

Usage of Electronic Infrastructures and Students' Learning Effectiveness in Nigerian Universities: A Polytomous Logistic Prediction

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Abstract

A preponderance of empirical research in higher education exists on the use of electronic resources to promote university education and learning. This suggests that this area of research has attracted significant interest worldwide. However, there seems to be inadequate information on the association between specific electronic infrastructures, how they are utilised for teaching and learning, as well as their effects on students' learning effectiveness in higher institutions. This research draws on previous studies and seeks to establish how different electronic resources are used in universities and how they affect students' learning effectiveness. Using a descriptive survey design, the survey examined 1,452 participants (undergraduates and postgraduates) from Nigerian universities. The data were analysed using mean and standard deviation, while a Polytomous Logistic Regression Model was used in testing the hypothesis formulated. Findings showed that the degree of the use of digital infrastructures in universities is low. The extent of learning effectiveness among students in universities is also low. The usage of *e-infrastructures* (such as *e-learning*, *e-communication* and *e-library* tools) significantly predicts students' levels of learning effectiveness. Based on these results, conclusions and relevant theoretical and practical implications are discussed for policy reforms in education and e-learning. This study faces the limitation arising from the small number of universities studied. However, it is suggested that future related studies extend their focus beyond the context of Nigeria.

Keywords: Effectiveness, electronic, infrastructure, learning, online resources, universities

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Introduction

A sound and dynamic university system is a formidable instrument for ensuring the development of any nation towards economic viability and global competitiveness. This is because universities are set up to develop a competitive workforce through the supply of graduates with the right expertise, abilities, competencies and skills. Higher education places premium value on the production with a high degree of intelligence and commitment to learning (Arop et al., 2018; Bassey, Owan and Agunwa 2019). The world economy has progressively advanced from industrial-based to knowledge-based, where the economic progress is measured by the type of skills acquired, applied and re-constructed by its workforce (Sepehrdoust, Davarikish, and Setarehie 2019).

It becomes imperative for every developing country to create a functional university system capable of producing a global-based knowledge-oriented workforce. Unfortunately, universities in developing countries tend to turn out graduates, the majority of whom lack appropriate skills to fit into the labour market demands. In the Nigerian context, it has been argued that the quality of graduates provided by universities are increasingly deteriorating, against the demands of the 21st century needs of the labour market (Odigwe, Offem, and Owan 2018). This may suggest that the process of creating these graduates in tertiary institutions is inefficient. Researchers have noted that products of Nigerian universities in the 21st century are skill-deficient. For example, some scholars revealed that many graduates lack basic skills (in areas such as entrepreneurship, communication, personal management, teamwork, computer literacy, and leadership) which results in an increasing level of unemployment in the country (Nwosu and John 2018; Odigwe, Offem and Owan 2018). These observed inadequacies among graduates in Nigeria may be attributed to the learning ineffectiveness in universities. This is because the quality of graduates from universities is directly affected by the quality of learning (Bassey, Owan, and Eze 2019). Therefore, when the learning process is ineffective, the outputs tend to be of poor quality.

Students' learning effectiveness is defined as the degree to which students are engaged in school programs and the commitment they have made to accomplish their goals (Owan and Ekaette 2019). Some higher education studies conceive learning effectiveness as the degree to which students have an uninterrupted flow of experiences with their instructors for guidance, feedback, correction and clarification may also decide the level of learning effectiveness among them (Swan 2002; Johnson et al. 2008; Long, Ibrahim, and Kowang 2014). This requires positive approaches to timeliness, lectures, tasks, tests and other co-curricular school programs (Owan and Robert 2019; Owan, Bassey, and Ekpe 2020). Learning effectiveness is maximised when there are sufficient resources for students to partake in constructive learning activities (such as group meetings, exchange ideas/opinions on previous learning content/experiences) and participate in realistic exercises (Adwan 2016; Bukoye 2019; Darling-Hammond et al. 2020; Savasci and Tomul 2013). Learning effectiveness may be holistically measured using students' access to materials for independent learning and research practices. The availability of platforms for group study and interactive learning among students and between students and lecturers constitute another aspect of learning effectiveness (Jimaa 2011; Watkins, Carnell, and Lodge 2007).

One of the reasons militating against effective and quality learning in higher education appears to be the shortage of state-of-the-art facilities. On many occasions, some university students tend to complain about the lack of adequate lecture halls, ill-functioning laboratories and libraries and basic modern information resources, as issues militating against smooth learning processes. Some universities have taken drastic measures to improve the learning situation among students. For instance, many universities worldwide tend to have digital libraries and additional lecture theatres to accommodate increasing number of students. It is further contended that effective and full integration of electronic infrastructure (EI) into learning may create unlimited access to education and information resources. The integration of EI can also enable constant contact between students and lecturers, thereby enhancing collaborative and integrative research culture among students of different institutions. This may potentially remove barriers to effective learning in universities.

Again, the pace at which students learn in universities may be used to quantify the degree to which institutions have accomplished specified priorities and objectives. If this is true, then students' learning effectiveness is at the core of successful universities worldwide. Since it has been argued that the capacity to think innovatively and respond to change, is a requirement in the 21st century (Kereluik et al. 2013), students must have access to materials for collaborative learning to meet this demand. Working in collaborative teams with other peers on the same learning

task has been reported to boost students' perception, learning motivation, and effectiveness (Krejčová, Chýlová, and Michálek 2019). Nevertheless, the students have the ultimate role in deciding how best to study for improved results. The reason is that students who are deeply involved in learning activities are likely to show deep interest in their academic work, obtain higher test grades (Jindrová, Vostrá, and Dömeová 2013; Ladd and Dinella 2009; Li and Lerner 2011). Furthermore, studies tend to document that learning is a reflective activity that involves students' active meta-cognition of processes in planning, monitoring and reflecting on experiences through interaction, practice and discussions (Dunlosky et al. 2013; Owan and Ekaette 2019). This should enable them to understand and evaluate the present, while shaping future actions to formulate new knowledge.

However, considering the complexities of the twenty-first century, it is obvious that no institution can encourage effective learning without sufficient use of electronic infrastructures (Perera and Richardson 2010; Apuke and Iyendo 2018). Electronic infrastructures are internetbased facilities that enhance teaching and learning in educational institutions and allow students to explore different ways of improving their learning (Ankrah and Atuase 2018). This study is informed by the need to provide an empirical answer to the question – what is the association between the use of various electronic infrastructures and students' learning effectiveness in universities? The study was specifically designed to assess the usage of electronic infrastructures such as e-learning, e-communication, and e-library infrastructures in universities. Each of these specific areas is treated briefly below including a review of related studies.

E-learning Infrastructures

E-learning is a learning paradigm that uses digital technologies to provide feedback and allow students to view curricula beyond conventional classrooms and to view or obtain other related content and facilities that are not accessible within the university (Górska 2016; Eze, Chinedu-Eze, and Bello 2018; Valverde-Berrocoso et al. 2020). Previous studies on e-learning have identified various platforms that can be used to enhance online instructional delivery. These studies have also highlighted the importance of these platforms. For instance, research highlighted the importance of Poll Everywhere (an e-learning platform) in reducing students' test anxiety while promoting a favourable academic performance in Mathematics (Owan et al. 2020).

