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Evaluating the Media Platforms, Devices and Challenges Associated with Online Teaching and Learning of Mathematics during the COVID-19 Pandemic

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Abstract

The study investigates the usage of online educational media platforms and devices used to access online Mathematics learning. It also identifies the challenges Mathematics pre-service teachers encountered in teaching and learning of Mathematics during the COVID-19 pandemic in the Northern Region of Ghana. The research design was descriptive cross-sectional survey with a sample of 345 Mathematics pre-service teachers selected from four (4) Colleges of Education in the Northern Region via simple random and purposive sampling techniques. Close ended questionnaire was developed by the researchers via Google forms and used as the main research instrument. Data were collected via a link sent through WhatsApp and Telegram to the pre–service teachers. The results revealed that Zoom, Telegram, WhatsApp, and Google Classrooms were the mostly used online learning platforms. Again, the devices used were desktop computers, laptops, tablets, iPads, with smartphones being the most commonly device used. The results further indicated that most challenges were; high cost of internet data subscription, lack of smart device due to its high cost, poor internet services in remote areas, pre-service teachers not seeing their lecturers face-to-face for more active interaction and real time feedback, inadequate electricity supplies to keep device always charged before online lectures and the issue of eye straining. It was recommended that Government should assist tertiary institutions with internet facilities to improve access to online learning and teaching of Mathematics.

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1 Introduction

Since 1990s, the world has witnessed significant influence of technology in education. An example is the implementation of online learning across different learning environments such as residential or remotely across the world. Since the outbreak of the COVID-19 pandemic, teachers and students gradually adopted e-learning, where teachers deliver lessons that are interactive, share resources, enhance student collaboration and interaction [1]. Barrot [2] indicated that online learning has since long been acknowledged for its efficacy. However, Boelens et al. [3] and Rasheed et al. [4] indicated that implementation challenges of online learning continue to build up.

World Health Organization (WHO) [5] on 12th March, 2020, officially declared COVID-19 as global pandemic. As a result of this declaration, educational institutions throughout the world were either closed or observing certain restrictions. COVID-19 pandemic has affected the educational systems throughout the world. For instance in Ghana, the president on 15th March, 2020, gave a directive on the closure of first and second cycle schools with effect from 16th March, 2020. This meant that, administrators of these institutions must employ strategies to ensure continuous teaching and learning during this period. One of such strategies was to quickly shift their mode of delivery from conventional (face-to-face) learning to online learning as it is believed to be a more flexible approach to teaching and learning [6]. Agbele and Oyelade [7] opined that, e-learning offers a platform for teachers to teach from anywhere, at any time and by any means, where both the student and teacher can connect computer/mobile phone to a network or radio/television. As researchers, we also think that e-learning is a means of delivering lessons where students and teachers use their home computers and phones to connect to the internet for exchange of both conceptual and procedural knowledge. For e-learning to be effective teachers and students may need to download and install educational platforms such as Zoom, Facebook/Twitter, YouTube/Skype, Telegram and Google meeting among others to promote efficient e-learning. Mukhtar et al. [8] indicated that e-learning encompasses the use of advanced technology to direct, design and deliver learning content, as it encourages two-way communication between students and faculty. They further opined that e-learning encompasses features such as whiteboards, chat rooms, polls, quizzes, discussion forums and surveys that permit teachers and learners to communicate online and share course content side by side.

There are several benefits of e-learning in the educational sector for both the teacher and the learner. For instance, Adeoye et al. [9] reported that the benefits of the e-learning in education comprise of quality content delivery, interactivity, and building confidence of teacher and learners. The authors went further to indicate that e-learning allows students to study at their own pace and at a convenient time since the learning material is readily available and quite accessible to the learner at all times. Also, Eduard and Lucian [10] indicated that e-learning is transmits and skills to learners via innovative platform. They further listed its benefits which include, least cost, time saving, wider coverage, promotion of team and collaborative learning. Currently, social media platforms provides an easy access for student engagement, independent and collaborative learning. Ansari and Ali Khan [11] indicated that there are advantages and challenges in the use of social media and mobile devices. Some of the benefits are, accessing course contents, video clip, transfer of the instructional notes etc. For us as researchers we also feel that social media and mobile devices are less costly and suitable tools for receiving significant information.

