Original Article

e-learning and digital media

E-Learning and Digital Media
2024, Vol. 0(0) 1–15

DOI: 10.1177/20427530241239426
journals.sagepub.com/home/ldm
Sage

Technology as a predictor of students' virtual learning experiences in post- covid era: Empirical analysis from a Ghanaian higher education institution

Joshua Ofori Essiam and Gerald Dapaah Gyamfi
Department of Business Administration, University of Professional Studies, Legon, Ghana

Jonathan Odame
Department of Distance Education, University of Ghana, Legon, Ghana

Angela Ayisi-Addo
Department of Sustainable Development, University of Environment and Sustainable Development, Ghana

Abstract

The devastating effect of the Covid pandemic negatively affect most economies while conspicuously changing the mode of interactions in the educational sector from the traditional face-to-face to a full online deployment or a blend of virtual and in-person interactions during the post covid. The aim of this study is to determine the impact of technology on students' virtual learning experiences after the peak of the covid pandemic. Three hundred and seventy-nine ($N = 379$) undergraduate students participated in the study. Findings showed that the use of technology significantly predicted student online teaching and learning and also, influenced student virtual learning experiences positively. These findings will help managers of higher education institutions to invest into training and technology driven interactions to enhance students' engagement.

Keywords

Higher education, online teaching and learning, technology, virtual learning experiences

Corresponding author:
Joshua Ofori Essiam, Department of Business Administration, University of Professional Studies, P.O.Box Lg 149, Legon, Accra, Ghana.
Email: joshuaoessiam@upsamail.edu.gh

Introduction

The Sub-Saharan Africa reported its first case of the Coronavirus in Nigeria on the 28th day of February 2020 (Afriyie et al., 2020; WHO, 2020) and since then all aspects of human systems and interactions have been to reduce the rate of spread of the coronavirus infections. This is evident by the varied strategies adopted by various governments in containing the virus. In Ghana, the government's strategy was to reduce and prevent the importation of the coronavirus, limit the spread by providing education and advocacy on the virus, provide resources to take care of the sick, reduce the social and economic impact on residents and promote domestic production potential to strengthen local productions (Ghana News Agency, 2020). During the early stages of the pandemic most countries closed their schools either fully or partially (Hallin et al., 2022; UNESCO, 2020). The throughput activities in higher education were neither spared. There were prohibitions of all forms of physical activities and meetings on various campuses across the globe which led to the migration of teaching and learning to online. These developments opened a critical period called "new normality" (Tesar, 2020; Mok et al., 2021). In this regard, Mok et al. (2021) makes a clarion call to stakeholders in higher education to rethink and reconsider the role of information and communication technologies in the effectiveness of online teaching and learning among both faculty and students.

In these modern times of information and communication technology, the use of technology in the learning process has become a necessity for students (Shatri, 2020). Hence, the usage of ICT tools in education, which enhances teaching and learning processes in different forms and levels of education, is very important (Ohlin, 2019). The use of technological innovations like the virtual learning platforms, content creation tools and technology and communication devices have aided teaching and learning mostly in this COVID-19 era, where social distancing is encouraged.

Paulsen (2002) explained e-learning as an interactive learning, where teachers and students are separated, yet a computer network is used to present and distribute educational content and also provide a two-way communication in order to provide automatic feedback to the student's learning activities. The student-teacher relationship has drastically changed to a technology-based class because of the influence of the coronavirus. Online education is a change in the approach of executing teaching and learning activities from the conventional system to the new digitized teaching-learning approach. In the face-to-face teaching setting, the teacher is seen as the center of the classroom. On the contrary, with the technology-based structure of teaching and learning, the teacher becomes a middleman between information and the student. Instead of becoming a passive listener in the face-to-face setting, the learners are now engaged in the gaining, the rearrangement and the displaying of information. This is possible with the developments of visual and audio-visual aids connected to the internet as well as the different forms of software, which are used to teach students and monitor their learning progress from a distance through the internet to improve efficiency, effectiveness and excellence (Osadebe and Osadebe, 2020).

Information and communication technology is changing the face of teaching and learning globally, compelling most educational institutions to adapt to a digitalized teaching and learning approach. Yet, the technological know-how of students varies with teachers today, since majority of students today are native speakers of the digital language of computers, video games and the internet, while most teachers today are now becoming used to most aspects of the new technology (Bennis, 2023; Prensky, 2001). (Figure 1).