In Science and engineering education, the role of virtual laboratories was extensively buttressed by a study (Potkonjak et al. 2016). The cited authors contended that the effective teaching of science courses faced a problem due to the poor adoption of virtual laboratories, especially for distance education purposes. Although the authors advocated that laboratories (real or software-based) be adopted in schools, they did not explore the extent to which institutions currently utilise virtual laboratories. Reacting to this gap, recent research found that the rate at which institutional leaders are aware, procure and manage virtual laboratories in high schools is low, but attributed this finding to the poor supply of cutting-edge facilities to schools (Ukpabio et al. 2020). The research of Ukpabio and colleagues made a case that the use of virtual laboratories is dependent on the degree of availability through procurement and effective management.

In a related study, Kučírková, Kučera, and Vostrá Vydrová (2012) found that students' posttest scores in the experimental group were neither better nor worse than that of the control group after exposure to e-learning platforms in terms of their listening and vocabulary reading, translation, and writing skills. The implication of the result of the cited study suggests that exposing students to e-learning platforms does not improve their language skills significantly. On the contrary, another study proved that key elements of e-learning, such as online assessments, played a substantial role in examination preparation (Kunstová 2012). In the same direction, a case study research did not find significant differences (for most courses) in traditional students' academic

performance versus those in virtual classroom situations taught by the same instructors (Al-Nuaim 2012). While the researcher did not explain the reasons for this finding, the importance of virtual classrooms was acknowledged. From another context, a related study rather confirmed a statistically meaningful gaps in the pre-and post-test scores of students regarding the processes, components and creation of e-learning systems to promote creative thinking (Songkram 2015). This suggests that the group were pleased with the e-learning method in a simulated learning environment to improve creative thinking. As a gap arising from the cited study, little information was offered concerning the effect of e-learning on students learning effectiveness.

Some studies have documented that students' motivation and achievement improved while they practised course materials using ICT in contrast to those who practised with papers (Bawa, Kaushal, and Dhillon 2020; Kuncová and Vojáčková 2015; Shopova 2014; Widenická 2014). Some more specific studies have clarified that students' mathematical skills improved significantly due to the utilisation of multimedia resources such as Zoom, YouTube (Subhi et al. 2020). The utilisation of Zoom and the integration of YouTube applications was concluded to be useful in potentially affecting the delivery of mathematics lectures to distance education learners. While the study of Subhi et al. is important, the extent to which distance education students used these applications and instructors were not covered. This is where the present study intends to fill by providing information on the extent to which these applications are utilised and how they impact the learning effectiveness of higher education students. It can also be argued that achievement is a product of learning effectiveness, however, both variables are not the same as some of the previous studies portrayed.

A cross-cultural study by Kobayashi (2015) analysed students' perception of the usefulness and ease of using Google Hangouts as a learning tool in Japan and the United States. It was concluded that Google hangout is not very easy to use, but very important as an instructional tool. Similarly, another research reviewed 219 studies focused on the Massive Open Online Courses (MOOCs) (Al-Rahmi et al. 2019). The scholars tested five dynamics related to the enhancement of MOOCs and concluded that students' academic success could be affected by the MOOC, which can encourage the learning process by providing materials and allowing knowledge exchange. The conclusions of this study were rather subjective and not based on empirical evidence, necessitating further research to justify the claims made.

Three uses of the Socrative mobile e-learning application was explored by a recent study (Cerqueiro and Harrison 2019). Results indicated that students welcomed the use of the Socrative app, but can increase their perceived satisfaction if integrated with gamification strategies. The cited research demonstrated how Socrative is an effective way of getting formative input and save time during classes, which has implications on students' learning effectiveness. However, beyond these findings, the research was conducted using a small group of first-year university students in a faculty of education in Spain, warranting further investigation, especially from developing nations in Sub-Saharan Africa.

Other e-learning applications that have caught scholars' attention include Educlipper, Edmodo, Mentimeter, Kahoot games, Google classroom, Seesaw, ClassDojo, Podcasting, and Prezi. For example, research used 40 participants in two experimental and two control groups to assess the effect of the Edmodo learning application on Iranian students writing skills (Ma'azi and Janfeshan 2018). It was observed that using Edmodo social learning network substantially influence the writing abilities of Iranian intermediate learners. Furthermore, Kahoot and Mentimeter applications have been shown to significantly influence the e-learning provision of prospective teachers training in the teaching department of the school (Gökbulut 2020).

Another research provided a critical analysis of the Kahoot game as an instructional tool for creating engagement in online classes and confirmed its wide acceptance by undergraduate and

postgraduate students (Plump and LaRosa 2017). However, the studies of Plump and LaRosa, and Gökbulut did not associate the use of the Kahoot to the learning effectiveness of students in higher education. The present study addressed this gap. However, in terms of the use of the Google classroom e-learning application, a study found its impact in enhancing students' writing and speaking skills, especially through assignments (Ratnaningsih 2019). This implies that students' learning effectiveness in speaking and writing can be improved by using the Google classroom application. Similarly, another research found that optimised adaptive e-courseware improved students learning at VSB-Technical University of Ostrava (Jurickova 2013).

Research focusing on podcasting showed that most students in the courses selected to use podcasts; few students used podcasts in the mobile mode, but most use them in their private study spaces as an additional resource (Collier-Reed, Case and Stott 2013). It was concluded that podcasting is used widely in the production of assessments and exams. Although the study CollierReed and others proved that there is a special advantage for learners who are not first-language speakers, nothing was said about the linkages between podcasting and learning effectiveness. The present study seeks to bridge this gap by assessing the extent to which podcasting and other elearning infrastructures are used and how their utility affects students' learning effectiveness in higher education.

E-communication infrastructures

E-communication infrastructures are another set of electronic resources that may impact students' learning in modern university systems. E-communication means any communication happening within the sphere of a digital environment through an electronic or digital medium (Akbaba and Başkan 2017). In providing higher education in the 21st century around the world, electronic communication resources have also been found to be substantially important (Talebian, Mohammadi, and Rezvanfar 2014). Researchers have also recognised the relevance of ecommunication services to promote communication, conversations, exchange of ideas, study and learning among university students worldwide (Gregory and Bannister-Tyrrell 2017).

Popular electronic communication infrastructures include e-mails, skype, YouTube, text messages, Instant messaging, video calls, blogs, Flickr, Wikis, Google+, Myspace, videoconferencing. Social media such as Telegram, Instagram, Facebook, Twitter, WhatsApp, and others are also considered e-communication infrastructure. Generally, e-communication services have gathered much attention from a growing body of studies (Okan and Taraf 2013; Kuznekoff, Munz, and Titsworth 2015). Specifically, the research results indicated that Flickr and Skype were used to encourage interaction and share between learners in geographically distant places; Web 2.0 technology was used to bridge the gap and facilitate exchange, cooperation and coordination in the simulated space (Fleischmann 2014). This indicates that some learning outcomes could not have been accomplished without using Flickr and Skype as exchange and networking resources in the virtual environment.

Another study discussed the use of Wikis and its importance for learning group management, research-based subject collection, instructor scaffolding, student assessment (Zheng, Niiya and Warschauer 2015). The investigation of another researcher put Google+ into a test, focusing on areas such as circles, hangouts, and huddles (Erkollar and Oberer 2013). As a preliminary evaluation, the research did not present any concrete evidence but concluded that any online service could be used on educational issues. Therefore, Google+ provides the possibility for constructive contact with teachers themselves, as well as students'-teachers' connection.