Most countries globally such as United States, Germany, India, Nigeria, Kenya, Saudi Arabia, Norway, Morocco, Jordan, Pakistan, Spain, Oman, United Arab Emirates, China and Ghana adopted online teaching that used both asynchronous and synchronous. In asynchronous learning, students can communicate and complete activities at their own time and pace while synchronous learning activities occurred through live video and/or audio with immediate feedback [12]. To ensure that no student was disadvantaged in Ghana, first and second cycle schools had asynchronous lessons through TV channels such as Joy TV and Ghana Learning TV in different subject areas.

2 The Situation in Ghanaian Colleges of Education

16th of March, 2020, was scheduled for Colleges of Education in Ghana to resume academic work for the second semester of the 2019/2020 academic year. As a result of the COVID-19 pandemic, Colleges had to

switch to online teaching and learning. The National Council for Tertiary Education, (NCTE) now Ghana Tertiary Education Commission (GTEC) in collaboration with Transforming Teacher Education and Learning in Ghana (T-TEL) instituted a task force which included all the five mentoring universities, and Principals of Colleges of Education whose purpose was to meet regularly to ensure that teaching and learning continued through online until the COVID-19 pandemic restrictions are lifted and Colleges of Education re-open [13]. This led the Colleges of Education to also employ asynchronous and synchronous. For the asynchronous, course materials and pre-recorded lecture videos were made available to the pre-service teachers. This was made possible through the distribution of subsidized smart phones which had learning material imbedded in the phones through the efforts of T-TEL. T-TEL also encouraged tertiary institutions to use online educational platforms such as Zoom, Facebook/Twitter, YouTube/Skype, Telegram, Google meet, Google Classroom, WhatsApp groups, Microsoft teams to deliver online teaching and learning during the COVID-19 pandemic. The outbreak of the COVID-19 pandemic necessitated the Colleges of Education to implement online teaching using essential media tools for learning mentioned above.

3 Literature Review

Lately, there has been a lot of studies concerning the new normal in the educational sector. Although several studies concentrated on national policies, professional development, and curriculum, others restricted their studies to learning experience of students during the COVID-19 pandemic. Among these are Gichuhi et al. [14] whose purpose among others was to investigate the use of social media on content delivery in higher education in Kenya. The sample used (150 students and 20 lecturers) revealed that 73% used WhatsApp to receive and 96.0% used it to send educational content, 22.0% and 5.0% of the students used YouTube and Facebook respectively to receive educational content. Similarly, Agormedah et al. [15] used descriptive survey design with 467 students to explore students' response to online learning in higher education in Ghana indicated that students used the following devices; (76.7%) used Smart phone, 1.3% used Desktop, 8.6% used Laptop, 0.2% used Tablet/iPad to learn during the COVID-19 pandemic online learning. The results further indicated that students used these online media platforms such as Facebook/Twitter, YouTube/Skype, Zoom and Google meeting for learning during the COVID-19 pandemic. Also, Ogbonnaya et al. [16] used descriptive survey research design and focused on the pre-service teachers' preparedness for online learning in terms of their digital literacy and technological devices used for online learning, their positive online learning experiences, and the challenges they encountered learning online during the COVID-19 restrictions. The study results revealed that the pre-service teachers used multiple devices but 92% used smartphones, 51% used laptops, 7% used tablets and 3% used a desktop computer from a sample of 147. The results further indicated that poor internet connectivity, the high cost of data, erratic power supply, lack of appropriate devices, inability to effectively manage their time, and family interruptions were some of the challenges during the COVID-19 pandemic online learning. Again, 49% used both the Zoom and Sakai learning management systems, 27% used WhatsApp, last but not the least 5% used Screencast, Google meet, and Google classroom during the study. Furthermore, Elfirdoussi et al. [17] used a quantitative case study whose purpose was to find out the limitations faced by professors and students when using e-learning platforms. The sample used was 3037 students and 231 professors from 15 Universities in Morocco. From the results, 66.8% used Personal computers and laptops, 66% used smartphones, 3.4% used television, 2.8% used tablets and 1.6% did not use any device during the COVID-19 pandemic online learning. The results further indicated that 54.7% used Moodle, 48.8% used Microsoft Teams, 23.9% used Zoom, 15.9% used Google Classroom and 17.4% used YouTube channels or others. More recently, Ujunwa [18] purpose was on challenges of e-learning during COVID-19 pandemic in Colleges of Education in south east states, Nigeria. The results showed that the challenges of e-learning during COVID-19 pandemic were epileptic power supply, high cost of procurement of electronic devices, high cost of maintenance of ICT equipment for e-learning, poor internet connectivity, shortages of relevant software, low level of incentive to lecturers, low level of student accessibility to internet facilities, poor technical support from management and high cost of data bundle to connect e-learning platform when descriptive survey design was adopted with 437 lecturers used as the sample.

