immediate online learning needs of students and enhance student engagement. This includes planning for the provision of hardware, software and internet connection (Almaiah et al., 2020) that will ensure a smooth implementation of online learning. In Ghana, challenges such as inadequate wireless technologies, low-speed internet bandwidths and poor network security continue to affect quality online teaching and learning delivery (Larbi-Apau et al., 2020). For students in the engineering, applied sciences, and health science disciplines, there is the need for more investment in virtual laboratories that will ensure that students have unhindered access to teaching and learning. Particularly, Technical Universities in Ghana could begin to explore partnerships with some local and international universities to share resources ð especially virtual laboratories. Such partnerships will also ensure that lecturers are provided with the needed resources to support the knowledge and skills development of students while students are also exposed to advance learning resources that may not be readily available in their learning environment.

Second, one of the challenges the majority of institutions faced during the initial stages of the COVID-19 pandemic was the lack of policies that address institutional arrangement for remote teaching and learning. Additionally, some universities had no policies on online examinations and rules governing the use of online learning resources. Certainly, HEIs are now faced with a greater challenge than ever to ensure that not only are structures and systems put in place to support online learning but more importantly, that policies that guide online learning are put in place. Another item worth mentioning is the need for teaching innovation that addresses emerging learning needs of students including monitoring students′ active participation in the online learning environment. In order to enhance student engagement, Mintz (2021) argues that the use of dashboards will provide instructors with information on the time students spend on the course websites, identify and respond to their challenges, and chart students′ progress. The importance of dashboards to students is that, it serves to prompt them of their tasks and expected outputs in a given period. Therefore the provision of dashboards in the online learning environment will lead to quality engagement between students and teachers in the online learning environment.

Third, HEIs must prioritize training for academics and students in the use of online learning technologies to enable them to cope with the expected learning outcomes of the diverse courses including those that require virtual laboratories. Previous study has revealed that instructional technologies are matched with corresponding diverse pedagogical approaches that require students to learn in teams, engage with each other, and engage with the instructor (Mintz, 2021) and content. This also means that instructors will have to develop innovative pedagogical approaches that enhance student engagement in the online learning environment.

Lastly, technology self-efficacy among students is essential to enhancing online teaching and learning. While most literature emphasize the online learning environment, instructional resources and institutional support systems, the current study has revealed the centrality of technology self-efficacy in enhancing student engagement in HEIs especially in Ghana. Undoubtedly, the COVID-19 pandemic served as a space for the deployment of full-scale online learning for students. Although management of the current study context put in place measures to support students in the early stages of the pandemic, one of the major challenges the institution faced was the fact that

many students did not have computers or smart phones. The data revealed that the majority of students who participated in the study (76%) had to rely on their mobile phones to access the online learning platforms. The challenge with this situation is that students will not be able to use their mobile phones to take online examinations when the university adopts a full-scale online learning system. While some of the universities, including the current study context resorted to the use of social networks such as Zoom and WhatsApp during the COVID-19 pandemic, the limitations of these tools became apparent especially because the teachers could not conduct examinations and grade students online. For instance, Larbi-Apau (2020) argues that the challenges in using social networks in teaching and learning include limited course content management, vulnerability of the tools and, lack of storage systems. There is therefore the need for resource support for the students and additional training to enable them use the online learning mode of delivery.

4.2. Limitations and Future Research

The findings of the current study should be interpreted in relation to two main limitations. First data for students′ online experiences during the COVID-19 pandemic was gathered at a time when the university had transitioned to the blended learning mode. This means that students had to reflect on their experiences during the peak of the COVID-19 pandemic to be able to provide their responses. The decision of the researchers to gather data on online learning during a face-to-face session was due to very low response rate among students in online surveys. Second, the study was conducted among a small sample of students in only one Technical University in Ghana. Therefore, future research could increase the range of students and Technical Universities that adopted online teaching and learning to enhance the generalisability of the study across Technical Universities. Thirdly, we limited our independent variables to only three therefore, we excluded other variables that may be important. Future research could explore the relationship between student engagement and other variables such as student-teacher, student-peer and student-content interaction.

