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Students' and lecturers' perceptions about the effectiveness and challenges of online mathematics instruction during the Covid-19 partial lockdown

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Abstract

This study sought to assess the nature of online mathematics teaching and learning, the associated challenges and the support system put in place for students due to COVID-19 at the University of Education, Winneba (UEW), Ghana. The study employed concurrent mixed method design. A sample size of 507 comprising 490 students and 17 lecturers respectively were used for the study. In the study, proportionate stratified sampling, and list-based sampling frame were employed by the researchers to select the sample of mathematics students whereas census was used to include lecturers. Data for the quantitative phase were garnered using questionnaire while interview was used for collecting data for the qualitative phase. Descriptive statistics and thematic analysis were used to analyse the quantitative and qualitative data respectively. From the study it was deduced that, among the challenges facing students and lecturers in the online teaching and learning of Mathematics are; high cost of internet data bundle, unreliable internet connection, unfamiliarity with some online platforms, difficulty in accessing some online platforms using smartphones, and difficulty in teaching some topics online. In addressing the issue of encountering difficulty in teaching some topics online, we recommend the University's Management to partner with agencies that host learning resources platforms to provide mathematics contents to help students explore. Again, we recommend that University's Management commences discussions with telecom providers to allow zero charges on the use of smartphones for content download from the university's learning sites.

Keywords COVID-19, perceptions; online mathematics instruction; effectiveness; challenges

Introduction

Coronavirus Disease 2019 (COVID-19) is primarily affecting public health, and its spillover effects can be observed in education, stemming largely from extended school closures. According to Sintema (2020), school closures due to COVID-19 have negatively impacted over 1 billion students. In spite of the reported low rate of infection among students, school closures still remain a critical tool in ensuring social distancing to mitigate the spread of the disease, and also not to overwhelm our health facilities.

Research suggests that school closures especially in countries that have recorded COVID-19 cases enhance social distance and contact tracing among school communities especially universities (UNESCO, 2020). It was noted that a closure of 4 to 8 weeks might be required in case of substantial community

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spread. In the case of Ghana, universities and other pre-tertiary institutions were closed for about 10 months as an attempt of curbing the spread of the virus. This interruption in the education system disengages students from the learning process in the face-to-face interaction, and that has the propensity of reversing gains in learning achievements especially in mathematics. The worse effect of this interruption is its impact on students with special learning needs who may not effectively cope with e-Learning strategies.

In our contemporary world today, e-learning has become an important part of higher education and much more in this COVID-19 era. Among the benefits of online teaching and learning are: (i) e-Learning provides continuity of education; (ii) provides opportunities for students' online activities at their own pace and at the time convenient for them; (iii) creates learning situations and makes learners responsible for their own learning; (iv) improves learners' time management skills; (v) provides opportunity for learners to skip the elements they do not need (Kuimova, Kiyanitsyna & Truntyagin, 2016).

There is a plethora of research on teaching and learning through the mode of e-learning. Many researchers in the field have defined e-learning in different ways. Kumar and Sridhar (2020) agree that the concept of e-learning has many forms, which means that there exist many different terminologies or definitions of the concept. However, what characterises e-learning in these varied definitions is the fact that it does not require the teacher and student to be roofed under the same physical environment. Irrespective of which terminology or definition being used, they have commonalities: (i) the learner is at a distance from the tutor or instructor; (ii) the learner uses some form of technology (usually a phone or computer) to access the learning materials; (iii) the learner uses technology to interact with the tutor or instructor and with other learners and; (iv) some form of support is provided to learners (Anderson, 2008, p. 16).

E-Learning is commonly defined in contradistinction to the face-to-face teaching and learning. Holmstrom and Pitkanen (2012) defines e-learning as the delivery of instruction in a flexible and easy way through the use of internet and digital device such as a computer or mobile device to support students learning. E-Learning is also considered as a form of instruction with the absence of the physical classroom, which is replaced by the use of web-based technologies offering opportunities for out-of-class learning independent of time, place and pace (Kattoua, Al-Lozi & Alrowwad, 2016; Nortvig, Petersen & Balle, 2018).

Online courses are usually dictated by the technology and are designed more for the convenience of the online system and the technology. Bailey and Card (2009) shared eight pedagogical practices that are considered to be highly effective in the online practice: (1) fostering relationships; (2) engagement; (3) timeliness; (4) communication; (5) organization; (6) technology; (7) flexibility; and (8) high expectations (Sun & Chen, 2016, p. 166). In their view, fostering good relationships and communication between instructors and students was crucial and can be achieved by instructors' empathy for students, passion for teaching, and willingness to help students succeed. E-Learning is therefore considered as an alternative for students' learning (Wang, 2014), which is intended to focus on critical thinking and creation. According to Washburn (2003), the most important reason IVC institutions support online learning was to increase student availability and access to courses at convenient places and times. Finch

and Jacobs (2012) stated these advantages: reducing the time and costs for travel; increasing opportunities to access and collabo-rate with expert professionals in a global range; providing students with flexibility to access courses at their convenience; and allowing adjustments to subjects and content need.

Considering the nature of online environment, online instructors are advised to engage their students, which can be accomplished by utilizing emails and online discussion boards, responding promptly to discussion questions, encouraging students to share their backgrounds and work experiences, and conducting meaningful small group projects. To achieve these objectives, Baily and Card (2009) proposed that online instructors should well organize course for students and give all course materials at the beginning of the class, provide direct links to the necessary websites and resources, and clearly inform students about how to navigate the university website to successfully complete the course.

Amidst COVID-19 and its associated school-closure, many countries including Ghana have turned to e-Learning as a means of mitigating for lost time in the face-to-face instructions. Some countries are simply putting learning resources on their websites, and making available more products, but not necessarily online classes. Universities in Ghana have been directed by the Ministry of Education to engage students online in order to ensure continuity in educational system. United Nations Educational Scientific and Cultural Organization [UNESCO] (2020) proposed among others some strategies in providing remote learning solutions during temporary school closures. These are: (i) assess the capabilities of students, teachers, and infrastructure to adopt high-technology and low-technology solutions.; (ii) train teachers how to instruct and engage all students through distance learning tools.; (iii) appreciate that distance learning is not interactive and work within that framework.; (iv) keep time and track of student engagement; (v) emphasize tools that are compatible with smartphones as they might be more widely available; (vi) engage in agreements with telecoms to eliminate cost of accessing resources for MoE sites. (vii) ensure accessibility and availability of education services for students with disabilities.