4 Statement of the Problem

Currently, the educational system globally has encountered an unprecedented shake up in its foundation as a result of the Corona Virus. To militate against the adverse impact of the Corona Virus pandemic on education, governments throughout the world including the government of Ghana launched crisis response strategies which

includes; curriculum revisions, provision of technological resources, revisions in academic calendar, online instructional delivery and assessment. These strategies forced educational institutions to migrate to online teaching and learning. Per the uncertainties today, it is very crucial to gain a deeper understanding of students' online learning experience during the COVID-19 pandemic.

There are a lot of studies abroad that looked at online learning and teaching during the Covid -19 pandemic, notably among them are Mahyoob [19] that investigated learners challenges of e-Learning during the COVID-19 Pandemic in Saudi Arabia, Goto and Munyai [20] looked at the acceptance and use of Online learning by Law students in a South African University. Also, Mukhtar et al. [8] studied the advantages, limitations and recommendations for online learning during COVID-19 pandemic era in University of Lahore in Pakistan. Furthermore, Almendingen et al. [21] investigated student's experiences with online teaching following COVID-19 lockdown in Norway. Again, Aduba and Mayowa-Adebara [22] looked at online platforms used for teaching and learning during the covid-19 pandemic era. Finally, Wu [23] conducted a study into how teachers conduct online teaching during the covid-19 pandemic.

However, there are limited studies in Ghana with respect to COVID-19 online teaching and learning. The few studies by Gyampoh et al. [24] concentrated on tutors from Eastern and Greater Accra Regions. Also, Ogbonnaya et al. [16] used Pre–Service teachers from University of Ghana. Furthermore, Owusu-Fordjour et al. [25] used second cycle schools and tertiary institutions while Agormedah et al. [15] used undergraduate students from University of Cape Coast. Lastly, in Aboagye [26] participants were College of Education tutors. From the above analysis, the gaps are that, there is no single study on online teaching and learning in Northern Region of Ghana. Also, there is only one study that involved Pre-service teachers in the Colleges of Education. Furthermore, all the numerous studies captured above both abroad and Ghana did not involve Mathematics pre-service teachers. To fill these gaps, the present study will use Mathematics pre-service teachers from the four (4) Colleges of Education in the Northern Region to conduct this study which is titled evaluating the media platforms, devices and challenges associated with online teaching and learning of Mathematics during the COVID-19 pandemic in Northern Region of Ghana.

5 Purpose of the Study

The purpose of this present study is to examine online educational media platforms and devices used to access online learning of Mathematics. It is also to identify the challenges Mathematics pre-service teachers encountered in teaching and learning of Mathematics during the COVID-19 pandemic in Northern Region of Ghana.

6 Research Questions

The study explores the following three research question:

1. What are the educational media or platforms used by Mathematics Pre-service teachers during the COVID-19 pandemic online learning?
2. What are the devices used by Mathematics Pre-service teachers during the COVID-19 pandemic online learning?
3. What challenges did the Mathematics Pre-service teachers encounter during the COVID-19 pandemic online learning?

7. Methodology

7.1 Research design

The research design for this study was descriptive cross-sectional survey with the main aim of obtaining answers to a series of items which were adequately organized for administering using purely quantitative research approach.

7.2 Population, sample size and sampling procedure

The population for the study was all Mathematics pre-service teachers in Colleges of Education in Northern Region of Ghana. The research used simple random and purposive sampling. Cohen et al. [27] indicated that simple random sampling enables researchers to ensure that all respondents have equal chance of being selected for a study. Purposive sampling was used because the study targeted Mathematics pre-service teachers. A sample of 345 Mathematics pre-service teachers were selected from the following Colleges of Education in Northern Region; Evangelical Presbyterian (E.P.) College of Education, Bimbilla, Tamale College of Education, Bagabaga College of Education, and St. Vincent College of Education. The sample constituted 21.7% females while 78.3% was made up of males. The modal age range was 21-25 years, most participants were from level 400.