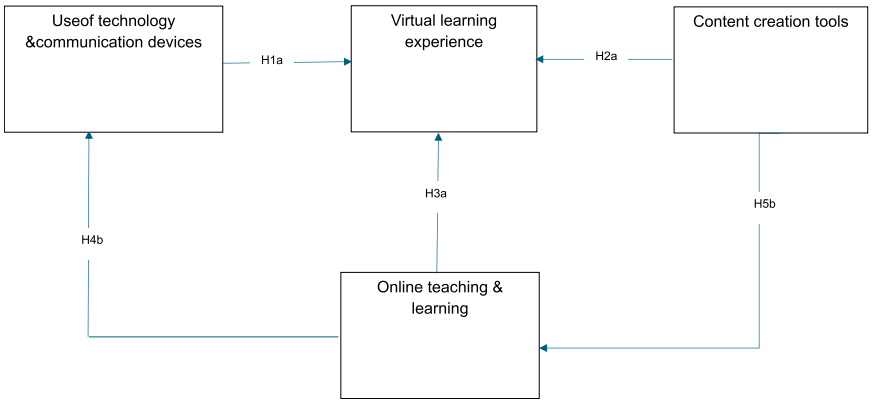

Figure 1. Proposed hypotheses model.

Research questions

The study was guided by five research questions, and these were:

RQ1: What is the influence of the use of technology and communication devices on students virtual learning experience?
RQ2: What is the influence of the content creation tools on students virtual learning experience?
RQ3: What is the influence of online teaching and learning on students virtual learning experience?
RQ4: Does use of technology and communication devices influence online teaching and learning?
RQ5: Does content creation tools influence online teaching and learning?

Study hypotheses

The study set out to test five hypotheses that were generated from the research questions, and these were tested in a two-model approach (Ha and Hb):

H1a: The use of technology and communication devices will positively influence students virtual learning experience.
H2a: Content creation tools will positively influence students virtual learning experience.
H3a: Online teaching and learning will positively influence students virtual learning experience.
H4b: Use of technology and communication devices will significantly influence online teaching and learning
H5b: Content creation tools will significantly influence online teaching and learning

Literature review

COVID-19 in higher education

The emergence of the corona virus disease in 2019 (COVID-19) which broke out in early 2020 negatively affected humanity in diverse ways including loss of lives, health and education

(Durnali, 2020). According to the World Health Organization (WHO), there is the anticipation that the viral infectious disease of the corona virus may continue to persist and threaten human life until effective treatment is found. The threat of COVID-19 has caused many higher education institutions, globally, to devise strategies that protect students, faculty and other staff of the institutions from the impact of the pandemic (Dlamini and Ndzinisa, 2020). The effects of COVID-19 on higher education include social isolation leading to the closing down of many higher education institutions worldwide (Raza et al., 2021). One of the strategies implored to enable the institutions to sustain teaching and learning is the application of technology which promotes virtual experience of students (Mishra et al., 2020). Despite the closure of many institutions of higher learning, teaching and learning continue at most of the institutions using the virtual learning platforms.

Virtual learning experiences

The virtual environment is a shared techno-social environment which provides space for digital communication. It is a relationship enabler that provides communication channel for students and other users based on advancement in technology for people at distant places. The virtual platform provides sufficient conditions for both teaching and learning (Gulum, 2018). The advent of COVID-19 is increasingly developing the learning experience of students through virtual learning. The gradual changes of teaching and learning styles from face-to-face to virtual platform are creating new environment for teaching and learning through the virtual learning platform. The student experience landscape resulting from virtual education is now moving towards new realities due to integration of virtual objects at the various levels of education and emergence of new technologies (Flavian et al., 2019). Essiam (2019) on how technology was deployed for academic work in tertiary education in Ghana revealed that students search the internet for videos to enrich their understanding in their courses (Mean = 4.125) was rated highest. This was followed by students using their mobile phones to search for information on topics of interest (Mean = 4.109) and then students watching video clips from the internet for better understanding (Mean = 4.080) of the courses they were studying. A study at a university in South Africa revealed that due to the epistemological foundation of teaching and learning in the classroom, translating to online instructional learning was met with some challenges including how to carry out the transition due to COVID-19 (Dlamini and Ndzinisa, 2020). It was revealed in a study on the influence of technology on virtual learning at some Jordanian universities that students using digital technology required additional guidance because most of them faced both economic and psychological stress that decreased their willingness to learn using the virtual platform. Nevertheless, the study also revealed that the attitude of the students towards learning improved because of the quality of the learning experience gathered through the virtual platform (Al-Salman and Heider, 2021). Research has proved that many libraries now adapt to the technologically evolving environment based on the information revolution resulting from the advent of COVID-19 and its challenges to human capital (Maddaluno, 2019).

Content creation tools

Content according to Majali (2017) is anything that is made known through some medium, such as speech, writing or any of various arts for self-expression, distribution, marketing and/or publication. Thus, content creation tools are the tools used by course leads and designers to create content which serves as learning materials on the virtual learning platforms. The content may exist in the form of videos, audio, pictures, slides, plain text and animations. These tools are Word, PowerPoint, FrontPage and Director (Paulsen, 2002). The most productive of these tools are the authoring tools

which are the software that aids in the creation of digital contents and assessment tools which help in assessing and evaluating student learning and can provide a variety of ways to examine students beyond the traditional exam.