Undeniably, infrastructure and familiarity with the e-Learning tools among university administrators, teachers and students seem to be driving successes of delivering quality teaching and learning in tertiary institutions. Sahu (2020) asserts that online teaching is not a new mode of delivery for any university. Sahu argues that universities teachers had already begun preparing lesson plans to deliver online teaching to their students. Although, many university teachers are acquiring training on how to use some of these virtual classrooms, there is always a tendency that some teachers will not be able to cope up with this new mode of teaching. Moreover, many universities do not have enough infrastructure or resources to facilitate online teaching with immediate effect (Sintema & Phiri, 2018). Most importantly, many students are not familiar with online platforms and also, do not have access to computers, internet facilities at home. These have adverse effects on the teaching and learning of mathematics.

Sintema (2020) in his study hypothesized that COVID-19 would negatively impact on the performance of students in the 2020 Grade 12 national examinations vis-à-vis mathematics, science and design and technology subjects. The study collected data from three teachers at a public secondary school in Chipata District of Eastern Province in the Republic of Zambia. The Head of Department for Mathematics, the Head of Natural Sciences Department and one science teacher were interviewed. Results of this study revealed that there is likely to be a drop in the pass

percentage of secondary school students in the year's national examinations.

Washburn (2003) conducted a study on the nature and characteristics of online learning in 66 Illinois colleges and universities. Washburn examined respondents' perceptions of institutional support for online programs/courses. A structured questionnaire developed by the National Education Association (2000) was used to collect data from Illinois Virtual Campus (IVC) institutions. Useable responses were received from 53 colleges and universities for a response rate of 83%. A 7-point Likert-type scale was used to assess nature and characteristics of online teaching/learning process, online course structure, student support and course evaluation. Washburn (2003) in his study explored respondents' view on how online learning was administered by their respective institutions. From the findings, there were varied administrative structures used by IVC institutions to administer online programs. Most programmes/courses were administered by individual departments, followed by an office/department of distance education, a separate office/department for online learning, or an office/department of continuing education. However, the structure employed by each institution to administer its online programmes is most likely unique to the organization where the program resides. The study found seventy-eight percent of the respondents having their online course management system housed on their own institution's server. Most institutions were found of using WebCT or Blackboard as the course management system to develop and deliver online courses. Courses were structured in a variety of ways to support online learning at IVC institutions. Library resources in the institutions were made available to students, and they were provided with supplemental course information to assist in completing online courses.

Washburn's (2003) study assess respondents' perceptions of the support provided by their institutions for online course offerings. Respondents reported that there was availability of orientation programs for all students including first-time online students. More than 80% of the institutions provide orientation programs to address the important need for technical skills, meeting software/hardware requirements, and understanding the characteristics of successful online learners. It was revealed that technical assistance were offered students throughout the duration of the course/program, and that a system was put in place to address student complaints. Washburn (2003) in their study reported that centers were established at all 40 community college districts in Illinois and provide a variety of services for faculty and students. Washburn (2003) in his study asked respondents to report how faculty evaluate student performance in for-credit online courses. From the study, it was found that most institutions did not mail or fax students' tests. However, some used proctors who receive tests and administer them to students. Institutions sometimes utilize IVC Student Support Centers but they were not the principal means for evaluating student performance. Most often, online students take their tests online as a means of evaluating student performance. It was also revealed that, institutions employed multiple methods to measure programmes effectiveness against specific standards that have been put in place to compare and improve learning outcomes.

Research has shown that, the transition from face-to-face teaching to online delivery has a serious impact on assessments and evaluation. Although technology has been used earlier to support teaching and learning, the assessment aspect is often under-developed (Kraemer, et

al., 2020; Timmis, Broadfoot, Sutherland, & Oldfield, 2016). Applying assessments online on mathematics courses designed for face-to-face learning is a daunting task for both teachers and students. Kearns (2012) noted that, both teachers and students are usually uncertain about the procedure for assessing teaching and learning. Kearns further stress that, teachers have to change the assessment types to fit online mode. Again, it is always difficult to monitor how students are taking assessment online, and also to ensure that students are not cheating during online tests. These go to a larger extent to undermine the quality of teaching and learning of mathematics among university communities including University of Education, Winneba. Moreover, students who do not have an Internet facility will suffer a clear disadvantage while participating in the evaluation process, which would adversely affect their grade point averages (GPAs) at the end of the day (Alruwais, Wills, & Wald, 2018). From Washburn (2003) study, more than one-half of the respondents indicated that they require basic technology skills as a prerequisite for enrollment in an online course.

There exists a plethora of literature on the closure of educational institutions in an attempt to curtail the spread of infectious diseases in communities by breaking central chains of transmission (Kumar & Sridhar, 2020; UNESCO, 2020; Wheeler, Erhart & Jehn, 2010). Taking into account the growing concerns about the current spread of COVID-19 pandemic, a growing number of universities (including UEW) across the world have either postponed or canceled all campus events such as teaching and learning, workshops, conferences, and other co-curricular activities. Universities have moved rapidly to transition various courses and programs from face-to-face to online delivery mode (Sahu, 2020; Sintema, 2020).

Having closed all learning institutions including universities in an attempt to contain the spread of COVID-19, and the introduction of e-Learning as a result, we hypothesized that COVID-19 with its associated e-Learning would negatively impact on the teaching and learning of mathematics. There is currently little or no literature assessing the nature of online mathematics teaching and learning in universities, and the associated challenges due to the impact of COVID-19 in Ghana. This study therefore sought to assess the nature of online mathematics instruction at UEW, the associated challenges and the support system put in place for students due to COVID-19. Specifically, the study sought to answer the following research questions:

(i) What are UEW mathematics students' and lecturers' perceptions about the nature of the content, effectiveness of the teaching and assessment processes involved in the online mathematics instruction?