5. Conclusion

This study examined the perceptions of students about online learning environment, instructional resources, institutional support systems during the COVID-19 pandemic, and student engagement in a Technical University in Ghana. Secondly, we examined the moderating effect of technology self-efficacy on: 1) the association between online learning environment and student engagement and; 2) the association between instructional resources and student engagement in the university during COVID-19. First, our results revealed that online learning environment, instructional resources and institutional support systems enhance student engagement in the study setting. Our findings are particularly important because it provide relevant information on how managers of HEIs could put in place structures and policies that address the online learning needs of students and enhance student engagement especially during unplanned disruptions such as COVID-19. Secondly, the current study revealed that technology self-efficacy 1) strengthens the positive relationship between online learning environment and student engagement and 2) strengthens the positive relationship between Instructional resources and Student engagement. Therefore, by emphasising the importance of online learning and social experiences in the knowledge and skills development of students by way of technology self-efficacy, we explain how social cognitive theory is linked to engagement. The outcomes of the current study are particularly important because they provide relevant information on how managers of HEIs could put in place structures and policies that address the online learning needs of students and enhance student engagement especially during unplanned disruptions such as COVID-19.

References

Adarkwah, M. A. (2021). òI′m not against online teaching, but what about us?ó: ICT in Ghana post Covid-19. *Education and Information Technologies*, *26*, 1665ð1685. https://doi.org/10.1007/s10639-020-10331-z

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Sage.

Alfelaij, B. (2016). Why integrating technology has been unsuccessful in Kuwait? An exploratory study. *E-Learning and Digital Media*, *13*(3-4), 126-139. https://doi.org/10.1177/2042753016672901

Alhabeeb, A., & Rowley, J. (2018). E-learning critical success factors: Comparing perspectives from academic staff and students. *Computers & Education*, *127*, 1-12. https://doi.org/10.1016/j.compedu.2018.08.007

Almaiah, M. A., Al-Khasawneh, A., & Althunibat, A. (2020). Exploring the critical challenges and factors influencing the E-learning system usage during COVID-19 pandemic. *Education and Information Technologies*, *25*, 5261-5280. https://doi.org/10.1007/s10639-020-10219-y

Azevedo, F. S., diSessa, A. A., & Sherin, B. L. (2012). An evolving framework for describing student engagement in classroom activities. *The Journal of Mathematical Behavior*, *31*(2), 270-289. https://doi.org/10.1016/j.jmathb.2011.12.003

Bandura, A. (1977). *Social learning theory*. New York: General Learning Press.

Barnard, L., Lan, W. Y., To, Y. M., Paton, V. O., & Lai, S. L. (2009). Measuring self-regulation in online and blended learning environments. *The Internet and Higher Education*, *12*(1), 1-6. https://doi.org/10.1016/j.iheduc.2008.10.005

Camas, L., Valero, A., & Vendrell, M. (2021). The teacher-student relationship in the use of social network sites for educational purposes: a systematic review. *Journal of New Approaches in Educational Research*, *10*(1), 137-156. https://doi.org/10.7821/naer.2021.1.591

Cassidy, S., & Eachus, P. (2002). Developing the computer user self-efficacy (CUSE) scale: Investigating the relationship between computer self-efficacy, gender and experience with computers. *Journal of Educational Computing Research*, *26*(2), 133-153. https://doi.org/10.2190/JGJR-0KVL-HRF7-GCNV

Chen, P. -S.D., Lambert, A.D., & Guidry, K.R. (2010). Engaging online learners: the impact of web-based learning technology on college student engagement. *Computer & Education*, *54*, 1222ð1232. https://doi.org/10.1016/j.compedu.2009.11.008

Christmann, E. P. (2017). A comparison of the achievement of statistics students enrolled in online and face-to-face settings. *E-Learning and Digital Media*, *14*(6), 323-330. https://doi.org/10.1177/2042753017752925

Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS quarterly*, 189-211. https://doi.org/10.2307/249688

Costley, J., & Lange, C. (2018). The moderating effects of group work on the relationship between motivation and cognitive load. *The International Review of Research in Open and Distributed Learning*, *19*(1), 68-90. https://doi.org/10.19173/irrodl.v19i1.3325

Dawson, J. F. (2014). Moderation in management research: What, why, when, and how. *Journal of Business and Psychology*, *29*(1), 1-19. https://doi.org/10.1007/s10869-013-9308-7

Dhawan, S. (2020). Online learning: A panacea in the time of COVID-19 crisis. *Journal of Educational Technology Systems*, *49*(1), 5-22. https://doi.org/10.1177/0047239520934018