In terms of social media, a study indicated the significance of Facebook, Twitter, WeChat, Telegram, Snapchat, WhatsApp, Skype, Instagram, Eskimi, and YouTube on students' attitudes towards academic activities (Owan and Robert 2019). Admittedly, students' attitudes towards

learning and learners' effectiveness are not synonymous but are related because learners' attitudes could affect their effectiveness in education. Similarly, the research of other scholars investigated the effect of Telegram on the colloquial learning of 40 EFL students from Iran who have been tested via a language ability test (Vahdat, Shoostari and Mazareian 2020). The study confirmed the effects of Telegram in improving colloquial knowledge among Iranian high school students. This suggests that telegram, as a new mobile application, successfully facilitated EFL instruction and provided numerous pedagogical benefits. Having reviewed studies in this section, the researchers considered the present study unique. Unlike previous studies, this study was designed to analyse several e-communication infrastructures, the extent of adoption and their impact on students learning effectiveness in a developing country.

E-library infrastructures

Electronic library services have already had a noticeable impact in universities libraries globally (Erich 2013; Akussah, Asante, and Adu-Sarkodee 2015). In the 21st century, it is apparent that no university system can offer students ample access to information for individualised and study group-oriented practises without digitising libraries. There has been abundant evidence of an increase in the learning and research rate among students of higher education institutions (Imran and Malik 2017; Luna-Nevarez and McGovern 2018). This ushers in the need for well-equipped libraries to be provided by higher education institutions (HEIs). Research on students' access to specific e-library resources such as ebooks, e-newspapers, web pages, electronic conferences, emaps, e-mail magazines, e-References and e-portals continue to receive considerable attention in the literature (Fojtik 2015; Camassola and Notari 2017; Owan et al. 2021; Mawere and Sai 2018; Owan et al. 2022).

For instance, a study used the reading of online journals to stimulate curiosity in reading and how revised texts can be chosen that attract students' attention (Camassola and Notari 2017). Findings revealed that 100% of the students were pleased with the case. The study concluded that while online journal reading is simple and easy, it develops the taste and habit of reading for various publics. Similar research was planned to summarise the most common ebook technology and the one embraced by Ostrava University (Fojtik 2015). The investigator discovered that the most common platforms used by students in reading ebooks were android and IOS devices. In contrast, some students plan to procure these devices for learning. This implies that not every higher education learner possesses the necessary e-library tools for effective learning.

A study reported that while many academic institutions in Zimbabwe have made electronic library facilities top of the agenda in their strategic plans, students' adoption rate remain very low (Mawere and Sai 2018). The researcher concluded that even though the millennial generation is identified as digital natives, it is quite clear that their involvement in technical advances is still weak. These results were attributed to various evidences, including counterproductive marketing tactics, students' lack of funding, and excessive data charges by Internet Service Providers (ISPs).

Another research presented evidence of students' satisfaction with electronic library resources in a university (Holley and Powell 2004). Extensive findings from the study indicated that almost 40 per cent of the students who replied said they were unaware of electronic services. Students who are aware of electronic resources have heard more about them from their teachers (38.3 per cent) than from the attempts of the library to publicise them (18.5 per cent). Students were mostly pleased (68%) even when something went wrong. A strong percentage of all students (92.4%) replied that the library should continue to expand its electronic services. The present study aims to also take off from the results of Holley and Powell by extending into assessing the rate at

which students use specific e-library infrastructures and how such usage impacts their learning effectiveness in higher education.

Self-efficacy plays a part in the student quest for information and the utilisation of the library's electronic services. This was the key subject of a survey which found that the use of a library was associated with the help of the library's electronic services by the students (Waldman 2003). It was also documented that students who demonstrated curiosity in learning about the electronic resources of the library were more likely to be more automatic. The study of Waldman appears to be the first of all cited studies to focus on specific electronic library resources and provided the extent of utility by students. Waldman's study revealed specifically that Lexis/Nexis, DPAC, Academic Search Premier, Ebsco Host, DPER, Dow Jones Interactive, Book Review Index, Business Source Premier, Literature Resource Center, PsycInfo, America: History and Life, C.Q. Researcher, Ethnic Newswatch, Sociological Abstracts and JSTOR were used by 44%, 36%, 29%, 26%, 9%, 8%, 6%, 4%, 4%, 3%, 2%, 2%, 2%, 2% and 0.3% of the students accordingly. The present study is similar to the research of Waldman but intends to focus on a different set of electronic library infrastructure from the ones studied earlier.

Based on students' knowledge and use of electronic library resources, a study indicated that 73% used computers daily and 82% felt that their level of computer literacy was average or above (Renwick 2005). The cited study also revealed the perception of many respondents that electronic resources were important and that they were skilled users. Despite the broad results of the study, it failed to identify the specific resources that students did not use. The present study has been designed to outline some particular electronic library resources and how students utilise them. The extent of the utility shall be further associated with the levels of their learning effectiveness to get an idea of the state of things from a developing country's perspective.

Theoretical Framework

This study is rooted in Lev Vygotsky's Socio-Cultural Theory of learning effectiveness published in 1978. Vygotsky submitted that learning is a collaborative process that occurs within a socio-cultural environment through mediated tools. The socio-cultural environment, according to Vygotsky, gives the students a range of roles, demands and incorporates the students into his world by mediation instruments. Mental engagement is the premise of a media process in which abstract and socio-cultural objects (technology) play an important role in the individual's mental lives (Kozulin 2002). "Learning as a mediated process is social in origin and then becomes individual as a result of mediated interaction between the child and teachers, making human relations to be mediated by physical and symbolic tools" (Wertsch 1991, 25). The employment of mediational tools fundamentally shapes the activities in the learning environment. The result of an integrated (mediated) technical process between teachers and students is efficient teaching and learning (Altinay-Gazi and Altinay-Aksal 2017).

The implication of the socio-cultural theory of learning efficacy by Vygotsky to the study is that it highlights the fact that learning effectiveness is maximised when the learning environment promotes collaboration, interaction and integration among learners and between learners and their instructors through mediated tools such as the electronic resources. This means that the availability of electronic infrastructures to enhance students' access to other learners within and outside their institutions is critical. Furthermore, access to information resources and lecturers at any time for the group, collaborative, interactive and integrative learning is basic for effective education in universities. This implies that the more electronic learning resources are effectively utilised in institutions, the more learning effectiveness is attained among students and vice-versa.

Research questions

1. What is the extent of e-learning infrastructures usage for teaching and learning purposes in universities?
2. To what extent are e-communication infrastructures used for teaching and learning purposes in universities?
3. How much are e-library infrastructures utilized for teaching and learning purposes in universities?
4. To what extent is learning effective among students in universities?
5. To what extent does the use of e-infrastructures (such as e-learning, e-communication and e-library) affect students' learning effectiveness in universities.

Materials and methods

This study adopted a descriptive survey research design. The design was deemed most appropriate for the study because the phenomena observed were current and ongoing practices in the institutions. The researchers studied them as they existed in the institutions at the time of the investigation. The population of the study comprised 14,897 students, including undergraduates (N = 9,683; 65%) and postgraduates (N = 5,214; 35%), from the University of Calabar (UNICAL) and the University of Cross River State (UNICROSS). A total of 9,820 were from UNICAL and 5,077 from UNICROSS. The researchers used stratified proportionate random sampling to select 9.75% of the population from each institution, making a total sample of 1,452 students. The population and sample distributions of this study are presented in Table 1 for clarity.