(ii) What are UEW mathematics students' and lecturers' perceptions about the support services provided for mathematics students in the online mathematics instruction?

(iii) What challenges do UEW mathematics students and lecturers face in the online mathematics instruction?

Undeniably, there cannot be effective online learning without technology being employed as student-centered approach to learning. Technology is a tool and therefore meant to be used to solve problems, and not just to deliver messages. Technology as a tool is used for "analyzing the world, accessing information, interpreting and organizing students' personal knowledge, and representing what they know to others" (Jonassen & Reeves, 1996, p. 694). Because the online classroom exists solely within the confines of technology, course activity is therefore occurring within the

confines of technological tools. As students are provided with a common platform through technology where they can create and disseminate knowledge among themselves, students become less dependent on lecturers for knowledge.

place emphasis on managing the learning experience of students and not the technology.

Although technology and content are inextricably connected in the online learning; nonetheless, technology can be made seamless so that lecturers and students can interact in an

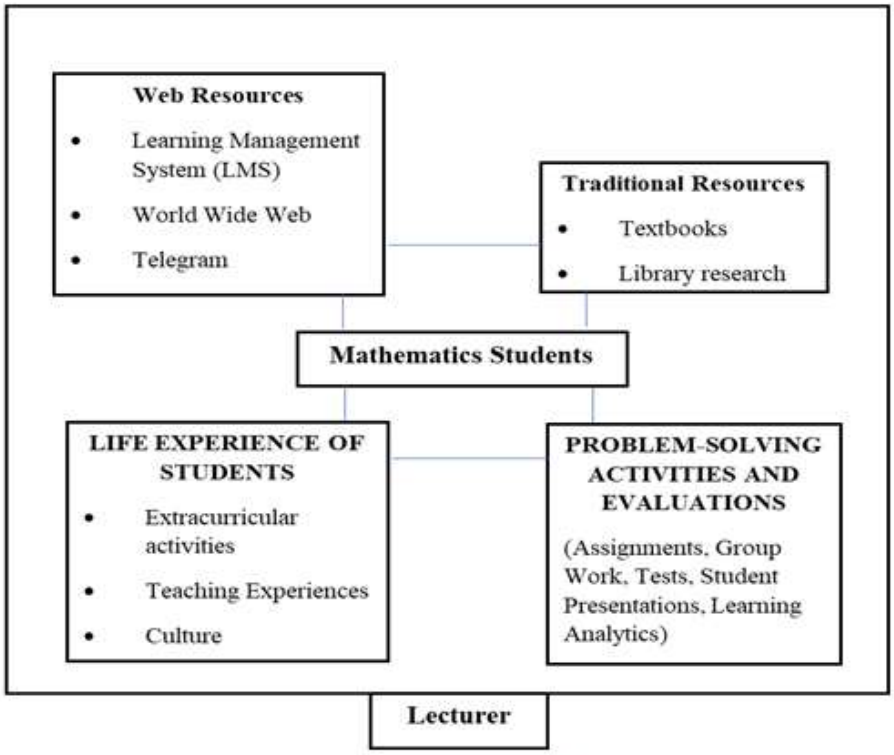

Figure 1 Conceptual Framework for Online Classroom

Source: Adapted from Knowlton (2003)

Figure 1 shows the nature of online mathematics classroom which put students at the center of the learning process. When used as a heuristic for pedagogical monitoring and self-evaluation of the online classroom, this framework can help lecturers ensure that students have valuable experiences. In the quest to implement the model, lecturers should bear in mind that while technology is inherent to the model, the focus is not on technology but on pedagogy (Knowlton, 2003). Therefore, it is required of lecturers to effort to understand the mathematics course content. In the online classroom, collaboration among students is considered critical in promoting learning (Anderson, 2011; Picciano, 2017). It worth noting that, the type and scope of interaction (collaboration) should depend on the shared academic goals of students. From Figure 1, the lecturer is found on the borders of the classroom however, the online classroom does not diminish the role of the lecturer (Olcott & Wright, 1995). It is the role of the lecturer in the online classroom is to frame the course and

supplement student interactions by providing resources and opportunities whilst at the same time maximizing independence among students. Knowlton (2003) explains that, for the lecturer to frame online mathematics classroom he/she should facilitate students' desire to develop and implement shared goals outlined in the course structure that will enable students to reach desired learning objectives. Also, one way by which lecturers can frame an online course is to establish clear goals, objectives, and learning outcomes (Palloff & Pratt, 1999).

Even when the design of a course is beyond the purview of the mathematics lecturer, he/she can still frame students' collaboration by focusing on each student's self-centeredness. It is by working together as a group that individual students can reach their own maximum potential. Evaluation of student work is another area where can frame a course to help students achieve efficiency. Students could perceive evaluation in the online course as a subjective and whimsical process and this could be upsetting (Knowlton, 2003). In this case, lecturers can foster dialogue and negotiation about assignment criteria to help students better understand the demands of an assignment. Knowlton (2003) argues that, beyond the responsibility of framing, lecturers are admonished to supplement student interactions with traditional resources, Web resources, and problem-solving opportunities. Lecturers could also encourage students to share their own unique personal experiences and resources with colleagues.

Methodology

Research Design

The study employed concurrent mixed method design where the quantitative data collection and qualitative data collection are concurrent, happening during single phase of the research study (Creswell, Plano Clark, Gutmann & Hanson, 2003). Results from these two methods are integrated during the interpretation phase. This design is much familiar to us and can result in well-validated and substantiated findings.

Population

The target population for the study was made up of all the mathematics students and lecturers in the first three academic levels (i.e., Level 100, 200 and 300) at the University of Education, Winneba. This population consists of 1010 students and 17 lecturers.