Technology and communication devices

The advancement of the internet and computer technologies coupled with the development of software that facilitates online learning and teaching systems (learning management systems) have attracted many people from different parts of the world to pursue distance or online university education with the aim of obtaining university degrees from institutions across the globe (Durnali, 2020). The advent of COVID-19 prompted many universities to enhance their e-learning platforms through transformation of their formal face-to-face classroom education into online education with the aid of virtual platforms (Shehzadi et al., 2021). As one of the remedies to mitigate the spread of COVID-19, many countries across the globe urged their universities to resort to the virtual platforms for their teaching and learning. Most universities enhanced the capabilities of their students to cope with the advancement in technology in order to meet the challenges of COVID-19 pandemic by educating the students on e-learning, e-teaching, and e-management systems (Durnali, 2020; Takalami et al., 2020). According to Ladyshewsky and Pettapiece (2015) many students required guidance on how to use technology to enhance virtual learning capabilities, for example, virtual coaching on the use of virtual platforms. Since the outbreak of COVID-19 there have been a myriad of virtual platforms for students. For example, a study by Chherawala and Gill (2020: p.517) revealed that "there has been a surge in videoconferencing technology used in response to the COVID-19 pandemic."

One of the gateways leading to the extension of the classroom to home-based learning in order to cope with the effect of COVID-19 on teaching and learning is the use of technology and communication devices. According to Yuanhong et al. (2021), 'technology generates the user's virtual experience and, subsequently, the behavioral response' (p. 170). Technology enhances students' experience and attitude towards learning using the virtual platform (Pleyers and Poncin, 2020). Internet of Things (IoT) technology has also contributed to the flexible management of virtual learning process. Remote learning with the aid of digital tools and flexible learning management systems has ensured safe distance learning and online collaboration that ensures continuity of education during the COVID-19 era (Ilieva and Yankova, 2020).

Many studies now reveal that students are now getting used to the use of the virtual platform due to the pressure resulting from the pandemic and the resulting new technologies which now make students' information seeking pathway transiting from face-to-face to virtual. For instance, the use of automated systems such as robotic retrieval systems, e-learning platforms, interactive cataloguing, and elegant space have enhanced students' usage of the library. Now the learning capabilities of students are enhanced and their information seeking journey is gradually moving from the tangible to the virtual (Maddaluno, 2019).

Online teaching and learning

The shift from traditional face-to-face to online teaching and learning as a rapid response to COVID 19 pandemic in educational institutions has influenced teaching and learning in diverse ways. Even though online teaching and learning is not new, the swift transition and enforcement of it within the pandemic as a new hybrid exposes both faculty and students to new experiences as well as coping strategies for effective usage.

The widespread adoption of technology in teaching and learning processes in recent times is said to bridge the gap between online and offline teaching and learning. Shenoy et al. (2020) for instance highlight that online teaching offers opportunities for using smart teaching and learning aids without experiencing a difference between online and offline teaching approaches. Similarly, the World Economic Forum (2020) adds that online learning is so beneficial that it increases retention of information and time efficiency.

Nevertheless, these experiences differ among individuals and nations. Research shows that the level of influence of online teaching and learning on students or instructors depends on different number of factors, ranging from contextual, relevance, access and technical know- how to financial strength of individuals and nations (Blundell et al., 2020; Callo and Yazon, 2020; Mittal et al., 2021; Mustafa et al., 2020). It is reported by the World Economic Forum (2020) that a greater percentage of developed countries had successful transmission from the traditional face-to-face to the online system and have also accumulated rapid benefits compared to those in developing countries with less expertise and internet connectivity problems. Similarly, Adarkwah (2021) emphasizes that e-learning is beneficial, but its effectiveness is contextually based. According to the author, while students in developing countries perform less in online classes and are more likely to withdraw compared to those in developed countries who perform better in online classes but less in offline sessions.

Even though students' engagement is a major challenge for instructors and academic institutions, especially within the traditional offline classroom sessions, the online session is said to cause 20% increase of class attendance over offline sessions and has resulted in almost 100% attendance while engaging students virtually (Shenoy et al., 2020). They further emphasize that online learning increases social interactions than that of offline.

To buttress this, Tartavulea et al. (2020) in an investigating on the impact of online teaching on education systems during COVID 19 using 362 professors and students from thirteen (13) European countries in 2020 found out that online teaching has an overall moderate positive impact on the educational process compared to offline approaches. Similarly, Ryan and Poole (2019) in a study investigating the impact of virtual learning environment on students' satisfaction, engagement recall, and retention found out that virtual environment shows improvement in students' satisfaction, engagement, and recall. Virtual learning environments, according to them, are associated with greater students' satisfaction/engagement and ease of learning. Online teaching and learning in recent times have significant influence on both instructors' and students' virtual learning experiences.

Methodology

Study design

The present research employed quantitative research design to study the relationship between the impact of information and communication technology and students' virtual learning experiences in tertiary institutions amidst this COVID season. The variables that were measured against virtual learning experience in tertiary institutions were content creation tools, technology and communication devices and online teaching and learning in a cross-sectional survey.