Table 1: Crosstab of the population and sample of the study

Institution	Population (N)			Sample (n)		
	Undergrads.	Post-grads.	Total	Undergrads.	Post-grads.	Total
UNICAL	6383	3437	9,820	622	335	957
UNICROSS	3300	1777	5,077	322	173	495
Total	9,683	5,214	14,897	944	508	1452

(Source: Authors' computation)

Usage of Electronic Infrastructure Scale (UEIS) and Learning Effectiveness Questionnaire (LEQ) were used for data collection. The UEIS was designed with 47 items organised into a six-point Likert-type scale. Response options ranged from Very High Extent (6 points) to Very Poor Extent (1 point) for positively worded items. The LEQ was designed with 10 items placed on a modified four-point Likert scale, with response options ranging from Strongly Agree (4 points) to Strongly Disagree (1 point) for positively worded items. However, all the items in both the UEIS and LEQ were reverse-coded for negatively worded items. The face and content validities of the instruments were established by psychometric and Educational Technology experts, all in the University of Calabar. The internal consistency of the questionnaire was determined using the Cronbach reliability method of internal consistency and was found reliable at a .83 alpha value.

In collecting data, letters of participation were given to all the participating students with detailed explanations of the purpose of the research as well as the advantages and dangers of participating in the study. A total of 1,490 students voluntarily accepted to participate in the

study; hence, copies of the UEIS and LEQ were administered. The aim was to measure how they have utilised electronic learning infrastructures and their learning effectiveness in their institutions. The researchers pleaded with the subjects to respond objectively to the items and gave two weeks duration for respondents to do so without interference. Out of the 1,490 copies of the instruments administered, 1,452 were retrieved successfully, while the remaining 38 could not be recovered due to attrition. The return rate on the distributed copies of the tools represents 97.45%, while 2.55% was due to attrition.

Mean, and Standard deviation were used to answer the research questions. In the decision-making process on the scale of the use of electronic learning infrastructures, scores below the mean value threshold of 3.5 were taken to mean low scores, scores equal to 3.5 were considered average, and those above were deemed to be high scores. Similarly, for learning effectiveness, scores below the criterion mean of 2.50 were understood to imply low extents, values equal to 2.50 were taken as average scores, and those above it were regarded as high extents. These formed the decision rule for all the research questions. The hypothesis of this study was tested at the .05 level of significance using the Polytomous Logistic Regression Model.

Result Research question 1

What is the extent of e-learning infrastructures usage for teaching and learning purposes in universities? Table 2 shows that all the items have mean scores below the criterion mean of 3.50. Given that the observed overall mean is 2.4, there low degree in the use of e-learning infrastructures for teaching and learning purposes in universities. This means that e-learning infrastructures are not adequately used for teaching and learning purposes in universities.

Table 2: Mean and standard deviation of the responses on the extent to which e-learning infrastructures are used for teaching and learning purposes in universities

S/N	E-learning infrastructures	\bar{x}	SD	Remark
1	Virtual laboratories	3.40	1.32	Low
2	Webinars	2.90	1.22	Low
3	Zoom	2.75	1.38	Low
4	Google Meet	2.85	1.11	Low
5	MOOC	2.30	1.01	Low
6	Socrative	2.55	1.29	Low
7	EduClipper	2.15	.91	Low
8	Edmodo	2.15	.91	Low
9	Kahoot	2.30	.84	Low
10	Google Classroom	2.95	1.11	Low
11	Seesaw	2.20	1.03	Low
12	ClassDojo	2.40	.97	Low
13	Podcasting	2.30	1.01	Low
14	Prezi	2.75	1.18	Low
Average		2.41	1.03	Low

(Source: Authors' computation)

Research question 2

To what extent are e-communication infrastructures used for teaching and learning purposes in universities? The results in Table 3 shows that apart from items 16 and 24, other items have mean scores below the criterion mean of 3.50. Given that the grand mean is 2.98, there is a low degree in the usage of e-communication infrastructures for teaching and learning purposes in universities. This means that e-communication infrastructures are not adequately used for teaching and learning in the universities except for phones and WhatsApp.

Table 3: Mean and standard deviation of the responses on the extent to which e-communication infrastructures are used for teaching and learning purposes in universities

S/N	E-communication infrastructures	\bar{x}	SD	Remark
15	E-mails	3.35	1.10	Low
16	Phones	3.50	1.25	High
17	Skype	2.95	1.06	Low
18	YouTube	3.05	1.29	Low
19	Text messaging	2.90	1.09	Low
20	Instant messaging	2.75	1.22	Low
21	Instagram	2.45	.67	Low
22	Facebook	2.65	1.19	Low
23	Snapchat	2.65	1.35	Low
24	WhatsApp	3.60	1.16	High
25	Twitter	2.75	1.05	Low
26	Flash share	3.00	1.30	Low
27	Video calls	2.80	1.47	Low
28	Telegram	3.20	1.45	Low
29	Blogs	2.90	1.30	Low
30	Flickr	3.10	1.30	Low
31	Pinterest	3.00	1.26	Low
32	Wikis	3.30	1.35	Low
33	Google+	2.85	1.15	Low
34	Myspace	2.75	1.26	Low
Average		2.98	1.15	Low

(Source: Authors' computation)

Research question 3

How much are e-library infrastructures utilized for teaching and learning purposes in universities? The evidence in Table 4 shows except for items 44, 45 and 46 which have mean scores above the criterion mean, all others have mean values below the criterion mean of 3.50. Given that the grand mean is 2.94, there is a low degree of acceptance among the students in their use of e-library infrastructures for teaching and learning purposes in universities. This means that e-library infrastructures are not adequately used for teaching and learning purposes in the universities except e-references, databases and e-portals.

Table 4: Mean and standard deviation of the responses on the extent to which e-library infrastructures are used for teaching and learning purposes in universities

<u>S/N</u>	<u>E-library infrastructures</u>	<u>\bar{x}</u>	<u>SD</u>	<u>Decision</u>
35	Ebooks	2.70	1.35	Low
36	E-journal	2.85	1.35	Low
37	E-thesis	3.05	1.02	Low
38	E-newspapers	2.35	1.28	Low
49	Websites	2.20	1.03	Low
40	E-conference proceedings	2.75	1.38	Low
41	E-reports	2.85	1.02	Low
42	E-maps	2.65	1.15	Low
43	E-magazines	2.75	1.18	Low
44	E-reference	3.60	1.32	High
45	Database	3.60	1.07	High
46	E-portals	3.90	1.37	High
	Average	2.94	1.24	Low

(Source: Authors' computation)

Research question 4

To what extent is learning effective among students in universities? Table 5 indicates that all the items have mean scores below the criterion mean of 2.50. Given that the average mean is 1.94, students learning effectiveness in universities is low. This means that there is a low level of learning among students in universities.

Table 5: Mean and standard deviation of the responses on the extent of learning effectiveness among students in universities

<u>S/N</u>	<u>Items</u>	<u>X</u>	<u>SD</u>	<u>Remark</u>
1	I have access to learning materials with less difficulty.	2.15	.573	Low
2	There is a high level of collaborative learning among students in my institution.	2.10	.769	Low students in my institution.
3	Students have easy access to their colleagues at any time for instructional purposes.	1.95	.591	Low for instructional purposes.
4	Students' learning process is not always interrupted by a lack of lecture venues.	2.10	.539	Low lack of lecture venues.
5	There is no platform for students to access their lecturers outside the classroom.	2.60	.663	Low outside the classroom.
6	Many students in my institution have been carrying out group research work with students in other institutions.	2.05	.670	Low group research work with students in other institutions.
7	In my institution, students have unlimited access to information resources.	2.05	.494	Low information resources.
8	Sometimes, students receive lectures online in my institution.	2.45	.669	Low
9	In my institution, students submit their assignments online.	2.45	.777	Low

10 There are institutional platforms for students to publish 1.75 .765 Low their research work in my institution.

Average	1.92	.651	Low
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(Source: Authors' computation)

Research question five

To what extent does the use of e-infrastructures (such as e-learning, e-communication and e-library) affect students' learning effectiveness in universities. The results of the analysis showed that 799 respondents (55%) demonstrated a high level of learning effectiveness; 290 students (20%) had average learning effectiveness; while 363 students representing 25% maintained a low level of learning effectiveness. A polytomous logistic regression analysis was performed to examine the relative effects of three continuous predictor variables (usage of elearning, e-communication and e-library infrastructure) on the three levels of an ordinal response variable – students' learning effectiveness (categorised into high, average and low). The result further revealed that the criterion model, which contained only the intercept, was significantly improved when the three independent variables were added to it $\chi^2 (6, N = 1452) = 147.730$, Nagelkerke $R^2 = .112$, $p < .05$. As shown in Table 6, the three predictor variables significantly made unique contributions to the response variable generally. This implies that there are significant partial effects of the usage of e-infrastructures (such as e-learning, ecommunication and e-library) on the levels of students' learning effectiveness (high, average and low) in universities. The deviance and Pearson goodness of fit indices were all significant at the .05 alpha level.