Sample and Sampling Procedure

The study employed a sample size of 507 comprising 490 students and 17 lecturers respectively. In the study, proportionate stratified sampling (Avli, 2016) and list-based sampling frame (Couper, 2000) were employed by the researchers to select the sample of mathematics students for the study. Proportionate stratified sampling method is used when population is heterogeneous (that is, when elements of population differ from one another on a characteristic of a predefined criterion). This technique is considered advantageous as the sample was more representative of the population than if taken from the population as a whole. On the basis of nature and purpose of investigation, we decided to take into account the academic levels of mathematics students at the University of Education, Winneba. In view of this, we grouped the mathematics students in the University of Education, Winneba into Level 100, 200 and 300 with population size of 460, 360 and 190 respectively. Using proportional allocation technique, the sample size of 490 is made proportional to the number of students present in each of the three strata. Proportional representation technique which is meant to allocate sample from the strata brought the sample size of mathematics students which comprises of Level 100, 200 and 300 students to 223, 175 and 92 respectively. Following that, student participants from the three academic levels

were selected through simple random sampling using list-based sampling frame. Lists of students' e-mails linked with their academic levels were randomly selected.

The mathematics lecturers who participated in the study were included through the census frame. Census technique was employed in order to reduce the risk of bias in the findings of the study since the entire lecturer population of the study was represented. This attempt was made to engage all the lecturers in the study considering that the total population relative to mathematics lecturers was not vast. Mathematics lecturers were considered in this study on the reason that, lecturers form an integral part of online teaching and learning and, therefore will be able to provide in-depth information about the subject matter being investigated. According to Asamoah-Gyimah and Duodu (2007), a sample of 10% to 30% to the accessible size is desirous in a survey. Hence, for the researchers to consider 50% of the target population is deemed appropriate for the study. The data for the in-depth description of the study was also garnered through interviews with 10 participants comprising 5 students and 5 lecturers. Yin (2014) proposes 6 sources of evidence in qualitative study; therefore, the selection of 10 participants is deemed appropriate.

Instrument

We used questionnaire and interview guide as the primary tools for collecting data. Google form online questionnaire and interview guide were used to solicit data from Mathematics students. Whiles only interview guide was used to solicit data from Mathematics lecturers. Each of the questionnaires had both closed and open-ended questions. The 22-item questionnaire for the students was divided into five sections, namely, section A – Bio Data, Section B- Nature of the online Mathematics course, section C – Course Content, and section D – Course Assessments and section E – Support Services and F – challenges of Learning Management System (LMS) and possible recommendation to improve it. Similarly, the interview guide for lecturers and students also followed the same theme: Nature of the online Mathematics course; Course Content; Course Assessments; Support Services; Challenges of Learning Management System (LMS) and some recommendations for improvement.

To ensure the face and content validity of the questionnaire instruments developed, copies were given to other colleague lecturers for their inputs before submitting it to experts in the field of online instruction for content validation. Also, reliability of the questionnaire was ensured by pre-testing the instruments to 25 mathematics students who were not included in the study. The Cronbach's Alpha reliability co-efficient obtained for the internal consistency of the questionnaire was 0.74. A co-efficient of reliability value of 0.74 is considered reliable (Kothari, 2004). In order to establish trustworthiness of the qualitative data, the researcher ensured that there was accurate reflection on the interview by cross-checking with the participants regarding what had been experienced during the interview. Also, we had a prolonged and concentrated engagement with the participants on phone during the interview.

Data Collection Procedure

Online questionnaires were designed for mathematics students and lecturers who teach in the regular programme at the University of Education, Winneba. The questionnaires were sent to their various online platform and respondents were asked to complete not more than one questionnaire. We used four weeks to collate all the responded questionnaires. The interviews for both lecturers and students were

Table 1: Demographic Characteristics of Student Participants

Respondents' Attributes	Frequency	Percentage %
Academic Level		
Level 100	229	47
Level 200	178	36
Level 300	83	17
Types of Settlement		
City	102	21
Town/Urban	325	66
Rural	63	13

Source: Field data (2020)

done via phone calls which spanned for two more weeks.

Data Analysis

With the aid of Statistical Package for Social Science (SPSS) software, descriptive statistics such as frequency counts, percentages and the mean and standard deviation were employed to analyse the questionnaire. The data collected using questionnaires were coded into the SPSS software to facilitate the analysis. The use of percentages and frequencies assisted us to clearly represent true data characteristic and findings with a great deal of accuracy devoid of subjectivity. In the analysis, we dichotomised the original 4-point Likert scale of the questionnaire responses (1=strongly disagree, 2=disagree, 3=agree, 4=strongly agree) by recoding responses 1 and 2 into a new disagree category with value 1, and 3 and 4 into a new agree category with the value 2 to facilitate the analysis of data. The rationale behind this dichotomization is for the study to gain more interpretability or simplicity in terms of capturing the trends in the data (Beamish, 2004). Also, thematic analysis was performed on the qualitative data garnered through interview. The interview data acquired was processed by coding, finding patterns and categorizing the data set into themes.

Results

The demographic characteristics of 490 student participants that were considered in the study included academic levels and the type of settlement they live in. Details of this information are presented in Table 1.

The academic level of the respondents in Table 1 indicates that out of the 490 students who participated in the study, 229 (47%) students were in Level 100. It was also revealed that 178 (36%) of the student participants were in Level 200, while the remaining 83 (17%) students were in Level 300. This shows that, there were more of the student participants being at the first level of the university than at the other levels. In terms of type of settlement, information elicited revealed in Table 2 that, 102 (21%) student participants live in cities whereas 325 (66%) of them live in towns. The remaining 63 (13%) students live in the village. This is an indication that, most of the student participants live in towns across the country.

What are UEW mathematics students' and lecturers' perceptions about the effectiveness of teaching and assessment processes involved in the online mathematics instruction?

This research sought to explore mathematics students' and lecturers' views about the nature of online mathematics instruction and assessment. In our quest to answer the research question, we employed both questionnaire and interview in gathering data about the phenomenon. The study explored participants' views on the nature of online teaching and learning of mathematics. It was evident from the interview with the

participants that the online teaching and learning was done on the UEW's Learning Management System, WhatsApp and Telegram.