The quantitative methodology was adopted to collect data from Level 200, 300 and 400 undergraduate students at a public university in Ghana. The methodology focused on gathering data from 2nd, 3rd, and final year undergraduate students due to their experiences with teaching and

learning during the pre-covid era due to the current global trends of the pandemic. The sample size for the study was 379 students.

Tsevi (2016) reported that on-campus, distance and online teaching remain the predominant mode of instruction delivery among higher education institutions in Ghana. However, with the changing dynamics of the covid virus most higher education institutions are gravitating towards online teaching and learning through multiplicity of pedagogical approaches. In line with ethical consideration, permission was granted by the Research Director of the University with more emphasis on voluntary participation, anonymity, and confidentiality of responses among the student respondents.

Study findings

Demographic characteristics of respondents. Personal data of the participants were analysed using descriptive statistics. Results from Table 1 indicated that majority of the participants were males (59.1%). In relation to the age of the participants, majority were in the 18–24 years age category (67.0%) followed by the less than 18 years (20.3%). Furthermore, majority of the participants were in their third year of (38.3%) followed by the final year students (32.5%) and then by the second-year students (29.3%).

Results from Tables 2–5 reveal the means and standard deviations of the individual items and the composited means scores of the study constructs. The results indicated that virtual learning experience (M = 3.166, SD = 1.198), content creation tools (M = 3.518, SD = 1.089), use of technology and communication devices (M = 3.838, SD = 0.778) and online teaching and learning (M = 3.385, SD = 0.626). These findings suggest that students use of technology and communication devices was rated as the most important construct among the study participants.

Factor analysis. As part of the analysis, the Principal Component Analysis (PCA) was conducted using the Varimax to determine the orthogonal structure of the dimensions of the study constructs (Awang, 2015; Baraldi and Enders, 2010; Hair et al., 1998; Watkins, 2018). The Kaiser-Meyer-Olkin and Barlett's test (KMO) was also conducted to establish sampling adequacy and suitability of the data sets for data analysis (Awang, 2015; Watkins, 2018). The study results were all significant indicating sampling adequacy and suitability of the extracted factors for further analysis. The regression factor method was used for the computations of factor scores for the study constructs as a result of the high predictability of the validity of the study items (Distefano et al., 2009).

The PCA results revealed that the Virtual Learning Experience (VLE) items had two extractions. Five out of six items were extracted into Component 1 while the remaining one item was extracted into Component 2. This means that Component 2 had extractions of less than three items and

Table 1. Demographic characteristics of study respondents (*N* = 379).

Characteristics	Distribution of answers
Gender	Male: 227 (59.1%); female: 152 (40.1%)
Age	Less than 18 years: 77 (20.3%); 18-24 years: 254 (67.0%); 25-30 years: 42 (11.1%) and above 30 years: 6 (1.6%)
Level of study	Level 200: 111 (29.3%); level 300: 145 (38.3%) and level 400: 123 (32.5%)

therefore, Component 2 was deleted from the factor structure as suggested by Awang (2015). Principal Component Analysis for the content creation tools also revealed two components. Component 1 had six items out of seven while Component 2 recorded a cross-loading of both Component 1 and 2. Therefore, Component 2 was discarded from further analysis due to cross-loading effect as suggested by Awang (2015).

Similarly, PCA extractions for the use of technology and communication devices revealed that six items were extracted in Component 1 while one item was isolated into Component 2. Further on, out of six items for the online teaching and learning, five items were extracted into Component 1 while Component 2 had one item. All the second components were deleted and were not used in further analysis as reported by previous authors (Awang, 2015; Baraldi and Enders, 2010; Essiam, 2019; Watkins, 2018).

Convergence validity was established by the evidence of high factor loadings leading to average variance extracted (AVE) values of greater than 0.50 and composite reliability values of greater than 0.80 as presented in Tables 2–5 (Gerbing and Anderson, 1998; Bagozzi and Yi, 2012; Fornell and Larcker, 1981). To establish discriminant validity, the square of the AVE must be larger than the intercorrelation values among the constructs in the data set of the study (Fornell and Larcker, 1981). Discriminant validity for the present study was established (see Table 6). Additionally, internal consistency among the items for measuring a construct was achieved using the Cronbach Alpha reliability scores (see Tables 2–5).

Findings from Table 7 showed linear regression was used in a two-model structure to test for the study hypotheses. The first model tested for H1, H2 and H3 while the second model was responsible for the results of H4 and H5. In the first model, technology and communication device use ($\beta = 0.342$, $p < .001$), content creation tools ($\beta = 0.182$, $p < .001$) and online teaching and learning ($\beta = 0.513$, $p < .001$) contributed significantly to student virtual learning experiences and that they explained 60.8% of the shared variance in the virtual learning experiences of the students. In the second model, technology and communication device use ($\beta = 0.393$, $p < .001$) and content creation tools ($\beta = 0.201$, $p < .001$) significantly influenced online teaching and learning and that they explained 68.7% of the variance in online teaching and learning.