7.3 Research instrument

Close ended questionnaire was developed by the researchers in line with the research questions and used as the main research instrument in collecting the data for the study. The questionnaire was divided into four (4) parts as follows; (i) demographic data (ii) types of educational media/online platforms (iii) types of devices used for online learning and (iv) challenges encountered during the online teaching and learning. The Likert scale for research questions 1 used "not utilized" and "utilized" as the main options. Research questions 2 also used two options which were "used" and "did not use". Research question 3 used Strongly Disagree -1, Disagree-2, Agree-3 and Strongly Agree-4 as four point response options. Likert scale is the most used techniques to measure studies on descriptive survey. The questionnaire was designed by the researchers using Google forms.

7.4 Validity and reliability

The questionnaire was subjected to face validation. To ensure this, the researcher presented a copy of the questionnaire with the title, purpose of the study and the research questions to two experts who are experienced tutors in Mathematics education. The experts' suggestions were taken into consideration which helped the researchers to produce the final copy of the questionnaire after revision and amendments based on their comments. The internal consistency of the items yielded Cronbach alpha coefficient of 0.81 after a pilot study.

7.5 Data collection

Data were collected using an online survey questionnaire developed with Google forms which was sent to the Mathematics pre-service teachers via a shortened version of the URL through WhatsApp and Telegram by the researchers to the four Colleges of Education. Two weeks was used to collect the data. Mathematics pre-service teachers who submitted incomplete demographic data were deleted before the analysis.

7.6 Data analysis

Quantitative method of data analysis was employed in this study. Research questions 1 and 2, were analyzed using frequency and percentages with pie chart and histogram respectively. Research questions 3 used frequency, mean and standard deviation via data generated from SPSS version 22. For research question 1, any statement or item below 50% was considered "not utilized" and any statement with percentage of at least 50% was regarded as "utilized". For research question 2, simple frequency and percentages used to analyze the data. For research question 3, a four–point response option of Strongly Agree (SA-3.50-4.49), Agree (A-2.50-3.49), Disagree (D-1.50-2.49) and Strongly Disagree (SD-0.00-1.49) was used in rating the responses to the questionnaire items. Any item with a mean response value of 0.00-2.49 was regarded as Disagree, while items with a mean response value of 2.50 and above was regarded as Agree.

8 Results and Discussion

This section presents the descriptive statistics of the demographic data of respondents, results, interpretation and discussion of the findings in relations to the research questions that were formulated.

Table 1. Descriptive statistics of the demographic data of respondents

Gender	**Number**	**Percent**
Female	75	21.7
Male	270	78.3
Total	**345**	**100**
Age	**Number**	**Percent**
15-20	16	4.6
21-25	251	72.8
26-30	67	19.4
31-35	7	2.0
36-39	2	0.6
Above 40	2	0.6
Total	**345**	**100**
College	**Number**	**Percent**
Tamale College of Education	100	28.98
Bagabaga College of Education	87	25.21
E.P. College of Education, Bimbilla	124	35.94
St. Vincent College of Education	34	9.87
Total	**345**	**100.0**
Level in College of Education	**Number**	**Percent**
Level 300	172	49.86
Level 400	173	50.14
Total	**345**	**100**

From Table 1, out of the 345 respondents, 270 (78.3 %) were males and 75 (21.7 %) were females. The modal age group was between 20-25 years constituting 251 (72.8%) of the respondents. Majority (35.94 %) of the participants were from E.P. College of Education, Bimbilla, followed by Tamale College of Education, with 25.21%. Respondents with respect to levels were as follows; level 300 was 172 (49.86%) while level 400 constituted 173 (50.14%).

8.1 Research question 1: What are the educational media or platforms used by Mathematics Pre-service teachers during the COVID-19 pandemic online learning?