From the students' responses in the interview, not only were lecture notes uploaded on the LMS, whatsapp and telegram platforms but also audio and video files were included to explain the notes. This is captured in the excerpts below:

> *"We were informed that the online course will be conducted on the LMS, however, lecturers will also engage us on Telegram and WhatsApp platform for clarification of certain key concepts and also for address our questions. In view of this, we were given usernames and passwords to access the LMS in order to download lecture material and audios for further discussion on the telegram platform. Sometime our lecturers upload the Power point note, PDF documents, they then explain the concept it with recorded audio. So it was our responsibly to download the materials and follow the class by listening to the audio and reading the slides."* (ST 2).

Another student respondent remarked:

> *"We created a telegram and WhatsApp platforms for each of the courses. But, the telegram was mostly used because it could contain more of us. The lecturers upload the audios and other documents online learning on LMS, telegram or WhatsApp. When the time for a particular course is due the audios, power point documents and PDF are sent to us on the Telegram or the WhatsApp platform for discussion. The lecturers are mostly online to respond to student questions." (ST 4).*

Similarly, interview with the mathematics lecturers revealed that lecture notes together with audio and video clips that explain the notes were uploaded on the LMS, Whatsapp and Telegram platforms. Comments by some of the lecturer participants are captured in the following excerpts:

> *"…the main medium for teaching and learning of Mathematics was the LMS, but we were also asked to meet students on the telegram for discussion. We were tasked to upload audio on the various topics on LMS. We were advised not to us any audio-visual means on teaching such as Google meet, Zoom, Skype and so on, because majority of the students may not be able to participate if such mediums of teaches are adopted." (LT 3).*

> *"…..LMS as a medium of teaching and learning mathematics served as a good medium for engaging students, and many students benefited because of management's directive for us to use telegram (which offer more students opportunity) and was successfully accomplished culminating in excellent instructional content outcome"(LT 5).*

Students' and lecturers' perceptions about the processes of teaching in the online mathematics instruction

The study sought to ascertain lecturers' and students' perceptions on the processes of teaching in the online mathematics instruction the results from exploring the views of student participants are presented in Table 2.

Table 2 Students' rating of their agreement to statements on the processes of teaching used by lecturers in online mathematics instruction

Items	Number (%) of respondents		Mean	Std Div.
	Disagreeing	Agreeing		
1. A clear statement of course requirements was provided at the beginning of the course.	185 (38)	305 (62)	1.62	0.49
2. The objectives for the course were clearly stated.	167 (34)	323 (66)	1.66	0.47
3. A complete list of required and recommended learning and reference material were provided.	158 (32)	332 (68)	1.68	0.47
4. The internet links to additional content were accurate and worked.	209 (43)	281 (57)	1.57	0.50
5. The learning materials were clear and understandable.	189 (39)	301 (61)	1.61	0.49
6. The materials were accurate and current.	190 (39)	300 (61)	1.61	0.49
7. The materials were well organized and sequenced appropriately.	193 (39)	297 (61)	1.61	0.49
8. The materials were interesting and engaging.	211 (43)	279 (57)	1.57	0.50
9. The course content was at the right level of difficulty.	185 (38)	305 (62)	1.62	0.49
10. The course activities helped me to examine issues, to evaluate new ideas, and to apply what I have learned.	217 (44)	273 (56)	1.56	0.50
11. The activities were realistic and could be performed with the resources I had available.	278 (57)	212 (43)	1.43	0.50
Average Per Item Rating			1.59	

Source: Field data (2020); Percentage in parenthesis

A cursory look at Table 2 shows that, the mean scores ranged from 1.43 to 1.68 and standard deviation scores from 0.47 to 0.50 for the items on online mathematics course content and activities with an average per item rating of 1.59. This seems to suggest that, majority of the student participants were to some extend impressed about the online mathematics courses and activities. For example, it was discovered from the student participants' responses that the teaching and learning materials provided to students were well organized and sequenced appropriately. Majority, 297 (61%) of the students conceded to the statement that 'materials were well organized and sequenced appropriately' while

193 (39%) of the them declined with a mean and standard deviation of 1.61 and 0.49 respectively. Again, 332 (68%) of the student participants agreed to the statement that a complete list of required and recommended learning and reference materials was provided whereas 158 (32%) of them disagreed with a mean and standard deviation of 1.68 and 0.47 respectively. This means that, students had as part of their online mathematics courses a complete list of required and recommended learning and reference materials. Conversely, it was revealed that teaching and learning activities that students were subjected to were not realistic and that, it could not be performed with the resources available to students. Majority, 278 (57%) of student participants disagreed to the statement that 'activities were realistic and could be performed with the resources I had available' while 212 (43%) of them agreed with a mean and standard deviation of 1.43 and 0.50 respectively.

The study further explored participants' views on the online mathematics course content in an interview. From the account of student participants, it appeared that students were not very much impressed with the e-learning activities; however, it did not affect the course content of the various courses they offered. One of the students stated that:

> *"... the course content for the Mathematics course was very good in terms of objectives, materials accuracy, material sequence and workload. Even though sometimes learning something individually is very difficult." (ST 3).*

Another student also commented:

> *"...the content of the various Mathematics courses were excellent as instructional objectives were clearly stated from general to specific. And the objectives of those courses were achieved" (ST 5).*

On the same subject, lecturers' views were explored. It was revealed that lecturer participants were presented with the challenge of teaching some topics online with audio presentation. This is captured in the comments below:

> *"... even though we did our best teaching the course, the truth is that some of the topics were very difficult to treat using audio presentation. For instance, teaching cross-section using mere audio description was very difficult. Due to this, lecturers proposed to use Zoom or Google meet but management advised that we stick to the initial plan, thus, the use of lecturer notes and audio explanations." (LT1).*

> *"...Lecture notes together with audio presentation of key concepts helped students to appreciate key aspects of the various courses vis-à-vis the questions and feedback received after each presentation. This brought into sharp focus the adoption of these combined approach to teaching and learning post covid-19 lecture" (LT 4).*

Assessment of Online Mathematics Course

In our quest to assess the online mathematics course, a questionnaire was designed to solicit views from student participants. Table 3 illustrates frequency, and percentage of the responses to each item on the questionnaire.