Ding, L., Er, E., & Orey, M. (2018). An exploratory study of student engagement in gamified online discussions. *Computers & Education*, *120*, 213-226. https://doi.org/10.1016/j.compedu.2018.02.007

Ferguson, R. (2012). Learning analytics: drivers, developments and challenges. *International Journal of Technology Enhanced Learning*, *4*(5-6), 304-317. https://doi.org/10.1504/IJTEL.2012.051816

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

Graham, D. (2018). PESTEL factors for e-learning revisited: The 4Es of tutoring for value added learning. *E-Learning and Digital Media*, *15*(1), 17-35. https://doi.org/10.1177/2042753017753626

Gupta, M., & Pandey, J. (2018). Impact of student engagement on affective learning: Evidence from a large Indian university. *Current Psychology*, *37*(1), 414-421. https://doi.org/10.1007/s12144-016-9522-3

Hair J.F.Jr., Hult, G.T.M, Ringle, C., & Sarstedt, M. (2014). *A primer on partial least squares structural equation modeling (PLS-SEM)*. Sage.

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

Howard, S. K., Ma, J., & Yang, J. (2016). Student rules: Exploring patterns of students′ computer-efficacy and engagement with digital technologies in learning. *Computers & Education*, *101*, 29-42. https://doi.org/10.1016/j.compedu.2016.05.008

Hung, M. L., Chou, C., Chen, C. H., & Own, Z. Y. (2010). Learner readiness for online learning: Scale development and student perceptions. *Computers & Education*, *55*(3), 1080-1090. https://doi.org/10.1016/j.compedu.2010.05.004

Ituma, A. (2011). An evaluation of students′ perceptions and engagement with e-learning components in a campus based university. *Active Learning in Higher Education*, *12*(1), 57-68. https://doi.org/10.1177/1469787410387722

Jesson, R., McNaughton, S., Rosedale, N., Zhu, T., & Cockle, V. (2018). A mixed-methods study to identify effective practices in the teaching of writing in a digital learning environment in low income schools. *Computers & Education*, *119*, 14-30. https://doi.org/10.1016/j.compedu.2017.12.005

Kahu, E. R. (2013). Framing student engagement in higher education. *Studies in Higher Education*, *38*(5), 758-773. https://doi.org/10.1080/03075079.2011.598505

Kuh, G. D. (2009). The national survey of student engagement: Conceptual and empirical foundations. *New Directions for Institutional Research*, *141*, 5-20.

Laird, T. N., & Kuh, G. (2005). Student experiences with information technology and their relationship to other aspects of student engagement. *Research in Higher Education*, *46*(2), 211-233. http://dx.doi.org/10.1007/s11162-004-1600-y.

Larbi-Apau, J. (2020, October 1). *Doing the right thing, and doing the thing right*. https://www.universityworldnews.com/post.php?story=20200929100048356

Larbi-Apau, J. Sampong, K., & Kwofie, B. (2020, May 7). *Barriers to online learning adoption in higher education*. https://www.universityworldnews.com/post.php?story=20200506200743715

Larbi-Siaw, O., & Owusu-Agyeman, Y. (2017). Miscellany of students′ satisfaction in an asynchronous learning environment. *Journal of Educational Technology Systems*, *45*(4), 456-475. https://doi.org/10.1177/0047239516667499

Lawson, M. A., & Masyn, K. E. (2015). Analyzing profiles, predictors, and consequences of student engagement dispositions. *Journal of School Psychology*, *53*(1), 63-86. https://doi.org/10.1016/j.jsp.2014.11.004

Lin, W. S., & Wang, C. H. (2012). Antecedences to continued intentions of adopting e-learning system in blended learning instruction: A contingency framework based on models of information system success and task-technology fit. *Computers & Education*, *58*(1), 88-99. https://doi.org/10.1016/j.compedu.2011.07.008

L·pez-P®rez, M.V., P®rez-L·pez, M.C., & Rodr²guez-Ariza, L. (2011). Blended learning in higher education: Students′ perceptions and their relation to outcomes. *Computers & Education*, *56*, 818-826. https://doi.org/10.1016/j.compedu.2010.10.023

Manwaring, K. C., Larsen, R., Graham, C. R., Henrie, C. R., & Halverson, L. R. (2017). Investigating student engagement in blended learning settings using experience sampling and structural equation modeling. *The Internet and Higher Education*, *35*, 21-33. https://doi.org/10.1016/j.iheduc.2017.06.002

Margaryan, A., Littlejohn, A., & Vojt, G. (2011). Are digital natives a myth or reality? University students′ use of digital technologies. *Computers & Education*, *56*(2), 429-440. http://dx.doi.org/10.1016/j.compedu.2010.09.004.