Table 2. Frequency and percentage of responses on the educational media or platforms used by Mathematics pre-service teachers during the COVID-19 pandemic

S/No.	**Media platform**	**Frequency**	**Percent**	**Response**	**Decision**
1	Google Hangouts	53	15.4	Utilized	
		292	84.6	Not utilized	Not utilized
2	Google Classroom	282	81.7	Utilized	
		63	18.3	Not utilized	**Utilized**
3	Google Meet	49	14.2	Utilized	
		296	85.8	Not utilized	Not utilized
4	WhatsApp	307	89.0	Utilized	
		38	11.0	Not utilized	**Utilized**
5	Skype	11	3.2	Utilized	
		334	96.8	Not utilized	Not utilized
6	Microsoft Teams	44	12.8	Utilized	
		301	87.2	Not utilized	Not utilized
7	Zoom	188	54.5	Utilized	
		157	45.5	Not utilized	**Utilized**
8	Facebook	40	11.6	Utilized	
		305	88.4	Not utilized	Not utilized
9	Interactive Whiteboard	53	15.4	Utilized	
		292	84.6	Not utilized	Not utilized
10	Moodle	42	12.2	Utilized	

S/No.	Media platform	Frequency	Percent	Response	Decision
		303	87.8	Not utilized	Not utilized
11	Voice over PowerPoint	116	33.6	Utilized	
		229	66.4	Not utilized	Not utilized
12	YouTube	57	16.5	Utilized	
		288	83.5	Not utilized	Not utilized
13	Telegram	279	80.9	Utilized	
		66	19.1	Not utilized	**Utilized**
14	Edmondo	22	6.4	Utilized	
		323	93.6	Not utilized	Not utilized

From the Table 2 above, it can be seen that, the top four platforms that were mostly utilized during the COVID-19 pandemic online learning were Google Classroom, WhatsApp, Zoom and Telegram. A total of 282 respondents representing 81.7% agreed to use Google Classroom platform for learning Mathematics. Again, 307 (89.0%) respondents used WhatsApp to learn Mathematics during the COVID-19 pandemic. Zoom was another online platform that was used to learn Mathematics during the pandemic with 188 (54.5%) of the respondents asserting to it. Telegram usage was at 80.9% which represents a frequency of 279 of the respondents. The data show that WhatsApp was the popular App and platform that was used in the learning process by the Mathematics pre-service teachers in the Colleges of Education in the Northern Region of Ghana during the COVID-19 pandemic. This is due to the fact that, WhatsApp is commonly used as the medium of communication and a medium of accessing information and almost all the Mathematics pre-service teachers have the app installed on their smart phones. A higher percentage of the students used smartphones and it was seen in the data that gathered from the respondents as the app stood out tall among the others in percentage-wise. Telegram was the next most popular platform that was used among the Mathematics pre-service teachers. This is because it is easily accessible and common among the Mathematics pre-service teachers and was used by tutors to send information. Course materials are sometimes kept on the platform for the Mathematics pre-service teachers to download and read. It is obvious from the data that, the educational media platforms that were used by these Mathematics pre-service teachers in the pandemic to carryout teaching and learning of Mathematics mostly fell within the bracket of Zoom, Telegram, WhatsApp and Google Classroom. This finding tallies with studies done by Gichuhi et al. [14] who found that; 73% and 96.0% of students used WhatsApp to receive and send educational content respectively, 22.0% and 5.0% of the students used YouTube and Facebook respectively to receive educational content in Kenya. This study results also agrees with a study done by Agormedah et al. [15] who found that students used online media platforms such as Facebook/Twitter, YouTube/Skype, Zoom and Google meeting for learning during the COVID-19 pandemic. Also, the current study corroborates with the study done by Elfirdoussi et al. [17] where 23.9 % used Zoom, 15.9 % used Google Classroom and 17% of the respondents asserted to using other online learning platforms such as Microsoft Teams and YouTube channels for online learning during the COVID-19 pandemic in some selected Moroccan Universities. Fig. 1 is a graphical representation of the utilized and not utilized media platforms.