Table 3 Students' rating of their agreement to statement on the processes of assessment lecturers used in the online mathematics instruction

Items	Number (%) of respondents		Mean	Std Div.
	Disagreeing	Agreeing		
1. The grading criteria were clear and explicit.	153 (31)	337 (69)	1.69	0.46
2. The instructions or directions were easy to follow.	212 (43)	278 (57)	1.57	0.50
3. The assignments were challenging.	202 (41)	288 (59)	1.59	0.49
4. The feedback provided by the instructors was useful.	198 (40)	292 (60)	1.60	0.49
5. Assignments and tests were marked and returned promptly.	337 (69)	153 (31)	1.31	0.46
6. The assignments helped me to learn the course material.	122 (25)	368 (75)	1.75	0.43
7. The assignments and examinations were marked fairly.	156 (32)	334 (68)	1.68	0.47
Average Per Item Rating			1.60	

Source: Field data (2020); Percentage in parenthesis

As depicted in Table 3, the mean scores ranged from 1.31 to 1.75 and standard deviation scores from 0.43 to 0.50 for the items on students' assessment of the online mathematics courses with an average per item rating of 1.60. This is an indication that, majority of the student participants are of the view that the online mathematics course assessment was fairly conducted during teaching and learning. For example, in our quest to find out from student participants whether the assignments given lecturers helped/challenged them to learn the course material, 368 (75%) of the students conceded while 122 (25%) of the them declined with a mean and standard deviation of 1.75 and 0.43 respectively. This indicates that, the assignments that were given by lecturers helped/challenged students to learn the course materials. Again, 334 (68%) of the student participants agreed to the statement that assignments and examinations that given to them were marked fairly whereas 156 (32%) of them disagreed with a mean and standard deviation of 1.68 and 0.47 respectively. This means that, scoring points from assignments and examinations were fairly distributed to students in their online mathematics courses. Conversely, it was revealed that the students' marked scripts from the assignments and tests conducted were not returned promptly. Majority, 337 (69%) of student participants disagreed to the statement that assignments and tests were marked and returned promptly while 153 (31%) of them agreed with a mean and standard deviation of 1.31 and 0.46 respectively.

The study through interview explored students' views on the nature of the online assessment. From the interview, it was revealed that students were given assignment to be submitted online within a given time-frame. Some of the students' comments are captured in the following excerpts:

> *"... We were given assignments, and the question was very that each person had to work on his or her own. The only challenge was that the submission date was very short. Beside this, everything was okay." (ST 3).*

> *"... I think the question and grading criteria were good. They were given a typographic map to undertake certain work on them. It was good for me because the nature of the question and the examination limited copy work. The questions were very that each person had to work on his or her own. The only challenge was the submission date was very short. Beside this, everything was okay." (ST 5).*

Lecturers' views of on the nature of their online assessment were also explored through interview. It was then revealed that, lecturers gave 'Take-Home Assignments' to students to be submitted online. A lecturer participant recounted:

> *"Even though assessing students through the LMS was unusual to us, we made sure they were assessed well, taking into consideration the quality assurance principle of the University. Using this medium mounted pressure on us, since we had to make sure we were not compromising standard of assessment of the University giving out take home assignment to the students. The only advantage was the fact that the subject in nature and therefore students were not able to engage in copy work" (LT 2).*

Another one also said that:

> *"LMS medium was adopted for the assessment and we were made to upload test items online with assigned duration programmed automatically. Being a new phenomenon with the emergence of covid-19, there were strict guide lines to ensure quality of the university assessment procedure was not compromised" (LT 4).*

What are UEW mathematics students' and lecturers' perceptions about the support services that are provided for the mathematics students in the e-Learning?

The study also sought to investigate the support services students are provided with in their struggle to take online mathematics courses. As evident in Table 4, the mean scores ranged from 1.40 to 1.81 and standard deviation scores from 0.40 to 0.49 for the items on the support services for students with an average per item rating of 1.66. This is an indication that, majority of the student participants share the view that there were provided with some support services as they took their online mathematics courses. For instance, in a bid to find out from student participants whether lecturers provided helpful information and explanations to issues that were of concern to them, only 95 (19%) of them declined. Majority of the students, 395 (81%) of the them conceded that lecturers provided helpful information and explanations to issues that were of concern to them with a mean and standard deviation of 1.81 and 0.40 respectively. This means that, mathematics lecturers provided helpful information and explanations to issues that were of concern to them regarding their online mathematics courses.

Table 4 Descriptive statistics of students' rating of their agreement to statements on the support services for students in the online mathematics instruction

Items	Number (%) of respondents		Mean	Std Div.
	Disagreeing	Agreeing		
1. Lecturers provided helpful information and explanations to issues of concern.	95 (19)	395 (81)	1.81	0.40
2. Lecturers could be contacted easily.	145 (30)	345 (70)	1.70	0.46
3. I was assisted by the librarian or learning resource personnel to access online material and resources.	127 (26)	363 (74)	1.74	0.44
4. Academic counsellors responded promptly to my requests.	168 (34)	322 (66)	1.66	0.48
5. The academic counsellors provided useful information.	147 (30)	343 (70)	1.70	0.46
6. The off-campus learning centres were appropriately equipped.	294 (60)	196 (40)	1.40	0.49
7. The off-campus learning centres personnel were helpful.	181 (37)	309 (63)	1.63	0.48
Average Per Item Rating			1.66	

Source: Field data (2020); Percentage in parenthesis

Also, 363 (74%) of the student participants agreed to the statement that they were assisted by the librarian or learning resource personnel to access online material and resources whereas 127 (26%) of them disagreed with a mean and standard deviation of 1.74 and 0.44 respectively. This supports the assertion that, students who took mathematics courses online were provided with some form of assistance by the librarian or learning resource personnel to access online material and resources. Conversely, it was revealed that the off-campus learning centres meant for students were not appropriately equipped. Majority, 294 (60%) of student participants disagreed to the statement that the off-campus learning centres meant for students were appropriately equipped whereas 196 (40%) of them agreed with a mean and standard deviation of 1.40 and 0.49 respectively.