Table 2. Factor analysis of Virtual learning experience.

Items	Loadings	AVE	Reliability	CR	Mean	SD
Virtual learning experience		0.698	0.893	0.889	3.166	1.198
I regularly participate in online class discussions using the VLP	0.884				3.272	1.452
The virtual learning platform provides access to an online library	0.861				3.024	1.472
It is easy to use the tools on the VLP to design and produce learning notes and assignments	0.857				3.098	1.501
I have the appropriate abilities and level of knowledge to use the VLP for learning	0.812				3.356	1.439
The use of the VLP has improved my learning abilities	0.757				3.079	1.287

Table 3. Factor analysis of Content creation tools.

Items	Loadings	AVE	Reliability	CR	Mean	SD
Content creation tools		0.579	0.884	0.827	3.518	1.089
The use of slides in content creation for lectures helps me to gain a visualised understanding of the subject matter	0.875				3.333	1.524
Content creation tools improves the understanding in online teaching and learning	0.852				3.493	1.222
I have the training required for using content creation tools for preparing teaching and learning materials	0.849				3.773	1.132
Content creation tools helps saves time in online teaching and learning	0.661				3.536	1.529
I prepare online scholarly presentations with the aid of content creation tools such as PowerPoint	0.657				3.303	1.548
The use of a content creation tool such as MS word helps in preparing online assignments	0.629				3.673	1.186

Table 4. Factor analysis of Use of technology and communication devices.

Items	Loadings	AVE	Reliability	CR	Mean	SD
Use of technology and communication devices		0.611	0.774	0.852	3.838	0.778
Technology and communication devices is a priority in online teaching and learning	0.888				3.731	1.139
Technology and communication devices encourage students to participate in online teaching and learning	0.862				3.338	1.533
I think that getting information from technology and communication devices in online teaching and learning is easier than face to face teaching and learning	0.821				3.457	1.473
I think that technology and communication devices improve online teaching and learning	0.747				3.380	1.544
I am comfortable using technology and communication devices in online teaching and learning	0.683				4.164	1.005
Teaching and communication devices is often use in online teaching and learning	0.662				4.156	0.800

Discussions

The purpose of this study was to analyze technology as a predictor of virtual learning experience gained by students after the surge of COVID-19. The study focused mostly on an institution of higher learning in Ghana, where it was observed that even the lockdown period during the peak of the pandemic, almost all the institutions of higher learning continued their academic work using virtual platforms.

There were two main issues the study sought to address. First was the influence of technology and communication device use, content creation tools and online teaching and learning on student virtual learning experience. The second part is concerned with the impact of technology and communication device use and content creation tool on online teaching and learning.

Table 5. Factor analysis of Online teaching and learning.

Items	Loadings	AVE	Reliability	CR	Mean	SD
Online teaching and learning		0.618	0.754	0.889	3.385	0.626
The virtual learning platform provides access to an online library	0.857				3.356	1.439
The use of a content creation tool such as MS word helps in preparing online assignments	0.832				3.979	1.101
I have the training required for using content creation tools for preparing teaching and learning materials	0.827				3.079	1.287
The use of the VLP has improved my learning abilities	0.777				3.333	1.524
I frequently use the VLP for online teaching and learning	0.612				3.493	1.222

Table 6. Intercorrelations matrix and discriminant validity for the study constructs.

Construct		1	2	3	4	SQRT AVE
1	Virtual learning experience	1	.519**	.213**	.642**	.835
2	Use of tech. and communication devices	.519**	1	.361*	.466**	.760
3	Content creation tools	.213**	.361**	1	.344**	.782
4	Online teaching and learning	.642**	.466**	.344**	1	.786

SQRT: Square root; AVE: Average variance extracted **. Correlation is significant at the 0.01 level (2-tailed).

Table 7. Model results for study hypotheses.

Hypotheses	Path	Beta coefficient	Result
H1a	Technology & communication device use -> virtual learning experience	.342**	Supported
H2a	Content creation tools -> virtual learning experience	.186**	Supported
H3a	Online teaching & learning -> virtual learning experience	.513**	Supported
R^2 - value		.608	
H4b	Technology & communication device use -> online teaching & learning	.393**	Supported
H5b	Content creation tools -> online teaching & learning	.201**	Supported
R^2 - value		.687	

Notes: *$p < .05$; **$p < .01$. (See Figure 2)

The outcome of this study reveals that COVID-19 affected the student' learning experiences in diverse ways. The pandemic enhanced the ability of the students and faculty to depend mostly on technology for their learning habit. The contagious nature of COVID-19 threatened close contact of people that prompted many institutions of higher learning to adopt the use of technology and communication gadgets for their learning from their homes during the eruption of 0the pandemic. Most of the students who, hither to, had no experience in the use of most computer and technology gadgets obtained diverse experiences from the use of the devices during the COVID-19 pandemic era. This revelation is an indication that there was a positive significant influence of the use of