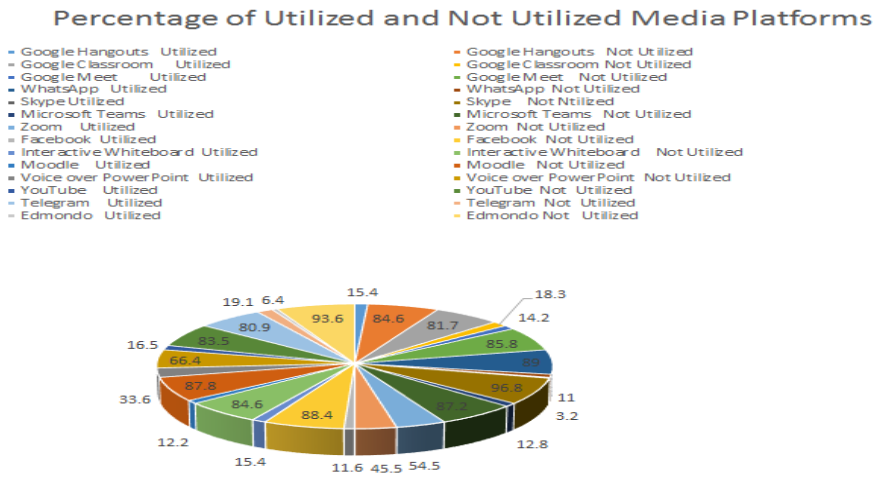

Fig. 1. Percentage of utilized and not utilized media platforms

8.2 Research question 2: What are the devices used by Mathematics Pre-service teachers during the COVID-19 pandemic online learning?

Table 3. Frequency and percentage of responses on devices used by Mathematics pre-service teachers during the COVID-19 pandemic

S/No.	Device	Decision	Frequency	Percent
1	Desktop	Used	22	7.3
		Did not use	279	92.7
2	Laptop	Used	246	79.4
		Did not use	64	20.6
3	Tablet	Used	19	6.3
		Did not use	283	93.7
4	iPad	Used	8	2.7
		Did not use	288	97.3
5	Smartphone	Used	334	97.7
		Did not use	8	2.3

The research question 2 of the current study sought to elicit from the Mathematics pre-service teachers on the devices that were used for teaching and learning during the COVID-19 pandemic. The results here are analyzed based on the most used device in descending order in terms of percentages. From Table 3, 334 (97.7%) of the Mathematics pre-service teachers agreed that they used smartphones to learn Mathematics during the COVID-19 pandemic. The second most used device was the laptop as 246 (79.4%) used it to access teaching and learning of Mathematics during the COVID-19 pandemic. Desktop computers were the next device with 22 (7.3%) usage. The next device that was used in the teaching and learning of Mathematics process during the pandemic was Tablets with 19 (6.3%) respondents. The least used device from the data gathered shows that, it is the iPad with only 8 (2.7%). This could be among other reasons for being expensive and not easy to afford by the pre-service teachers. The findings from the data gathered on the question of devices used by the Mathematics pre-service teachers during the COVID-19 pandemic agrees with Elfirdoussi et al. [17]. They reported that 66.8% used Personal computers and laptops, 66% used smartphones, 3.4% used television, and 2.8% used tablets during the COVID-19 pandemic online learning. This study also concur with Agormedah et al. [15] which indicated that 76.7% of students used Smart phone, 1.3% used Desktop, 8.6% used Laptop, 0.2% used Tablet/iPad to learn during the COVID-19 pandemic online learning. Also, this study corroborates with Ogbonnaya et al. [16] which indicated that majority of students used smart phones and a few used Tablets and computers. Fig. 2 below is a graphical representation of the Used and did not use devices.