The researchers through an interview asked student participants of their views of the nature of the online support services. From the students' responses, it was revealed that university management and lecturers gave students the needed support services such as assisting them to fix some challenges associated with passwords and usernames. This is illustrated by the following comments made by some of the student respondents:

> *"... Lecturers and management did very as far as support services were concerned. They were help line to fix passwords and usernames challenge. Notwithstanding, sometimes it take very long time before feedbacks were given and this affected patronage of the LMS." (ST 1).*

> *".... some of us with poor internet connectivity were asked to come to*

> *campus to use the university fast internet facility so as to not be disadvantage in the test assessment. There was a feedback platform for us to communicate difficulties encountered during instructional hours for management to address those accordingly" (ST 4).*

Judging from the responses given by the lecturers in the interview, it was revealed that lecturers were not in best position to provide technical support services and therefore, channel such issues to appropriate authorities for redress. This is captured in the following excerpt:

> *"Students were constantly asking for technical support services from us, but we were not in position to solve those problems. However, some of the issues were channeled to the administrator for rectification."* (LT 4).

Another lecturer also said:

> "*Management occasionally contacted some of us to deal with our challenges that emanated from the use of MLS service. And also guided and supported us with relevant data connectivity and logistics for smooth and effective delivery of contents to our students"* (LT 2).

What are UEW mathematics students' and lecturers' perceptions about the challenges mathematics students and lecturers face in the online teaching and learning?

Three major challenges emerged from the students and lecturer interviews on Mathematics e-learning: connectivity challenge, internet bundle and devices use. Below are quotations from an interview with Mathematics students and lecturers.

On internet connectivity, participants who were engaged in the study indicated that since majority of them are living in rural communities they were highly challenged by network problem in during online teaching and learning. In inquiring about this phenomenon through interview, it was revealed among students that unreliable internet source was a major challenge in the online learning platform. This is evident in the following excerpt:

> *"...Where I lived was far from where the internet mask was, so downloading documents from the LMS was very difficult. It sometimes takes about three hours before a download a single audio. This wasted time and internet bundle. We were thinking the University would have provided as with monthly data to reduce our burden but nothing of that nature happened." (ST 4).*

One student also narrated that:

> *"I used to travel from my village to a nearby communities to download audios and documents from the LMS every two days. It was not easy for me but I did not have any option since COVID-19 had pushed the world to a corner." (ST5).*

Through the interview conducted among lecturers, participants similarly recounted how they were been challenged with constant internet interruption. This is illustrated by the following comments made by the respondents:

> *"...constant internet interruptions were a challenge throughout the online programme. Sometimes, we*

[students] need to relocate to an area with strong internet connectivity to upload our documents on the LMS." (LT 1).

"... this problem was not limited to students alone, sometime, lecturers send documents on the telegram platform and it take some time before we get it. Usually, we receive messages attached to the documents before the documents get to us." (LT 3).

With respect to internet bundle, the respondents unanimously claimed they were facing internet bundle problem during the interview. The major issue was the fact that it was very expensive to purchase data bundle, and therefore making the online course very expensive.

From the student participants' account, it was revealed that buying data bundle for the online courses was a major challenge for students. This is captured in the excerpts below:

"...we all make use of internet bundle during the online lecturers and we all complain that downloading audio and PowerPoint documents were draining all our monies. We were told that accessing materials on the LMS was free but we were not experiencing any free internet data. We tried to convince the SRC president to lure the university to purchase us monthly internet data but all our effort were fruitless." (ST 2).

"I never visited the LMS, I was relying on friends [colleagues] for materials because I don't see why two of us should be downloading the same documents with internet bundle." (ST 4).

Similarly, lecturers' interview also revealed that buying data bundle to engage students online poses a challenge to them. One of the lecturer participants commented that:

"I was buying internet bundle a lot each time I visited the LMS and telegram to upload my documents. This is because I was far away from campus where I could not get internet for free" (LT 1).

Another respondent also remarked:

"I could buy GH¢20 data and all would be used up by close of day. This is mostly as a result of bad and unstable internet connectivity and really got me cash trapped along. I resolved not to miss any lesson but couldn't carry this resolution through because of the financial toll of data cost." [LT 3]

Problems with devices such as phones and lap top also emerged as a major challenge of online teaching and learning of Mathematics through the interview. It was evident from the student interview that, most of the students were using their phones for the Mathematics class. The following excerpt depicts this claim:

"I don't have a laptop [computer], so I use my phone for the online Mathematics classes. Sometimes, people will be calling will you are having online discussion. This made the learning a bit difficult." (ST 3).

One student also recounted:

"...My phone could not display PDF and PowerPoint document, so I took my sister phone for the course. She was always on my neck for her phone. Almost all my colleagues' uses phone for the online class" (ST 5).

Another respondent also recounted:

"I was okay because I had a brand-new laptop [computer] and I was

> *using it purposely for the online class." (ST 1).*

Lecturers who were interviewed also disclosed that they encounter challenges anytime they use their phones to instruct online. This is captured by the below excerpt:

> *"I used laptop [computer] but sometime, when the light goes off I used my phone. There were a lot of interruption each time I used my phone for class." (LT 2).*

Lastly, it was revealed through an interview that lecturers were seriously challenged with using online audio and lecture notes to explain certain topics with needed both audio-visual presentations. This is evident in the following excerpts:

> *"One of our major challenges was teaching some mathematics topics through audio presentations and notes. This is because we needed to perform examples for students to see in class and to also guide them to do same. This would have helps them to acquire that skill but here is the case that we were strictly limited to audio recording of topics and lecture notes." (LT 3).*

Another lecturer added that:

> *"It was not easy teaching some topics, at a point we wanted to skip those topics. We did our best by giving detailed information on those topics and also, constantly advising students to take those topics very serious." (LT 2).*

The general impression of students and lecturers concerning the online teaching and learning Mathematics was ascertained through interview.

