

# COVID-19 Pandemic and Higher Education: Leveraging on Digital Technologies and Mobile Applications for Online Learning in Ghana

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## Abstract

Since mid-March 2020, educational systems worldwide and particularly Ghana were under increasing pressure to use the new Digital Technologies (DTs) and mobile applications (apps) to assist teachers in guiding students to continue with online learning activities due to the COVID-19 pandemic. The study is aimed at assessing the utilization of DTs and apps tools by students during the COVID-19 pandemic and how those technologies have affected online learning in institutions of higher education in Ghana. The researcher adopted an online survey and exploratory-based design that utilized quantitative and qualitative approaches to purposively collect data from N=784 students from three major public universities in Ghana. Also, the study applied Uses and Gratification as the theoretical basis in understanding the utilization of DTs and their possible limitations for remote learning during the peak of COVID-19 in Ghana. This study reported that the specific DMTs and mobile apps used by students in higher education for online learning are smart phones and apps such as Class In, Zoom, Skype, and Instagram live stream. This study also revealed that Personal Learning Network (PLN) such as WhatsApp, Facebook, Twitter were also actively used by students for remote online learning. Again, the study shows that 77.1% of students in the sampled three universities were fully aware of the DTs and apps utilized for online learning during COVID-19. Also, the findings from this study report that students in higher institutions identified unstable electricity for continuous online learning, especially for those students in rural areas, unreliable internet service, poor WiFi connections, expensive smartphones / laptops, and high cost of inter bundle as key challenges of using DMTs and mobile apps for online learning during the COVID-19 pandemic. Finally, on the perceived usefulness of DTs and mobile apps among students for online learning in higher educational institutions, the findings from this study suggest that DMT's and apps were of great benefit to students for remote online learning.

**Keywords:** Educational systems, Digital technologies, Applications (apps), COVID-19 pandemic, Online learning

## Introduction

The year 2020 will go down in the history of the world as the most devastating year that affected almost every facet of human existence. Due to the effects of the COVID-19 pandemic, governments and organizations worldwide have initiated all sorts of inventive projects, exhaustive research work, and activities that encourage knowledge-sharing regarding the effective and appropriate application of Digital Technologies (DTs) in the education systems (Mingis, 2020). While countries in the developed world have needed technology and infrastructure to prosecute for online learning via technology, their counter parts in the developing world can not apply. The digital divide among countries of the world was brought to bear by COVID-19 and has affected online learning delivery in developing countries (Demuyakor, 2020; Ferri, et al., 2020; Chatterjee & Chakraborty, 2020; European Commission Joint Research Centre, 2020).

Education is a social endeavor. Therefore, there is a need to empower both the teachers and students to teach and learn, respectively through Digital Technologies (DTs) and mobile applications (apps). The students and teachers should be trained on Digital Technologies and applications because adapting to pedagogy is essential in the current world (Lakhal, & Khechine, 2021; Lam, et al., 2021). A combination of different modes of teaching (offline / online or a combination of both) is considered to be more effective with more focus being put on pedagogy and not just using technology (García-Martínez, et al., 2019; Montrieux, et al., 2015; Rapanta, et al., 2020).

Lengthy closure of schools in Ghana and many African countries due to COVID-19 is likely to cause not just a loss in teaching and learning among the teachers and students in the short term but also a decline of the human capital and reduced chances of economic opportunities in the long run (Amewu, et al., 2020; Adarkwah, 2020). Most countries are trying to cope with the closure of the school and are trying out online learning as a way of ensuring that there is continuity of knowledge acquisition among the learners. In 2020, a World Bank report titled “the COVID-19 pandemic: shocks to education and policy responses” pointed out that to effectively mitigate the loss of learning, most countries are trying out new technology means of teaching to cope with the predicament. The situation has exposed the existence of inequalities as far as digital access is concerned, and that ‘business as usual’ may not work for the transfer of education to all students. This study aims at evaluating the effects and use of DTs and mobile applications (apps) during the COVID-19 on higher education and how these technologies have helped students to continue with their online learning.