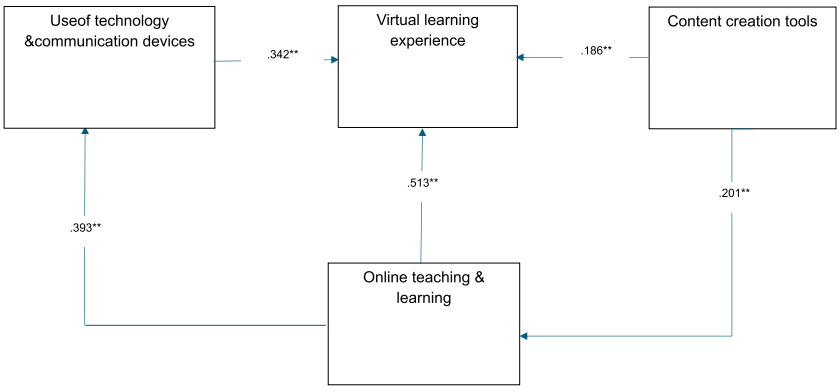

Figure 2. Tested technology-online-content – learning experience model.

technology and communication devices on the students' virtual learning experience as supported by the current study. Factor analysis of this study realized that majority of the students gained more experience on online class discussion, how to use the online library, how to design and produce learning notes and assignments, using the online learning platform. Other experiences gained, as revealed by the current study, were the use of appropriate abilities and level of knowledge gained from the virtual platform, during the outbreak, to use the virtual learning platform. These findings are in line with the outcomes of the studies conducted by Shatri (2020), Durnali (2020), and Mishra et al. (2020).

Nevertheless, this study also revealed that to use technology to leverage on the students' learning abilities required experiences on the content creation tools. During the COVID-19 surge most of the students learned and gained experiences on the use of the content creation tools. Factor analysis of this study realized that unlike the face-to-face classroom learning, which is involved with more paperwork, the virtual approach requires the creation of a learning platform that demanded learning experiences from both the learner and the faculty. The findings indicate that majority of the students gained experience in the use of slides in content creation tools for lectures that increased their visualized understanding of the subject matter learned through the virtual platform. Most of the students gained more experience in preparing online teaching and learning materials using content creation tools. Other experiences gained from knowledge acquired in using content creation tools included preparing online scholarly presentations such as the use of PowerPoint and the use of MS Word for online assignments. The result of the current student is positively related to the study outcome of Shehzadi et al. (2021), Takalami et al. (2020) and Chherawala and Gill (2020). Majority of the participants were of the view that the platform provided them more experiences on how to access online libraries, the training required for using content creation tools for preparing teaching and learning materials and using the online facilities for teaching and learning. The study by Tartavulea et al. (2020) on the relationship between online teaching and education system from 13 European countries confirms the outcome of this study on experiences gained by students on the use of content creation tools.

Conclusions and implications

Many authors have used different scales and variables to measure the relationships between technology and student learning experiences. In view of these observations, the study sought to

achieve rigor by ensuring convergence and discriminant validity were established among the data sets to bridge the knowledge gap in different research paradigms across different fields and locations.

Study findings indicated that technology and communication device use, online teaching and learning and content creation tools significantly predicted student virtual learning experiences. The empirical analyses from a higher education institution in Ghana and the outcomes of the current study confirm that technology was a predictor of students virtual learning experiences during and after the COVID-19 surge.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iD


Joshua Ofori Essiam https://orcid.org/0000-0002-3487-4801

References

Adarkwah MA (2021) "I'm not against online teaching, but what about us?": ICT in Ghana post Covid-19. *Education and Information Technologies* 26(2): 1665–1685.

Afriyie DK, Asare GA, Amponsah SK, et al. (2020) COVID-19 pandemic in resource-poor countries: challenges, experiences and opportunities in Ghana. *The Journal of Infection in Developing Countries* 14(08): 838–843.

Al-Salman S and Heider AS (2021) Jordanian University students views on emergency online learning during COVID-19. *Online Leaning* 25(1): 286–302.

Awang Z (2015) *SEM Made Simple: A Gentle Approach to Learning Structural Equation Modeling*. Bangi: MPWS Rich Publication, ISBN 978 967 110 998 4.

Bagozzi RP and Yi Y (2012) Specification, evaluation, and interpretation of structural equation models. *Journal of the Academy of Marketing Science* 40(1): 8–34.

Baraldi AN and Enders CK (2010) An introduction to modern missing data analyses. *Journal of School Psychology* 48(1): 5–37. DOI: 10.1016/j.jsp.2009.10.001.

Bennis M (2023) Cyberculture in Higher Education: Narrowing the digital gap between Mark Prensky's "Digital Natives" and "Digital Immigrants". *International Journal of Research in Humanities and Social Studies* 10(1).