Mintz, S. (2021, March 22). *Why Most Ed Tech Fails*. https://www.insidehighered.com/blogs/higher-ed-gamma/why-most-ed-tech-fails

Moore, J. L., Dickson-Deane, C., & Galyen, K. (2011). e-Learning, online learning, and distance learning environments: Are they the same?. *The Internet and Higher Education*, *14*(2), 129-135. https://doi.org/10.1016/j.iheduc.2010.10.001

Mutisya, D. N., & Makokha, G. L. (2016). Challenges affecting adoption of e-learning in public universities in Kenya. *E-Learning and Digital Media*, *13*(3-4), 140-157. https://doi.org/10.1177/2042753016672902

National Accreditation Board [NAB]ð Ghana (2019). Accredited tertiary institutions in Ghana. Available at: http://nab.gov.gh/news1/477-nab-conducts-cyclical-review-of-university-of-ghana. Accessed on 20/03/2019

Northey, G., Govind, R., Bucic, T., Chylinski, M., Dolan, R., & van Esch, P. (2018). The effect of òhere and nowó learning on student engagement and academic achievement. *British Journal of Educational Technology*, *49*(2), 321-333. https://doi.org/10.1111/bjet.12589

O'Connor, K. (2020). Constructivism, curriculum and the knowledge question: tensions and challenges for higher education. *Studies in Higher Education*, 1-11. [Advance online publication]. https://doi.org/10.1080/03075079.2020.1750585

Oliver, R., & Herrington, J. (2003). Exploring technology-mediated learning from a pedagogical perspective. *Interactive Learning Environments*, *11*(2), 111-126. https://doi.org/10.1076/ilee.11.2.111.14136

Orey, D. C., & Rosa, M. (2018). Developing a mathematical modelling course in a virtual learning environment. *ZDM ð Mathematics Education*, 50(1), 173-185. https://doi.org/10.1007/s11858-018-0930-8

Owusu-Agyeman, Y., & Larbi-Siaw, O. (2017). Reframing the principle of specialization in legitimation code theory: A blended learning perspective. *Education and Information Technologies*, *22*(5), 2583-2603. https://doi.org/10.1007/s10639-016-9563-0

Pearson, J. M., Bahmanziari, T., Crosby, L., & Conrad, E. (2003). An empirical investigation into the relationship between organizational culture and computer efficacy as moderated by age and gender. *Journal of Computer Information Systems*, *43*(2), 58-70. https://doi.org/10.1080/08874417.2003.11647086

Pellas, N. (2014). The influence of computer self-efficacy, metacognitive self-regulation and self-esteem on student engagement in online learning programs: Evidence from the virtual world of Second Life. *Computers in Human Behavior*, *35*, 157-170. https://doi.org/10.1016/j.chb.2014.02.048

Philip, T., & Garcia, A. (2013). The importance of still teaching the iGeneration: new technologies and the centrality of pedagogy. *Harvard Educational Review*, *83*(2), 300-319. http://dx.doi.org/10.17763/haer.83.2.w221368g1554u158.

Porter, W. W., Graham, C. R., Spring, K. A., & Welch, K. R. (2014). Blended learning in higher education: Institutional adoption and implementation. *Computers & Education*, *75*, 185-195. https://doi.org/10.1016/j.compedu.2014.02.011

Premlatha, K. R., & Geetha, T. V. (2015). Learning content design and learner adaptation for adaptive e-learning environment: a survey. *Artificial Intelligence Review*, *44*(4), 443-465. https://doi.org/10.1007/s10462-015-9432-z

Prokes, C., & Housel, J. (2021). Community College Student Perceptions of Remote Learning Shifts Due to COVID-19. *TechTrends*, 1-13. [Advance online publication] https://doi.org/10.1007/s11528-021-00587-8

Rahimi, E., van den Berg, J., & Veen, W. (2015). Facilitating student-driven constructing of learning environments using Web 2.0 personal learning environments. *Computers & Education*, *81*, 235-246. https://doi.org/10.1016/j.compedu.2014.10.012