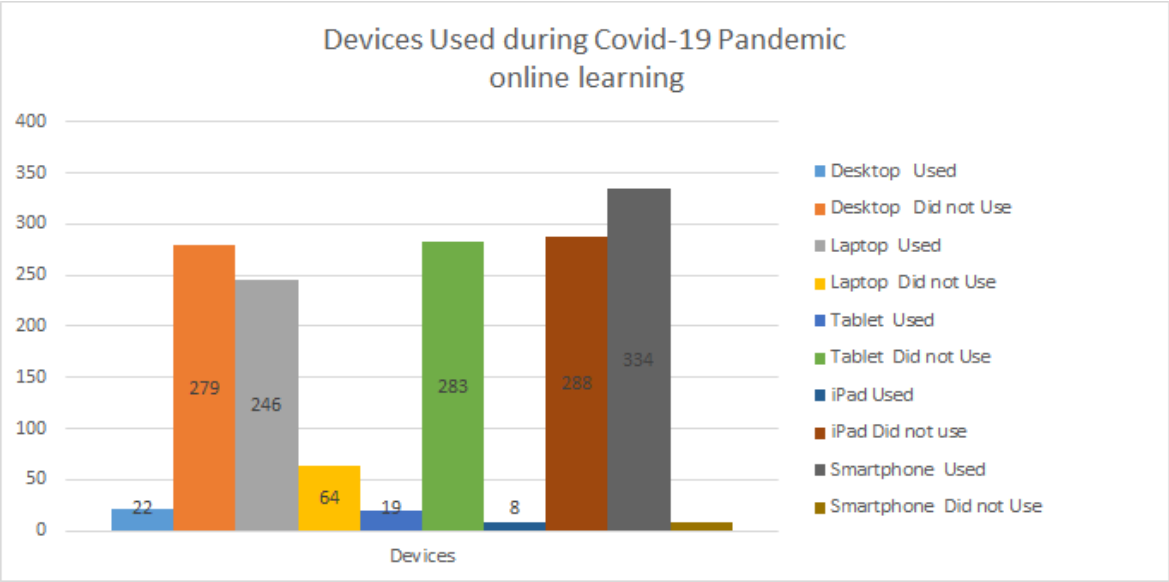

Fig. 2. Device used and not used during covid-19 pandemic online learning

8.3 Research question 3: What challenges did the Mathematics Pre-service teachers encounter during the COVID-19 pandemic online learning?

Table 4. Mean rating of the challenges by Mathematics pre-service teachers during the COVID-19 pandemic

S/No.	Statement	N	Mean	Standard deviation	Decision
1	I feel emotionally disconnected or isolated during online class	345	2.46	.938	Disagree
2	High cost of data for internet subscription is a big problem	345	3.68	.734	Agree
3	Poor internet services in remote areas	345	3.65	.717	Agree
4	Inadequate electricity supplies to keep device always charged before lectures	345	3.10	.922	Agree
5	Lack of smart device (phone, Laptop, tablet) due to high cost	345	3.33	.807	Agree
6	Technical issues like poor internet connectivity and signals causing interruption during classes	345	3.48	.763	Agree
7	Lack of motivation for independent learning	345	3.04	.885	Agree
8	Classes were not interactive	345	3.00	.905	Agree
9	I missed seeing my lectures face -to- face during lectures	345	3.21	.881	Agree
10	Online Examination was easy	345	2.60	.063	Disagree
11	low level of incentive to lecturers	345	2.97	.826	Agree
12	Resistance to change among lecturers and students	345	2.90	.777	Agree
13	Poor level of lecturers' readiness to adopt e-learning	345	2.99	.905	Agree
14	Insufficient skills among lecturers to use the digital platforms	345	3.02	.918	Agree
15	There is no eye straining during online learning	345	2.49	.813	Disagree
	Grand Mean		**3.056**	**0.790**	**Agree**

Research question 3 was seeking to find out the various challenges that were encountered by the Mathematics pre-service teachers during the COVID-19 pandemic. From Table 4, it was realized that the Mathematics pre-service teachers agree to 12 items which are all above a mean of 2.49. They also disagree on 3 items (1, 10 and 15) which produced a mean of 2.49 each. The key challenges were; high cost of internet data subscription, lack of smart device due to its high cost, poor internet services in remote areas, technical issues like poor internet connectivity and signals causing interruptions during classes with mean scores of 3.68, 3.33, 3.65 and 3.48 respectively. The rest of the challenges were; pre-service teachers not seeing their lecturers face-to-face for more active interaction and feedback with a mean of 3.21, inadequate electricity supplies to keep device always charged before lectures with a mean of 3.10 and the issue of eye straining by pre-service teachers with a mean score of 2.49. The overall standard deviation score of 0.790 indicated that there is homogeneity among their responses. The grand mean score of 3.056 is far above the mean score of 2.49 and this indicated agreement that there are many challenges of E-learning during COVID-19 pandemic in Colleges of Education in Northern Region of Ghana.

The findings of this study is consistent with that of Ujunwa [18] who also found challenges of e-learning during COVID-19 pandemic in Colleges of Education in Nigeria as follows; intermittent cuts in power supply, high cost of procurement for electronic devices, high cost of maintenance for ICT equipment for e-learning, poor internet connectivity, poor technical support and high cost of data bundle. Furthermore, the findings from this study also concur with that of Ogbonnaya et al. [16] which indicated that poor internet connectivity, the high cost of data, erratic power supply, lack of appropriate devices, inability to effectively manage their time, and family interruptions were the challenges for online learning during COVID-19 pandemic.