Blundell GE, Castañeda DA and Lee J (2020) A multi-institutional study of factors influencing faculty satisfaction with online teaching and learning. *Online Learning* 24(4): 229–253.

Callo EC and Yazon AD (2020) Exploring the factors influencing the readiness of faculty and students on online teaching and learning as an alternative delivery mode for the new normal. *Universal Journal of Educational Research* 8(8): 3509–3518.

Chherawala N and Gill S (2020) Up-to-date reviewer of psychotherapy via video conference: implication and recommendations for the RANZAP psychotherapy written case during the COVID-19 pandemic. *Australian Psychiatry* 28(5): 517–520.

DiStefano C, Zhu M and Mindrila D (2009) Understanding and using factor scores: considerations for the applied research. *Practical Assessment, Research and Evaluation* 14(20): 1–11.

Dlamini R and Ndzinisa N (2020) Universities trailing behind unquestioned epistemological foundation, constraining the transition to online instructional delivery and learning. *South African Journal of Higher Education* 34(6): 52–64.

Durnali M (2020) The effect of self-directed learning on the relationship between self- leadership and online learning among university students in Turkey. *Tuning Journal for Higher Education* 8(1): 129–165.

Essiam JO (2019) *Influence of Student Engagement on Academic Performance in Higher Education in Ghana*. Doctoral dissertation. Accra: University of Ghana.

Flavian C, Ibanez-Sanchez S and Orus C (2019) The impact of virtual, augmented and mixed reality technologies on the customer experience. *Journal of Business Research* 100: 547.

Fornell C and Larcker DF (1981) Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research* 18: 39–50.

Gerbing AG and Anderson JC (1988) An updated paradigm for scale development incorporating unidimensionality and its assessment. *Journal of Marketing Research* 25: 186–192.

Ghana News Agency (2020) *Successful Testing Regime and Controls Inform Lifting of Lockdown*. Accra: Ghana News Agency. https://newsghana.com.gh/successful-testingregime-and-controls-inform-lifting-of-lockdown/ (Accessed 21 April 2022).

Gulum UE (2018) Virtual environment as a digital communication technologies-mediated folkloric experience sphere. *Milli Folklor* 119: 127–139.

Hair J, Anderson R, Tatham R, et al. (1998) *Multivariate Data Analysis with Reading*. New York, NY: Macmillan.

Hallin AE, Danielsson H, Nordström T, et al. (2022) No learning loss in Sweden during the pandemic evidence from primary school reading assessments. *International Journal of Educational Research* 114: 102011.

Ilieva G and Yankova T (2020) IoT in distance learning during the COVID-19 pandemic. *TEM Journal* 9(4): 1669–1674.

Ladyshewsky R and Pettapiece RG (2015) Exploring adult learners' usage of information communication technology during a virtual peer coaching experience. *Online Learning* 19(2): 1–15.

Maddaluno P (2019) The use of new technologies from virtual to pragmatic: the experience of the Luca Pacioli library. *Bibliothecae.it* 8(2): 382–393.

Majali K (2017) *Content Creation Definition*. Kharkiv, Ukraine: Europe IT outsourcing. Available at: https://europeitoutsourcing.com/blog/content-creation/content-creation-definition/.

Mishra L, Gupta T and Shree A (2020) Online teaching-learning in higher education during lockdown period of COVID-19 pandemic. *International Journal of Educational Research Open* 1: 100012. DOI: 10.1016/j-ijedro.2020.100012.

Mittal A, Mantri A, Tandon U, et al. (2021) A unified perspective on the adoption of online teaching in higher education during the COVID-19 pandemic. *Information Discovery and Delivery* 50: 117–132.

Mok KH, Xiong W, Ke G, et al. (2021) Impact of COVID-19 pandemic on international higher education and student mobility: student perspectives from mainland China and Hong Kong. *International Journal of Educational Research* 105: 101718.

Mustafa DF, Khursheed A, Rizvi SMU, et al. (2020) Factors influencing online learning of university students under the covid-19 pandemic. *IJERI: International Journal of Engineering Research & Innovation* 15(1): 342–359.

Ohlin C (2019) Information and communication technology in a global world: teachers' perceptions of continuing professional development. *Research in Social Sciences and Technology* 4(2): 41–57.

Osadebe FJ and Osadebe UP (2020) Undergraduate business education students' perception on information and communication technology use in teaching and learning. *International Journal of Evaluation and Research in Education* 9(2): 359–363.

Paulsen FM (2002) *Online Education Systems: Discussion and Definition of Terms*. Norway: NKI Distance Education. Available at: https://home.nettskolen.com/~morten.

Pleyers G and Poncin I (2020) Non-immersive virtual reality technologies in real estate. How customer experience drives attitude toward properties and the service provider. *Journal of Retailing Customer Service* 57: 102175. DOI: 10.1016/j.jretconser.2020-102175.