Table 6: Partial contributions of the three predictors on the dependent variable holistically

Predictors	χ^2	Df	p
e-learning infrastructure	37.492	2	.000
E-communication infrastructure	91.249	2	.000
E-library infrastructure	6.211	2	.045

Chi-square statistics are the gap in -2-log similitudes between the final and a reduced model. The reduced model consists of the final model's inability to achieve a response. Both parameters of the effect are 0, which is a null presumption.

(Source: Authors' computation)

To assess the partial effects of the independent variables on the different levels of students' learning effectiveness, the average level of students' learning effectiveness was set as the reference category. Consequently, each predictor variable has two parameters in predicting students' high and low learning effectiveness. The results presented in Table 7 revealed that the usage of e-infrastructures such as e-learning, e-communication and e-library tools significantly predicted students' high level of learning effectiveness in universities. In the 'low' category of students' learning effectiveness, the results indicated that students' usage of e-learning and ecommunication infrastructures were significant predictors. However, students' usage of elibrary infrastructure did not significantly predict their learning effectiveness in the 'low' category.

Table 7: Partial parameters of the three predictors on students' learning effectiveness in the high and low category, with the average category as the reference group

Levels SL effectiveness ^a		β	SE	Wald	p	Exp (B)
High	E-learning	.064	.011	33.967	.000	1.066
	E-communication	.133	.015	74.804	.000	1.142
		.019	.008	5.472	.019	1.019
Low	E-library	.065	.013	26.838	.000	1.067
	E-learning					
	E-communication	.133	.017	60.511	.000	1.142
	E-library	.008	.009	.859	.354	1.008

a. The reference category is: Average; SL = Students' Learning
(Source: Authors' computation)

Discussion

This study revealed that the use of electronic infrastructures for teaching and learning in universities was considerably low. It was also discovered that the degree of learning effectiveness among students in the institutions was also low. The result highlights that the low extent of learning effectiveness among students in the institutions may be occasioned by the low utilisation of electronic learning infrastructures. This is in line with the opinion of different researchers who stressed that learning in this 21st century higher institution is a collaborative, group and integrative process driven by electronic learning resources (Shava, Chinyamurindi, and Somdyala 2016; Ali 2018; 2020). This result is also in tandem with the tenets of Vygotsky's socio-cultural theory of learning effectiveness, which explains that learning is a collaborative process that occurs within a socio-cultural environment through mediated tools. Vygotsky holds that the employment of mediational tools fundamentally shapes the activities in the learning environment. This implies that learning effectiveness was not maximised among the students in the institutions because e-learning, e-communication and e-library infrastructures were not adequately utilised for teaching and learning purposes in the universities.

This study agrees with the findings of various empirical studies, which established that effective use of electronic learning infrastructures in institutions enhanced teaching and learning, thus promoting learning effectiveness among the students (Perera and Richardson 2010; Apuke and Iyendo 2018). Though this study did not directly address educational delivery during an educational crisis, the result has significant implications for the reorganisation of university learning experiences given the emerging need to reform learning practices as due to the pandemic – COVID-19. Therefore, administrators of universities should redesign learning contents and experiences using electronic tools to match the emerging global-based education delivery practices and boost the learning effectiveness of higher education students.

This study also discovered that the usage of e-learning, e-communication and e-library infrastructures significantly predict students' learning effectiveness in universities, respectively. Students low and high rates of learning effectiveness were greatly dependent on the usage of electronic infrastructures in universities, other things being equal. This implies that students are likely to be learning efficient to a high or low extent based on the degree to which e-infrastructures are utilised. Consequently, a high rate of students' learning effectiveness is

attributed to a high rate of electronic infrastructures utilisation and vice versa. This finding strengthens the results of previous researches, which documented that various e-library services increase the students' learning level in higher education (Luna-Nevarez and McGovern 2018; Mawere and Sai 2018).

Although previous studies did not explain the category of students that benefited from e-library resources, the present study has shown that students with both high and low degrees of learning effectiveness significantly benefited from e-learning and e-communication infrastructures, respectively. However, the use of e-library infrastructure partially improved students' learning effectiveness in the high but not the low category. An explanation for this result may be due to the cognitive demands required to efficiently deploy e-library resources, which may be problematic for students in the low category. In the high category, students can comfortably search and make use of relevant materials from the electronic library and databases, boosting their knowledge and understanding.

The limited number of universities surveyed seems to be a major limitation of this work. The scope of related studies may be expanded in the future to cover many universities in Africa and beyond to enable us to have adequate knowledge of the extent to which the usage of electronic infrastructures across universities globally. The study's design did not allow for the categorisation of the independent variables into different nominal classes. Consequently, it is difficult to say whether higher rates of e-infrastructure usage are associated with low or high rates of students' learning effectiveness. In the present study, all the independent variables were treated continuously. Nevertheless, this study has provided the basis for future studies in related areas.

Conclusion

This study was conducted to examine the effect of the utilisation of e-infrastructure, such as e-learning, e-communication and e-library resources, on the learning effectiveness of universities. Based on the result of this study, it was concluded that the extent of usage of electronic learning infrastructures (e-learning, e-communication and e-library infrastructures) for teaching and learning in universities is low. The extent of students' learning effectiveness generally in universities is low. Students with a high rate of learning effectiveness would significantly benefit from the usage of e-infrastructure for teaching and learning in universities. Students with low rates of learning effectiveness in universities would dramatically benefit from the usage of e-learning and e-communication but not e-library infrastructures for teaching and learning. Based on this conclusion, it was recommended that electronic learning gadgets be fully adopted and applied for university teaching and learning to enhance students' learning effectiveness.

References

- Adwan, Jihad. 2016. "Dynamic Online Peer Evaluations to Improve Group Assignments in A Nursing E-Learning Environment." *Nurse Education Today* 41: 67–72. <https://doi.org/10.1016/j.nedt.2016.03.028>.
- Akbaba, Yasemin, and Filiz Başkan. 2017. "How to merge courses via Skype™? Lessons from an International Blended Learning Project‡." *Research in Learning Technology* 25: 42-53. <https://doi.org/10.25304/rlt.v25.1915>.