An interview with the student participants revealed that they were not fully prepared for online instruction in spite of the introduction of LMS. This is captured in the excerpt below:

> *"Even though the COVID-19 emergency online teaching and learning of Mathematics was a prudent initiative which helped to complete the semester successfully, both student and teacher were not fully prepared for some Mathematics online lesson." (ST 1).*

It was also commented by one of the student participants that:

> *"I would want to commend the management of UEW for introducing LMS during COVID-19 period to enable us to complete the semester, but will suggest that if we will still use this means to complete the outstanding semester, they should make provision for smartphone and internet bundle for all of us to enhance the online learning." (ST 4).*

Another respondent also remarked:

> *"Mathematics is a course, so teaching it online without any visual impression made understanding of the some of the topics very difficult, so better ways of teaching Mathematics online should be used going forward." (ST 2).*

Lecturers in an interview also shared their views that university management should support with proper strategies to improve teaching and learning of Mathematics online. This is depicted in the comment made by one of the lecturer respondents below:

> *"We understand the global challenge COVID-19 has presented, however, proper strategies should be implemented to improve teaching and learning of Mathematics online. For instance, the use of Zoom, Google meeting etc. can help improve teaching and learning Mathematics*

courses since it requires audio and visual means of teaching. But, the online teaching of Mathematics has not been totally bad." (LT 1).

Discussions

Undoubtedly, the spillover effects due to COVID-19 is now observed in university education, stemming largely from partial closedown of schools in Ghana. As a result of this closure, management of the University of Education, Winneba like many other reputable tertiary institutions, many countries have turned to e-Learning system as a means of mitigating for lost instructional time in continuing education programmes. Consequently, mathematics lecturers have now taken their instructions online where they prepare online content and offer online classes to students as it was revealed from the findings of the study that students are engaged through UEW-LMS, WhatsApp and Telegram platforms. This was revealed from the study when respondents disclosed that mathematics contents were captured in the form of PowerPoint, and PDF file which were uploaded on the LMS, WhatsApp or Telegram platforms with recorded audio or video that explains the lecture notes. This was confirmed by Washburn (2003) study which found seventy-eight percent of the respondents having their online course management system housed on their own institution's server. Most institutions were found of using WebCT or Blackboard as the course management system to develop and deliver online courses. Courses were structured in a variety of ways to support online learning at IVC institutions.

Nevertheless, familiarity with these e-Learning tools seem to be driving successes (and challenges) of delivering learning effectively. This corroborates the findings from the study which revealed that, most students including some lecturers were not fully prepared for online instruction in spite of the introduction of LMS. Kearns (2012) noted that, both teachers and students are usually uncertain about the procedure for assessing teaching and learning online as they have to change the assessment types to fit online mode. Although, online teaching is not a new mode of delivery for many lecturers at the universities (Sahu, 2020), there is always a tendency that some teachers will not be able to cope up with this new mode of teaching.

Among the study findings, it was revealed that students had as part of their online mathematics courses a complete list of required and recommended learning and reference materials. The nature of online instruction is such that online instructors need to engage their students, which can be accomplished by utilizing emails and online discussion boards, responding promptly to discussion questions, encouraging students to share their backgrounds and work experiences, and conducting meaningful small group projects. In order to achieve these objectives, Bailey and Card (2009) argue that, online instructors should well organize courses such that students are given all course materials at the beginning of the class, provide direct links to the necessary websites and resources, and clearly inform students about how to navigate the university website to successfully complete the course. This supports the findings from the study which revealed that students were given assignment to be submitted online within a given time-frame. However, the students' marked scripts from the assignments and tests conducted were not returned promptly.

The findings from the study showed that, students who took mathematics courses online were provided with some form of assistance by the librarian or learning resource personnel to access online material and resources. This is consistent with the Washburn's (2003) findings that technical assistance were offered students who were engaged in online learning in IVC throughout the duration of the

course/program, and that a system was put in place to address student complaints. Library resources in the institutions were made available to students, and they were provided with supplemental course information to assist in completing online courses. Again, it was found that students were provided with off-campus learning centres but these centres were not appropriately equipped. This corroborates Washburn's (2003) findings which revealed that colleges and universities sometimes utilize IVC Student Support Centers. However, they were not the principal means for evaluating student performance.

Research has shown that some online learning gadgets could efficiently access online LMS. From the study findings, it was discovered that students and lecturers often encounter challenges with the use of their phones to engage instruction online. There is therefore the need for UEW management to emphasize on tools that are compatible with smartphones as they might be more widely available to both students and lecturers. Also, the quest of universities to make amends for the lost instructional time with students through e-Learning, there is always the difficulty in reaching all students equally. From the study, it was found out that most students live in the towns and villages where is it sometimes difficult to get access to good internet services. This means that those who live in the communities where there is no proper internet connectivity may quite often lost some valuable instructional hours especially in the synchronous sections as result. This would clearly disadvantage these students while participating in the evaluation process, which would adversely affect their grade point averages (GPAs) at the end of the day (Alruwais, Wills, & Wald, 2018). And this will ultimately have adverse effects on the quality of teaching and learning of mathematics at the university.

Conclusions and recommendations

As e-learning is gaining prominence in the world due to the presence and impact of the novel coronavirus, teaching and learning of Mathematics is going to be done using the e-learning system very often. The study concludes that both social media and university learning management system (e-Learning) platforms are used in teaching and learning by the University of Education, Winneba in Ghana due to the partial closedown of universities due to COVID-19. However, it presents to us the challenge of preparing pedagogical and content materials in a structured way such that it could capture the interest of all students. Moreover, the study concludes that among the challenges facing students and lecturers in the online teaching and learning of Mathematics include: high cost of internet data bundle, unreliable internet connection, unfamiliarity with some online platforms, difficulty in accessing some online platforms using smartphones, and difficulty in teaching some topics online.

In addressing the issue of finding difficulty in teaching some topics online, we recommend the University's Management to partner with agencies that host learning resources platforms to provide mathematics contents to help students explore. Also in the study, both students and lecturers expressed their displeasure about the cost of purchasing data bundle to partake in online mathematics courses. On this note, we recommend that University's Management commences discussions on the uses of smartphones with telecom providers to allow zero charges for content downloaded the university's learning sites. Moreover, it was found out that the off-campus learning centres meant for students were not appropriately equipped. Therefore, it is recommended that university management should adequately equip these learning centres

and create support communities among teachers and students to share knowledge.

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