Prensky M (2001) Digital natives, digital immigrants part 2: do they really think differently? *On the Horizon* 9: 1–6.

Raza SA, Qazi W, Khan KA, et al. (2021) Social isolation and acceptance of the learning management system (LMS) in the time of COVID-19 pandemic: an expansion of the UTAUT model. *Journal of Educational Computing Research* 59(2): 183–208.

Ryan E and Poole C (2019) Impact of virtual learning environment on students' satisfaction, engagement, recall, and retention. *Journal of Medical Imaging and Radiation Sciences* 50(3): 408–415.

Shatri ZG (2020) Advantages and disadvantages of using information technology in learning process of students. *Journal of Turkish Science Education* 17(3): 420–428.

Shehzadi S, Nisar QA, Hyssain MS, et al. (2021) The role of digital learning toward students' satisfaction and university brand image of educational institutes of Pakistan: a post-effect of COVID-19. *Asian Education and Development Studies* 10(2): 276–294.

Shenoy V, Mahendra S and Vijay N (2020) COVID 19 lockdown technology adaption, teaching, learning, students engagement and faculty experience. *Mukt Shabd Journal* 9(4): 698–702.

Takalami M, Rayhuhali F and Mapotso K (2020) Disaster Management Act No. 57 of 2002 and its framework of 2005 in response to coronavirus: South African universities vulnerability. *Gender & Behavior* 18(1): 15190–15201.

Tartavulea CV, Albu CN, Albu N, et al. (2020) Online teaching practices and the effectiveness of the educational process in the wake of the COVID-19 pandemic. *Amfiteatru Economic* 22(55): 920–936.

Tesar M (2020) Towards a post-Covid-19 'new normality?': Physical and social distancing, the move to online and higher education. *Policy Futures in Education* 18(5): 556–559. DOI: 10.1177/1478210320935671.

Tsevi L (2016) Quality and accreditation of private higher education in Ghana. In: *A Global Perspective on Private Higher Education*. Oxfordshire: Chandos Publishing, pp. 287–297.

UNESCO (2020) *COVID-19: How the UNESCO Global Education Coalition Is Tackling the Biggest Learning Disruption in History*. Paris: UNESCO. https://en.unesco.org/news/covid-19-how-unesco-global-education-coalition-tackling-biggest-learning-disruption-history

Watkins MW (2018) Exploratory factor analysis: a guide to best practice. *Journal of Black Psychology* 44(3): 219–246. DOI: 10.1177/0095798418771807.

World Economic Forum (2020) *The COVID-19 Pandemic Has Changed Education Forever*. Cologny: Global Agenda.

World Health Organization (WHO) (2020) *WHO Coronavirus Disease (COVID-2019) Situation Reports*. Geneva: WHO. https://www.who.int/emergencies/diseases/novel-coronavirus2019/situation-reports (Accessed 2 April 2022).

Yuanhong M, Yunzhong C, Liangqiang L, et al. (2021) Following the flow: exploring the impact of mobile technology environment on users' virtual experience and behavioral response. *Journal of Theoretical & Applied Electronic Commerce Research* 16(2): 170–187.

Author Biographies

Dr. Joshua Ofori Essiam holds a Ph.D. in Adult Education and Human Resource Studies from the University of Ghana and a Commonwealth Executive Masters in Business Administration from the Kwame Nkrumah University of Science and Technology. He is a Lecturer at the University of Professional Studies Accra, Ghana. His teaching spans Human Resource Management, Operations Management, and Risk and Insurance Management, while his research delves into diverse areas including human resource engagements, student engagements, research methodology, higher education management, policy formulation, and sustainable development indicators, showcasing multidisciplinary expertise.

Dr. Gerald Dapaah Gyamfi, FCIS, a Fellow of ICSA, UK, and a holder of a Ph.D. in Higher Education Administration from the University of Phoenix, USA. He is a Dean at the University of Professional Studies Accra, Ghana. He is highly interested in police research and management research. He is a management professional and teaches Risk Management. Gerald is also an entrepreneur and a Proprietor of a Professional Education Center in Accra. Ghana.

Dr.Jonathan Odame holds a Ph.D. in Adult Education and Human Resource Studies from the University of Ghana. He is a Lecturer at the Department of Distance Education, University of Ghana. He holds a BA (Hons) degree in Psychology with the Study of Religions and an MPhil in Clinical Psychology both from the University of Ghana. His research interests are in E-Learning, Guidance and Counselling, Adult Psychology, and Human Resources.

Dr. Angela Ayisi-Addo holds a Ph.D. in Adult Education and Human Resource Studies from the University of Ghana. She is a Lecturer at the Department of Sustainable Development and Policy (DSDP) at the University of Environment and Sustainable Development, Somanya-Ghana. She is involved in community improvement programs. She is currently researching women's participation in development work. Her research interests include Sustainable Development, Climate Change, Agribusiness, Green Entrepreneurship, and Research Methods.