## Literature Review

### Education and COVID-19 Pandemic

The Global Education Coalition of the UNESCO report 2020 cited that, at the peak of the COVID-19 pandemic and nationwide lockdowns, 1.6 billion students were seriously affected by the closure of schools. This caused one of the largest mass disruptions of the education system in modern history (UNICEF, 2020 & UNESCO, 2020). Despite all this, before the nationwide closure of schools, UNICEF &

UNESCO had reported that one in five school-going children were already out of school, and even those that were already in school were not receiving the appropriate learning. Close to 617 million children and adolescents across the globe failed to attain the minimum proficiency level in both mathematics and reading. To successfully address the serious issues, over 90% of the education ministries worldwide came up with some form of remote learning policy. Together with other stakeholders, they have sought to apply modern technology to improve the levels of education (UNESCO, 2020 and UNICEF, 2020)

To respond to the unexpected challenges in the education sector brought about by the COVID-19 pandemic, over 90% of the countries worldwide have managed to implement some online learning programs (De Giusti, 2020; Li & Lalani, 2020). According to the survey carried out by UNICEF (2020) and UNESCO (2020), the factsheet approximates that about 463 million students have been left out of digital learning due to lack of the required sources in various homes and poor policies by various government agencies. This information was received from joint research carried out by UNESCO, UNICEF, and World Bank survey regarding the National Response to COVID-19 school closure (June-July 2020). It has to be understood that the actual number of students who could not be reached for the response was likely to be higher compared to what was indicated in the factsheet. However, the figure represented the best-case scenario if the policies that were implemented and technologies used were anything to go by. In many instances, despite the policies that were in place and the availability of technology in various homes, the learners may not be able to learn because of the presence of huddles among the teachers or lack of support from the parents.

It is essential to be aware of the number of children who did not get the opportunity to benefit from digital learning opportunities because this will help improve the policies. By highlighting the challenges faced by children who did not benefit from online learning during school closure occasioned by COVID-19 pandemic, the factsheet seeks to provide choices that will help in improving the situation through ensuring that children can acquire education during COVID-19 period and beyond. With the emergence of the

COVID-19 pandemic, some issues are evolving in the technology sector. Teaching and learning methods are improving, especially from teacher-centered and lecture-based instruction to student-centered with minimal interaction. There has been an increase in the designing and implementation of ICT-based educational reforms during the COVID-19 period is the key to fundamental to covering the educational calendar (Trust, 2020; Espino-Díaz, et al., 2020; UNESCO, 2020; UNICEF, 2020).

The spread of the COVID-19 pandemic led to almost 1 billion children falling behind because of the closure of learning institutions to control the spread of COVID-19. To ensure that learning was going on during the period, countries introduced information and communication technology programs through distance learning, especially online learning, as a means of continuing the engagement of students at all levels of the education ladder (Li & Lalani, 2020 and Drane, et al., 2020). Yet, most children worldwide cannot access the internet in their homes, especially those from poor households. Facilities like TVs, personal computers, and radios are a luxury to most homes, which defined the existing learning inequalities. There is a lack of new technologies that can aid in the acquisition of knowledge through home-based learning. Consequently, many children are faced with the possibility of not going back to school, which could pose the risk of undoing the many steps of progress that had already been achieved across the world (UNESCO, 2020; UNICEF, 2020).

According to UNICEF COVID-19 and Education report, as of April 2020, 188 countries have closed schools, a number of the schools are looking for alternative ways of teaching through the use of technologies such as the Internet, TV, and Radio. The main stumbling block has, however, been the minimal access of the technologies among the low and middle-income countries because most households cannot afford them (Bloom et al., 2017). While 90% of the countries embraced digital learning, only 60% did for pre-primary levels of education (UNICEF, 2020; Li & Lalani, 2020; Ferri, et al., 2020). The measures that have been taken by various governments to ensure that there is continuity of learning through digital platforms enabled 69% of the children across the globe to continue learning.

Nevertheless, 31% of the children, which translated to 463 million children, across the world could not be reached through broadcast and online learning. This was either due to a lack of technological equipment such as the internet and computers, or the policies that were put in place were not well executed (UNESCO, 2020 and UNICEF, 2020).

During the period when the schools remained closed, most governments resorted to delivering education through online platforms. Close to 83 of the countries used the platform to impart knowledge to the learners (Lyons, et al., 2020 and Dhawan, 2020). However, only a quarter of the students were able to access learning through the platform. Television had the highest percentage with about 62% globally. 16% accessed the learning through the radio. Globally, 3 out of 4 students who could not be reached online came from rural areas and belonged to the poorest households. It is important to note that expanding access to the internet as well as digital learning solutions for students across the world would be the best long-term strategy in reducing learning vulnerabilities as a result of COVID-19 (World Bank, 2020; UNESCO, 2020; UNICEF, 2020; United Nations, 2020).