9 Implication of the Findings

Some of the practical implications of these findings are that if the Mathematics pre-service teachers have (1) the devices, (2) are able to use the devices for the various online media platforms, and (3) when online learning and teaching challenges are addressed, then the Mathematics pre-service teachers will benefit from quality Mathematics online content delivery, interactivity, and build their confidence. Also, Mathematics pre-service

teachers will have the opportunity to speed up or slow down as and when they learn mathematics online. That is, it will allow the Mathematics pre-service teachers to study at their own pace and at their convenient time since the lecture material is readily available and quite accessible to them at all times. Furthermore, transmission of knowledge and skills to the Mathematics pre-service teachers via innovative platforms will be enhanced, because it is less costly, time saving, and has a wider coverage. It also promotes team and collaborative online learning. This will further provide an easy access for Mathematics pre-service teachers engagement, independent and easy accessibility of course contents, video clip, transfer of the instructional notes much easier which will results in enhance performance in mathematics. Also, pre-services teachers will be able to download extra mathematics learning material online for their personal development from trusted websites. Lastly, pre-service teachers will enjoy flexibility of access to online and travel cost for mathematics lectures will be eliminated.

10 Conclusion

From the results, the following conclusions were made;

Beginning with the issue of the educational media platforms that were used by the Mathematics pre-service teachers during the COVID-19 pandemic, it was evident that Zoom, Telegram, WhatsApp, and Google Classrooms were the mostly used online platforms. Others that were not used greatly were Google Hangouts, Google Meet, Skype, Microsoft Teams, and Facebook.

Secondly, the most common devices that were used by the Mathematics pre-service teachers during the COVID-19 pandemic lockdown included Desktop computer, laptops, tablets, iPads and smartphones. However, smartphone and laptops were the most common device used for the online teaching and learning of Mathematics during the COVID-19 pandemic.

Last but not least, key among the challenges that were encountered by the Mathematics pre-service teachers in learning Mathematics online were; high cost of internet data subscription, lack of smart device due to its high cost, poor internet services in remote areas, technical issues like poor internet connectivity and signals causing interruptions during online lessons. The rest of the challenges were; pre-service teachers not seeing their lecturers face-to-face for more active interaction and real time feedback, inadequate electricity supplies to keep device always charged before lectures and the issue of eye straining by the Mathematics pre-service teachers.

11 Recommendations

Based on the findings of the study, the following recommendations were made.

Firstly, Governments across the world, should ensure constant and regular electricity supply to institutions of higher learning most especially, in Ghana. Secondly, Government should establish e-learning centers across the country for regular in-service training of mathematics teachers as well as regular training of students on the usefulness and know–how of these online media platforms and devices with dedicated IT specialist to swiftly provide routine assistance and support to students and teachers. This will enable the ease of usage in case there is an unforeseen pandemic again. Thirdly, Governments all over the globe especially Ghana should liaise with telecommunication companies to subsidize; the cost of high speed internet access and broadband services, as well as devices such as iPad, laptops, smartphones and tablets for student to be able to purchase through their institutions. Furthermore, short courses addressing the usage of online learning management systems: Zoom, Google Classroom, Edmodo, etc. should be added to the school's curriculum. Last but not least, the current curriculum for Colleges of Education should be revised to include components of both conventional and online learning approaches at Colleges of Education so that a change in pedagogy in case of any global pandemic teaching and learning would not be affected. This will help tutors and students to familiarize themselves with online pedagogical models to enhance teaching and learning.

12 Study Limitations and Strengths

One of the limitations of this study was the method of data collection. This is because it exclusively focused on Mathematics pre-service teachers with internet connection. Hence, Mathematics pre-service teachers who lived

in districts without access to the internet may have been omitted. Also, due to lack of interest, some Mathematics pre-service teachers involved in online learning may have intentionally decided not to respond to the questionnaire. Another, shortcoming was the small sample size used hence the results should not be generalized for all Mathematics pre-service teachers in Ghana.

This study has numerous strengths. The most significant strength is rapid and timely data collection shortly after a national lockdown due to the COVID-19 pandemic. Another strength is the sample which was only Mathematics pre-service teachers in levels 300 and 400 which serves the purpose of this study. Similarly, participants who did not fill their demographic details completely were omitted from this study.

Consent

As per international standard or university standard, participants' written consent has been collected and preserved by the author(s).

Competing Interests

Authors have declared that no competing interests exist.

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