- Akussah, Maxwell, Edward Asante, and Rosemary Adu-Sarkodee. 2015. "Impact of Electronic Resources and Usage in Academic Libraries in Ghana: Evidence from Koforidua Polytechnic & All Nations University College, Ghana." *Journal of Education and Practice* 6 (33): 33-38. <https://files.eric.ed.gov/fulltext/EJ1083497.pdf>.
- Ali, Wahab. 2018. "Transforming Higher Education Landscape with Hybrid/Blended Approach as an Evolving Paradigm." *Journal of Advances in Social Science and Humanities* 3 (7): 43-169. <https://doi.org/10.15520/jassh47334>.
- Ali, Wahab. 2020. "Online and Remote Learning in Higher Education Institutes: A Necessity in Light of COVID-19 Pandemic." *Higher Education Studies* 10 (3): 16-25. <https://doi.org/10.5539/hes.v10n3p16>.
- Al-Nuaim, Hannah Abdullah. 2012. "The Use of Virtual Classrooms in E-Learning: A Case Study in King Abdulaziz University, Saudi Arabia." *E-Learning and Digital Media* 9 (2): 211–222. <https://doi.org/10.2304/elea.2012.9.2.211>.
- Al-Rahmi, Waleed, Ahmed Aldraiweesh, Noraffandy Yahaya, Yusri Bin Kamin, and Akram Zeki. 2019. "Massive Open Online Courses (MOOCs): Data on Higher Education." *Data in Brief* 22: 118–125. <https://doi.org/10.1016/j.dib.2018.11.139>.
- Altinay-Gazi, Zerah, and Fahriye Altinay-Aksal. 2017. "Technology as a Mediation Tool For Improving Teaching Profession in Higher Education Practices." *Eurasia Journal of Mathematics, Science and Technology Education* 13 (3): 803–813. <https://doi.org/10.12973/eurasia.2017.00644a>.
- Ankrah, Ebenezer, and Diana Atuase. 2018. "The Use of Electronic Resources Postgraduate Students of the University of Cape Coast." *Library Philosophy and Practice (e-journal)* 2018: Article 1632. <https://digitalcommons.unl.edu/libphilprac/1632/>.
- Apuke, Oberiri Destiny, and Timothy Onosahwo Iyendo. 2018. "University Students' Usage of the Internet Resources for Research and Learning: Forms of Access and Perceptions of Utility." *Heliyon* 4: 1052-1086. <https://doi.org/10.1016/j.heliyon.2018.e01052>.
- Arop, Festus Obun, Martin Akan Ekpang, Blessing Iheoma Nwannunu, and Valentine Joseph Owan. 2018. "Personnel Management and Corrupt Academic Practices in Universities in Cross River State, Nigeria." *International Journal of Economics, Commerce and Management* 6 (9): 405–19. <https://doi.org/10.2139/ssrn.3250019>.
- Bassey, Bassey Asuquo, Valentine Joseph Owan, and Judith Nonye Agunwa. 2019. "Quality Assurance Practices and Students' Performance Evaluation in Universities of South-South Nigeria: A Structural Equation Modelling Approach." *British Journal of Psychology Research* 7 (3): 1–13. <https://bit.ly/2YsFHhj>.
- Bassey, Bassey Asuquo, Valentine Joseph, and Eze Aji Eze. 2019. "Nexus Between Students', Teachers' and School System Effectiveness: Construction and Factorial Validity of a Measuring Instrument." *British Journal of Education* 7 (7): 62–75. <https://tinyurl.com/y3hr7jd3>.
- Bawa, Surinderjit Kaur, Rekha Kaushal, and Jaswinder Kaur Dhillon. 2020. "Unification of Multimedia with Techniques of Art and Vedic Aphorisms for Development of Mathematical Skills: A Study of Indian and U.K. School Students." *Journal on Efficiency*

and Responsibility in Education and Science 13 (3): 130-139.
<http://doi.org/10.7160/eriesj.2020.130303>.

Bukoye, Roseline Olufunke. 2019. "Utilisation of Instruction Materials as Tools for Effective Academic Performance of Students: Implications for Counselling." *Proceedings* 2: 13951402. <https://doi.org/10.3390/proceedings2211395>.

Camassola, Marli, and Daniel Luis Notari. 2017. "Online Newspapers as an Effective Tool to Generate interest in Reading for Students of Youth and Adult Education', *Scientia cum Industria (Knowledge with Industries)* 5 (2): 51–55.
<https://doi.org/10.18226/23185279.v5iss2p51>.

Cerqueiro, Fátima Faya, and Ana Martín-Macho Harrison. 2019. "Socratic in Higher Education: Game vs. Other Uses." *Multimodal Technologies and Interaction* 3 (3): 24-35.
<https://doi.org/10.3390/mti3030049>.

Collier-Reed, Brandon, Jennifer Case, and Angela Stott. 2013. "The Influence of Podcasting on Student Learning: A Case Study Across Two Courses." *European Journal of Engineering Education* 38 (3): 329–339. <https://doi.org/10.1080/03043797.2013.786026>.

Darling-Hammond, Linda, Lisa Flook, Channa Cook-Harvey, Brigid Barron, David Osher. 2020. "Implications for Educational Practice of the Science of Learning and Development." *Applied Developmental Science* 24 (2): 97-140.
<https://doi.org/10.1080/10888691.2018.1537791>.

Dunlosky, John, Katherine Rawson, Elizabeth Marsh, Mitchell Nathan, and Daniel Willingham. 2013. "Improving Students' Learning with Effective Learning Techniques: Promising Directions from Cognitive and Educational Psychology." *Psychological Science in the Public Interest* 14 (1): 4-58. <https://doi.org/10.1177/1529100612453266>.

Erich, Agnes. 2013. "The Role of The University Library for an Efficient Use of the Electronic Resources." *Library and Information Science Research* 17: 75-83.
<https://core.ac.uk/download/pdf/25570102.pdf>.

Erkollar, Alptekin, and Birgit Oberer. 2013. "Putting Google+ to the Test: Assessing Outcomes for Student Collaboration, Engagement and Success in Higher Education." *Procedia - Social and Behavioral Sciences* 83: 185–189.
<https://doi.org/10.1016/j.sbspro.2013.06.036>.

Eze, Sunday Chinedu., Vera Chinwendu Chinedu-Eze, and Adenike Oluyemi Bello. 2018. "The Utilisation of E-Learning Facilities in the Educational Delivery System of Nigeria: A Study of M-University." *International Journal of Educational Technology in Higher Education* 15 (34): 1-20. <https://doi.org/10.1186/s41239-018-0116-z>.

Fleischmann, Katja. 2014. "Collaboration through Flickr & Skype: Can Web 2.0 Technology Substitute the Traditional Design Studio in Higher Design Education?" *Contemporary Educational Technology* 5 (1): 39–52. <https://doi.org/10.30935/cedtech/6114>.

Fojtik, Rostilav. 2015. "Ebooks and Mobile Devices in Education." *Procedia - Social and Behavioral Sciences* 182: 742–745. <https://doi.org/10.1016/j.sbspro.2015.04.824>.

Gökbulut, Bayram. 2020. "The Effect of Mentimeter and Kahoot Applications on University Students' E-Learning." *World Journal on Educational Technology: Current Issues* 12(2): 107–116. <https://doi.org/10.18844/wjet.v12i2.4814>.