### **DTs and Mobile Apps used for Online Learning by Students during the COVID-19 Pandemic**

In addition to the already existing Digital Technological (DTs) and mobile apps, the UNESCO and UNICEF, World Health Organization (WHO) report that as of July 2020, about 50 national governments have released various applications to assist the fight against Covid-19. According to a 2020 study carried out by UNICEF and the International Telecommunication Union (ITU), about 2.2 billion children, which translates to two-thirds of children and young adults aged two and below, do not have access to the internet in their home. This is based on the report “How Many Children and Youth Have Internet Access at Home” in a joint effort by UNICEF and ITU. Through the use of the latest household survey data, the report found out that there are significant inequalities between various countries and regions. The report pointed out the differences in wealth groups and urban-rural settings. For instance, it was discovered that only 5% of the children and

young adults in both central and West Africa have internet access at home compared to 33%, which is the global average. There is also a huge disparity between the rich and the developing countries. About 6% of children and young adults in low-income countries can access the internet compared to 87% in high-income countries. To ensure that students can comfortably acquire knowledge and skills, it is important to expand internet access to students to support a sustainable future. To this end, UNICEF and ITU have come together to launch Giga, an ambitious initiative to ensure that all schools are connected to the internet. Through the support of Generation Unlimited, UNICEF as an organization is working under Reimagine Education initiative to address the learning crisis and transform the education sector by providing students and young adults equal access to quality online learning (UNESCO, 2020; UNICEF, 2020; ITU, 2020).

According to UNESCO (2020), the COVID-19 has transformed and the students out of their traditional teaching and learning environment and shifted to online learning. By responding to the effects of COVID-19, the faculty of education has swiftly transitioned the whole pre-clerkship curriculum online. This is done by arranging smaller groups to meet in smaller groups. Students use many online learning technologies to ensure that there is continuity of education regardless of the presence of COVID-19 (Demuyakor, 2020; Chatterjee & Chakraborty, 2020; Vargo et al., 2020; Yoshida, 2021).

Online collaboration tools, as well as social media applications, are among the popular choices for students compared to university websites. This is because they are more convenient and exclusively interactive (Demuyakor, 2020). They allow for collaborative discussions on important topics that are of great importance to the learners (Sarwar et al., 2019; Ayebi-Arthur, 2017; Chatterjee & Chakraborty, 2020). Facebook groups are used to host those kinds of discussions (Chatterjee, & Chakraborty, 2020; Dawson & Al-Masri, 2020). One other popular medium of facilitation of discussion is WhatsApp. Just like Instagram live streaming, WhatsApp is a technology that is supported through social media-based live streaming services (Motteram, et al.,

2020; Chatterjee, & Chakraborty, 2020; Cole et al., 2017). Social media platforms provide avenues for live teaching and learning. Discussions are enhanced through qualified personalities like professors. There is a need to encourage teleconferencing and audience response methods to promote the participation of students during the lessons. Both video conferencing and collaboration tools allow students, teachers as well as school administrators to carry out related practical courses. LinkedIn and Twitter have consistently enabled professors and students to advance their interaction through resourceful engagements (Ngalomba, 2020; Azlan, 2020; Sukardi, 2019; Kapoor, 2018; Willbold, 2019).

As part of the fulfillment of the education process, attending lectures delivered by professors plays a great role in knowledge acquisition. Teachers who attended those important lectures are now sharing the prerecorded lectures with their students in class. Others find it better to live-stream the lectures to the students. During the learning sessions, students are encouraged to ask questions through a chat response or video conferencing. At the same time, sessions may be recorded (Pillai, et al., 2021; Free, et al., 2021). The entire process requires a considerable amount of time and effort to assemble multimedia resources as well as simulation tools that are required for teaching a course, yet not many of the same kinds of tools are currently in use now (Rapanta, et al., 2020; Vargo, et al., 2020). Rapanta, et al. (2020) and Houlden & Veletsianos (2020) recommend students be able to attend online conferences both within and outside their universities and seek to be provided with the best possible mentorship based on a one-on-one or in small groups. According to UNESCO (2020) and UNICEF (2020), online symposiums can be carried out to foster education and research. The symposiums can be carried out through the use of posters, holding discussions, and organizing talks. Practical skill lessons can also be delivered online, though there are several challenges. Practical courses typically require more time and resources to be handled virtually (Roddy, et al., 2017).

According to Roddy, et al., (2017) and Vargo, et al., (2020), examinations are also transitioning into the virtual way. Preparing for any future academic session, such as selecting potential candidates, will

be carried out virtually through video conferencing (Roddy, et al., 2017). Teachers are trying hard to keep the educational approach simple but at the same time coming up with innovations and transitioning teaching techniques from the normal face-to-face instructions to the current modern technology where sessions are carried out virtually (Arkorful, et al., 2021). The focus and future of DMTs remain on innovation and exploring new environments through novel technologies and adaptation to flexible learning plans (Rapanta, et al., 2020; Boni, 2018).