Rashid, T., & Asghar, H. M. (2016). Technology use, self-directed learning, student engagement and academic performance: Examining the interrelations. *Computers in Human Behavior*, *63*, 604-612. https://doi.org/10.1016/j.chb.2016.05.084

Reyna, J., Hanham, J., & Meier, P. (2018). The Internet explosion, digital media principles and implications to communicate effectively in the digital space. *E-Learning and Digital Media*, *15*(1), 36-52. https://doi.org/10.1177/2042753018754361

Shin, N., & Chan, J. K. (2004). Direct and indirect effects of online learning on distance education. *British Journal of Educational Technology*, *35*(3), 275-288. https://doi.org/10.1111/j.0007-1013.2004.00389.x

Skinner, E. A., & Pitzer, J. R. (2012). Developmental dynamics of student engagement, coping, and everyday resilience. In Handbook of research on student engagement (pp. 21-44). Springer, Boston, MA.

Soetanto, D., & MacDonald, M. (2017). Group work and the change of obstacles over time: The influence of learning style and group composition. *Active Learning in Higher Education*, *18*(2), 99-113. https://doi.org/10.1177/1469787417707613

Srisupawong, Y., Koul, R., Neanchaleay, J., Murphy, E., & Francois, E. J. (2018). The relationship between sources of self-efficacy in classroom environments and the strength of computer self-efficacy beliefs. *Education and Information Technologies*, *23*(2), 681-703. https://doi.org/10.1007/s10639-017-9630-1

Wang, S., Zhang, K., Du, M., & Wang, Z. (2018). Development and measurement validity of an instrument for the impact of technology-mediated learning on learning processes. *Computers & Education*, *121*, 131-142. https://doi.org/10.1016/j.compedu.2018.03.006

Wood, R., & Bandura, A. (1989). Social cognitive theory of organizational management. *Academy of management Review*, *14*(3), 361-384. https://doi.org/10.5465/amr.1989.4279067

Zhoc, K. C., Webster, B. J., King, R. B., Li, J. C., & Chung, T. S. (2019). Higher education student engagement scale (HESES): Development and psychometric evidence. *Research in Higher Education*, *60*(2), 219-244. https://doi.org/10.1007/s11162-018-9510-6

Appendix 1. The student engagement and online learning instrument

Engagement

Online engagement (ENGL)

I regularly use web-based resources and information designed specifically for the course.
I regularly use email and/or other electronic means (such as WhatsApp and Facebook) to contact friends in my programme.
I regularly use the internet for study purpose
The e-learning interface is friendly and does not require detailed sign-in information.

Cognitive engagement (ENGC)

I enjoy the intellectual challenge of courses I am studying.
I derive satisfaction from studying online.
I find my courses intellectually stimulating.
I am motivated to study amidst the COVID-19 pandemic.

Social engagement with peers (ENGP)

I regularly work with other students on course areas I have problems.
I regularly get together with other students to discuss courses online.
I regularly study with other students online.
I feel part of a group of students committed to learning online.

Instructional resource (INR)

I receive frequent communication regarding new learning materials online.
The electronic learning materials that are posted online are sufficient for my use.
The online test and quizzes are regularly posted online by my lecturers
The online learning portal enhance communication between students and lecturers
The online learning portal allows for course interactivity between lecturers and students
My lecturer is able to measure my learning progress online
The learning materials posted online is up-to-date

Institutional support systems and interventions (ISS)

I receive the needed support from staff when I need technical assistance.
I find it convenient to get information on the online courses and resources from my department.
We have internet connectivity for our assignments and classroom activities on campus.
The university provides us with adequate technical support in the online learning platform.
The university has clear policies on the use of online learning platforms.

Technology self-efficacy (TSE)

I am capable of solving my computer-related problems when I am using the online learning platform.
I am very comfortable doing class work that is put online.
I am capable of using the internet to find information I need in relation to my study.
I feel confident in performing the basic functions of Microsoft Office programs (MS Word, MS Excel, and MS PowerPoint).
I feel confident in using the Internet (Google, Yahoo) to find or gather information for online learning.

Online learning environment (ENV)

I choose a location where I study for my online courses to avoid too much distraction.
I find the online learning environment very easy to use.
I know where I can study most efficiently for my online course.
I choose a time with few distractions for studying for my online courses.