- Górska, Dorota. 2016. "E-learning in Higher Education." *The Person and the Challenges* 6 (2): 35–43. <https://doi.org/10.15633/pch.1868>.
- Gregory, Sue, and Michelle Bannister-Tyrrell. 2017. "Digital Learner Presence and Online Teaching Tools: Higher Cognitive Requirements of Online Learners for Effective Learning." *Research and Practice in Technology Enhanced Learning* 12 (1): 18. <https://doi.org/10.1186/s41039-017-0059-3>.
- Holley, Robert, and Ronald Powell. 2004. "Student Satisfaction with Electronic Library Resources at Wayne State University." *Journal of Access Services* 2 (1): 41–62. https://doi.org/10.1300/J204v02n01_06.
- Imran, Sheikh Mohammad, and Basharat Ahmad Malik. 2017. "Evaluation of e-Learning WebPortals." *DESIDOC Journal of Library and Information Technology* 37 (3): 205–212. <https://doi.org/10.14429/djlit.37.3.10961>.
- Jimaa, Shihab. 2011. "The Impact of Assessment on Students Learning." *Procedia - Social and Behavioral Sciences* 28: 718–721. <https://doi.org/10.1016/j.sbspro.2011.11.133>.
- Jindrová, Andrea, Hana Vostrá Vydrová, and Ludmila Dömeová. 2013. "The Students' Evaluation of the E-Support in the Full-Time Form of Study." *Journal on Efficiency and Responsibility in Education and Science* 6 (2): 119-133. <https://doi.org/10.7160/eriesj.2013.060205>.
- Johnson, Richard, Johnson Steven Hornik, and Eduardo Salas. 2008. "An Empirical Examination of Factors Contributing to the Creation of Successful E-Learning Environments." *International Journal of Human-Computer Studies* 66: 356-369. <https://doi.org/10.1016/j.ijhcs.2007.11.003>.
- Juříčková, Radka. 2013. "Recognizing Personal Learning Styles and Using Learning Strategies while Learning English in an Electronic Environment". *Journal on Efficiency and Responsibility in Education and Science* 6 (2): 71-83. <https://doi.org/10.7160/eriesj.2013.060202>.
- Kereluik, Kristen, Punya Mishra, Chris Fahnoe, and Laura Terry. 2013. "What Knowledge is of Most Worth: Teacher Knowledge for 21st-Century Learning." *Journal of Digital Learning in Teacher Education* 29 (4): 127-140. <https://files.eric.ed.gov/fulltext/EsJ1010753.pdf>.
- Kobayashi, Michiko. 2015. "Students' Evaluation of Google Hangouts through a CrossCultural Group Discussion Activity." *Turkish Online Journal of Distance Education* 16 (2): 28-39. <https://eric.ed.gov/?id=EJ1092852>.
- Kozulin, Alex. 2002. "Sociocultural Theory and the Mediated Learning Experience." *School Psychology International* 23 (1): 7-35. <https://doi.org/10.1177/0143034302023001729>.
- Krejčová, Kristýna, Hana Chýlová, and Pavel Michálek. 2019. "A Role of Siblings in Perception of Academic Self-Efficacy and Social Support." *Journal on Efficiency and Responsibility in Education and Science* 12 (4): 126-34. <https://doi.org/10.7160/eriesj.2019.120403>.
- Kučírková, Lenka, Petr Kučera, and Hana Vostrá Vydrová. 2012. "A Comparison of Study Results of Business English Students in E-Learning and Face-To-Face Courses." *Journal*

- on Efficiency and Responsibility in Education and Science* 5 (3): 173-84. <https://doi.org/10.7160/eriesj.2012.050306>.
- Kuncová, Martina, and Hana Vojáčková. 2015. "Analysis of the Dependence of the E-Learning Usage on the Study Results." *Journal on Efficiency and Responsibility in Education and Science* 8 (1): 24-34. <https://doi.org/10.7160/eriesj.2015.080104>.
- Kunstová, Renata. 2012. "Analysis of Study Results and the Use Of E-Learning Materials Within Distance Education". *Journal on Efficiency and Responsibility in Education and Science* 5 (4): 185-94. <https://doi.org/10.7160/eriesj.2012.050401>.
- Kuznekoff, Jeffrey, Stevie Munz, and Scott Titsworth. 2015. "Mobile Phones in the Classroom: Examining the Effects of Texting, Twitter, and Message Content on Student Learning." *Communication Education* 64 (3): 344-365. <https://doi.org/10.1080/03634523.2015.1038727>.
- Ladd, Gary, and Lisa Dinella. 2009. "Continuity and Change in Early School Engagement: Predictive of Children's Achievement Trajectories from First to Eighth Grade?" *Journal of Educational Psychology* 101 (1): 190–206. <https://doi.org/10.1037/a0013153>.
- Li, Yibing, and Richard Lerner. 2011. "Trajectories of School Engagement during Adolescence: Implications for Grades, Depression, Delinquency, and Substance Use." *Developmental Psychology* 47 (1): 233-247. <https://doi.org/10.1037/a0021307>.
- Long, Choi, Zaiton Ibrahim, and Tan Kowang. 2014. "An Analysis of the Relationship between Lecturers' Competencies and Students' Satisfaction." *International Education Studies* 7 (1): 37-46. <https://doi.org/10.5539/ies.v7n1p37>.
- Luna-Nevarez, Cuauhtemoc, and Enda McGovern. 2018. "On the Use of Mobile Apps in Education: The Impact of Digital Magazines on Student Learning." *Journal of Educational Technology Systems* 47 (1): 17-31. <https://doi.org/10.1177/0047239518778514>.
- Ma'azi, Halaleh, and Kamran Janfeshan. 2018. "The Effect of Edmodo Social Learning Network on Iranian Efl Learners Writing Skill." *Cogent Education* 5 (1): Article 1536312. <https://doi.org/10.1080/2331186X.2018.1536312>.
- Mawere, Talent, and Kundai Sai. 2018. "An Investigation on E-Resource Utilisation among University Students in a Developing Country: A Case of Great Zimbabwe University." *S.A. Journal of Information Management* 20 (1): 1-7. <https://doi.org/10.4102/sajim.v20i1.860>.
- Nwosu, Jonathan, and Henry Chukwudi John. 2018. "Entrepreneurship Education and the Challenges of Graduate Employability in Nigeria." *International Journal of Innovation, Management and Technology* 9 (5): 189-193. <https://doi.org/10.18178/ijimt.2018.9.5.812>.
- Odigwe, Francisca Nonyelum, Odim Otu Offem, and Valentine Joseph Owan. 2018. "Vocational Training Duration and University Graduates' Job Performance in Cross River State, Nigeria." *International Journal of Current Research* 10 (7): 72024–72028. <https://doi.org/10.5281/zenodo.4320545>.
- Okan, Zuhail, and Hayriye Ulaş Taraf. 2013. "The Use of Blogs in Second Language Teacher Education." *Procedia - Social and Behavioral Sciences* 83: 282–289. <https://doi.org/10.1016/j.sbspro.2013.06.055>.