The World Bank Education Global Practice report, 2020 argues that, as countries continue to adapt and invest in new technologies to learn online as an immediate way of reaching out to students, there are challenges that are faced (World Bank, 2020; Free, et al., 2021). During this coping phase period, rather than simply coming with new content that is likely to take a significant amount of time and a high level of expertise, it is essential that countries concentrate on curating the available content, which free and open to all, on aligning it to the new curriculum (Cromwell, 2020 and World Bank, 2020). As a way of preparing for the future, countries need to develop short modular content to be distributed through various channels, mobile being the basic channel. Re-imagining how content is designed should be able to look into the unique skills and general background of the students give various options through which the students can be able to realize their full potential. During the coping stages, examination and evaluation of the process have exposed several limitations. In situations where online systems are applied in teaching, the data collected provide a clear picture of progress made in learning (Kingsbury, 2021). In situations where students apply online learning through radio and TV, which have minimal interaction, short questions and feedback through mobile devices are used to facilitate engagement between the teachers and students. The use of both digital content, data, algorithms, among others, can provide continuous feedback to the students (Mills, et al., 2020; Montgomery, 2015; Winthrop, 2020).

## **Challenges of Online Learning in Higher Education during the COVID-19 Pandemic**

One of the greatest challenges for online learning during COVID-19 is the increased level of inequality as far as access to internet technology is concerned (Ferri, et al., 2020). According to A 2020 UNICEF report, for instance, indicated that, in homes of elementary school-going students in Africa, only thirty percent of the poor household could access radio services while 79% of the rich household have radios (UNESCO, 2020 and UNICEF, 2020).

The disparity in the ownership of TV among the poor and the rich also evident, with only 4% of the poor and 82% of the rich. The computer has 1% for the poor and 25% for the rich. Only 0.3% can access the internet among the poor which the rich households have 25% access to the internet. There is, however, some little hope as far as the use of mobile phones is concerned as 46% of the poor household have a phone while rich is at 79% (UNESCO, 2020).

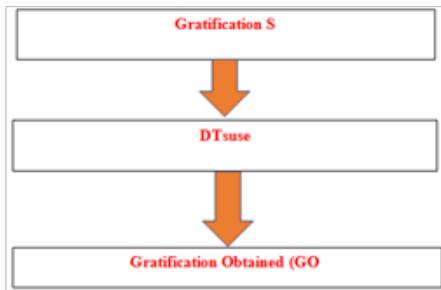
The distribution of digital content can be done through various channels to ensure that it reaches all students on a wider scale. Consequently, the systems of education should be able to come up with multi-faceted solutions to leverage the available technologies such as the radio, TV, computers, internet, among others. The combination of the various mediums can ensure that students are fully engaged during the COVID-19 pandemic. Mixed-mode delivery has to be adopted by the stakeholders so that all students access the necessary learning. The education system should address the inequality in access to the internet and the associated devices (UNESCO, 2020; United Nations, 2020; UNICEF, 2020).

## **The Theoretical Underpinning of the Study**

Upon a careful review of the literature, one can conclude that several theories might apply to this study. The theory that strongly relates to the content of this paper and can aid in given many explanations is the theory of Uses and Gratification (UGT). For us to have a better understanding of what motivates students and teachers to use digital mobile technologies during the COVID-19, Uses and Gratification Theory (UGT) (Trowbridge, 1976) must be examined. This theory is premised

on the audience’s point of view. It is Katz, et al., (1973) based on some core this theory stands on the audience’s (students and teachers) theatrical and methodological assumptions; the audience (students and teachers) is active and goal-oriented, taking a proactive role in deciding how to use media in their lives, the audience (students and teachers) knows their needs and is choosing the media to meet their own needs by linking their needs to a specific medium, the media is competing with other resources for the need of satisfaction, and the audience(students and teachers) is well-aware of their usage, interests, and value judgments (López, et al., 2019; Raza, et al., 2016). The four core indices of UGT are Personal Identity, Education/output, Entertainment, Personal Relationships as well as Social Interactions. Digital Technologies (DTs) serve all four gratifications identified. DTs are entertained, knowledge dissemination, and socialized. Often enough, users find their sense of humor by following DTs that have academic discussions and quotes and pictures that amuse them (Chuang, 2015).

**Figure 1: Gratification Sought and Gratification Obtained**



From the theoretical framework and review of literature, the researcher developed the following research questions to guide this study;

**Research Questions (RQ)**

**RQ1.** What is the level of awareness on Digital Technologies (DTs) and mobile apps used among university students for online learning?