- Owan, Valentine Joseph, and Igwe Augustine Robert. 2019. "Analysis of the Utilization of Social Media Platforms and University Students' Attitudes towards Academic Activities in Cross River State, Nigeria." *Prestige Journal of Education* 2 (1): 1–15. <https://doi.org/10.5281/zenodo.4458693>.
- Owan, Valentine Joseph, and Samuel Okpon Ekaette. 2019. "Students' Personnel Management and Academic Effectiveness of Secondary School Students in Calabar Education Zone of Cross River State, Nigeria." *International Journal of Psychological and Brain Sciences* 4 (2): 13–19. <https://doi.org/10.11648/j.ijpbs.20190402.12>.
- Owan, Valentine Joseph, Bassey Asuquo Bassey, and Mercy Bassey Ekpe. 2020. "Assessment of Students' Attitude towards Test-Taking in Secondary Schools in Afikpo Education Zone Ebonyi State, Nigeria." *American Journal of Creative Education* 3 (1): 1–9. <https://doi.org/10.20448/815.31.1.9>.
- Owan, Valentine Joseph, Bassey Asuquo Bassey, Garieth Omorobi Omorobi, and Uwase Uwase Esuong. 2020. "Poll Everywhere E-Learning Platform, Test Anxiety, and Undergraduates' Academic Performance in Mathematics: Empirical Evidence from Nigeria." *American Journal of Social Sciences and Humanities* 5 (1): 141–50. <https://doi.org/10.20448/801.51.141.150>.
- Owan, Valentine Joseph, Daniel Clement Agurokpon, and Abahcham Valentine Owan. 2022. "Evaluation of the Availability and Utilization Status of Texts in Core Subjects in Primary Schools' Libraries." *Library Philosophy and Practice (e-Journal)* 2022: Article 6150. <https://digitalcommons.unl.edu/libphilprac/6150>.
- Owan, Valentine Joseph, Rosemary O. Osim, Emanghe E. Emanghe, Eyiene Ameh, and John Asuquo Ekpenyong. 2021. "Principals' Management of Library Resources and Teachers' Lesson Preparation Practices in Secondary Schools: A Predictive Evaluation." *Library Philosophy and Practice (e-Journal)* 2021: Article 6180. <https://digitalcommons.unl.edu/libphilprac/6180>.
- Perera, Luckmika, and Peter Richardson. 2010. "Students' Use of Online Academic Resources within a Course Web Site and its Relationship with their Course Performance: An Exploratory Study." *Accounting Education* 19 (6): 587-600. <https://doi.org/10.1080/09639284.2010.529639>.
- Plump, Carolyn, and Julia LaRosa. 2017. "Using Kahoot! in the Classroom to Create Engagement and Active Learning: A Game-Based Technology Solution for Elearning Novices." *Management Teaching Review* 2 (2): 151-158. <https://doi.org/10.1177/2379298116689783>
- Potkonjak, Veljko, Michael Gardner, Victor Callaghan, Pasi Mattila, Christian Guetl, Vladimir M. Petrović, and Kosta Jovanović. 2016. "Virtual Laboratories for Education in Science, Technology, and Engineering: A Review." *Computers and Education* 95: 309–27. <https://doi.org/10.1016/j.compedu.2016.02.002>.
- Ratnaningsih, Paskalina Widiastuti. 2019. "The Use of Google Classroom Application for Writing and Speaking in English Education Class". *Indonesian EFL Journal: Journal of ELT, Linguistics, and Literature* 5 (1): 93-110. <https://bit.ly/343hCpC>.

- Renwick, Shamin. 2005. "Knowledge and Use of Electronic Information Resources by Medical Sciences Faculty at the University of the West Indies." *Journal of the Medical Library Association : JMLA* 93 (1): 21–31. <https://pubmed.ncbi.nlm.nih.gov/15685270>.
- Robert, Igwe Augustine, and Valentine Joseph Owan. 2019. "Students' Perception of Teachers Effectiveness and Learning Outcomes in Mathematics and Economics in Secondary Schools of Cross River State, Nigeria." *International Journal of Contemporary Social Science Education (IJCSSE)* 2 (1): 157–65. <https://bit.ly/2VbLzfK>.
- Savasci, Havva, and Ekber Tomul. 2013. "The relationship between educational resources of the school and academic achievement." *International Education Studies* 6 (4): 114-122. <https://doi.org/10.5539/ies.v6n4p114>.
- Sepehrdoust, Hamid, Razieh Davarikish, and Maryam Setarehie. 2019. "The Knowledge-Based Products and Economic Complexity in Developing Countries." *Heliyon* 5: 29792990. <https://doi.org/10.1016/j.heliyon.2019.e02979>.
- Shava, Herring, Willie Chinyamurindi, and Anathi Somdyala. 2016. An Investigation into the Usage of Mobile Phones among Technical and Vocational Education and Training Students in South Africa." *South African Journal of Information Management* 18 (1): 18. <https://doi.org/10.4102/sajim.v18i1.716>.
- Shopova, Tatiana. 2014. "Digital Literacy of Students and its Improvement at the University." *Journal on Efficiency and Responsibility in Education and Science* 7 (2): 26-32. <https://doi.org/10.7160/eriesj.2014.070201>.
- Songkram, Noawanit. 2015. "E-learning System in Virtual Learning Environment to Develop Creative Thinking for Learners in Higher Education." *Procedia - Social and Behavioral Sciences* 174: 674–679. <https://doi.org/10.1016/j.sbspro.2015.01.600>.
- Subhi, M A, N Nurjanah, U Kosasih, and S A Rahman. 2020. "Design of Distance Lectures in Mathematics Education with the Utilization of the Integration of Zoom and YouTube Application." *Journal of Physics: Conference Series* 1663: 12058. <https://doi.org/10.1088/1742-6596/1663/1/012058>.
- Swan, Karen. 2002. "Building Learning Communities in Online Courses: The Importance of Interaction." *Education Communication & Information* 2 (1): 23-49. <https://doi.org/10.1080/1463631022000005016>.
- Talebian, Sogol, Hamid Movahed Mohammadi, and Ahmad Rezvanfar. 2014. "Information and Communication Technology (ICT) in Higher Education: Advantages, Disadvantages, Conveniences and Limitations of Applying e-Learning to Agricultural Students in Iran." *Procedia - Social and Behavioral Sciences* 152: 300–305. <https://doi.org/https://doi.org/10.1016/j.sbspro.2014.09.199>.
- Ukpabio, Godfrey E., Ekpenyong E. Ekanem, Usen F. Mbon, and Festus O. Arop. 2020. "Administrators' Awareness, Procurement and Management of Virtual Laboratories for Teaching Science Subjects in Secondary Schools: A Case Study." *The Journal of Social Sciences Research* 6 (65): 598–605. <https://doi.org/10.32861/jssr.65.598.605>.
- Vahdat, Sedigheh, Zohre Gooniband Shooshtari, and Farhad Mazareian. 2020. "The Impact of Telegram on Learning of Collocational Knowledge among EFL High School Students." *ALRJournal* 4 (3): 37–51. <https://doi.org/10.14744/alrj.2020.18189>.

- Valverde-Berrocoso, Jesús, María del Carmen Garrido-Arroyo, Carmen Burgos-Videla, and María Belén Morales-Cevallos. 2020. "Trends in Educational Research about E-Learning: A Systematic Literature Review (2009–2018)." *Sustainability* 12 (12): 5153-5176. <https://doi.org/10.3390/su12125153>.
- Vygotsky, Lev Semyonovich. 1978. *Mind in society: The development of higher psychological processes*. Cambridge MA: Harvard University Press.
- Waldman, Micaela. 2003. "Freshmen's Use of Library Electronic Resources and Self-Efficacy." *Information Research* 8 (2): Article 150. <https://informationr.net/ir/82/paper150.html>
- Watkins, Chris, Eileen Carnell, and Caroline Lodge. 2007. *Effective Learning in Classrooms*. London: SAGE Publications Ltd. <https://dx.doi.org/10.4135/9781446211472>.
- Wertsch, James V. 1991. *Voices of the mind: A socio-cultural approach to mediated action*. Cambridge MA: Harvard University Press.
- Widenská, Eva. 2014. "Efficiency of Practicing with Materials Using ICT and Paper Ones in Mathematics". *Journal on Efficiency and Responsibility in Education and Science* 7 (2): 37-43. <https://doi.org/10.7160/eriesj.2014.070203>.
- Zheng, Binbin., Melissa Niiya, and Mark Warschauer. 2015. "Wikis and Collaborative Learning in Higher Education." *Technology, Pedagogy and Education* 24 (3): 357-374. <https://doi.org/10.1080/1475939X.2014.948041>.