**RQ2.** What specific DTs and mobile apps did students used for online learning during COVID-19?

**RQ3.** What is the perceived usefulness of the DTs and mobile apps for online learning among university students during COVID-19?

**RQ4.** What are the perceived challenges university students face using DTs and mobile apps for online learning during COVID-19?

**Research Methodology**

**Study Site and Population of the Study**

The researcher randomly chooses 3 public universities for the study are: The University for Development Studies, the University of Cape Coast, and the Kwame Nkrumah University of Science and Technology. The choice of these universities was to give a fair representation of the public. The universities cut across three regions in Ghana, namely the Northern Region, Central Region, and Ashanti Regions. The justification for purposively sampling the three institutions of higher learning is to give a fair representation of the north-south divide in Ghana. The study population is 798 students of the three sampled institutions of higher education in Ghana. The population included students from the three sampled universities.

**Study Design**

This particular study employed the use of an online survey as well as an exploratory-based design that utilized a quantitative and qualitative approach to examine digital mobile technologies are used by students in three of Ghana’s best institutions of higher education during the COVID-19 pandemic for online learning.

**Sampling Procedure and Data Collection and Analysis**

An online survey technique was employed as a data-gathering instrument. The respondents were deliberately selected to take part in this particular study, with the selection being based on characteristics that were relevant to this research. As noted by Creswell (2018), the logic behind purposeful sampling usually lies in picking information-rich cases to facilitate in-depth study. A study sample of N=798 respondents comprising students and teachers was employed for this particular study. Out of the N=798 students purposefully sampled from the three major institutions of higher education, n=784 questionnaires were validly filled, which translates to 98.2% of the total sampled population.

The survey questions enabled the researchers not only to probe further but also to understand and explore respondents' contributions (Kaufman, 2020). All 30 online survey questionnaires were administered. This approach permitted the researchers to conduct an in-depth investigation of how the use of digital mobile technologies and apps among students during the COVID-19 pandemic has affected online learning practice in Ghana. The online survey design contained a five-point Likert scale (*1 = strongly disagree, 2 = somewhat disagree, 3 = neither disagree nor agree, 4 = somewhat agree, 5 = strongly agree*).

The online survey questionnaire was sent via the WhatsApp group pages of the students who volunteered to participate in the study. Every week, the administrators of the various WhatsApp group page sent a reminder to students requesting them to fill the questionnaire. The data collection took four months (October 2020 to January 2021), with every online questionnaire lasting about 10 minutes. SPSS version-24 was employed to facilitate statistical analysis. The collected data were prepared for analysis, with 20% of the data scrutinized for accuracy, and all the data verified to establish discrepancies. Standard descriptive data were employed in summarizing respondents' characteristics, as well as their access to and perception regarding digital mobile technologies and applications use in the provision of public healthcare. Lastly, percentages, mean as well as standard deviation were employed to establish discrepancies in terms of digital mobile technologies and applications use, access, as well as preferences.

### Validity and Reliability

To ensure the meticulousness and integrity of the study and consequently guarantee the credibility of the research findings, various steps were undertaken to improve the reliability of this particular study (Noble & Smith, 2015 and smith & Noble, 2014). First, comparisons were undertaken to establish the similarities and the differences across the respondents' accounts, an action aimed at ensuring that divergent viewpoints were represented. Furthermore, an active and continual reflection was carried out during the process of data interpretation to not only guarantee

the quality of the collected data but also to mirror the respondents' experiences. Hence, as enhance the credibility of the study. The background of this research, as well as the assumptions relevant to this study, was comprehensively described to attain transferability. Besides, the criteria used were made clear to suit not only the objective of the study but also its orientation (Sundler, 2019). Furthermore, the views of other researchers were taken into account to help minimize research bias, as well as ensure that findings, conclusions, and recommendations were in line with the collected data and that the interpretation of the collected data was relevant to the research.

## Results and Findings

### Demographic Characteristics of Respondents

Table 1 a detailed analysis of the responses from the students. Respondents were 31.6% female (n=247), 68.4% male (n=537), and 2.8%. Respondents were of ages 21-30 at 76.0% (n=596), 31-40 years at 21.3% (n=167), and 41+ at 4.7% (n=37). The study also sought to find out the academic level of respondents. From the responses, the majority 28.0% were level 300 students, followed by 26.0% level 200 students, 23.0% level 100 students, and 18.0% were level 400. The universities where the respondents were as follows: University for Development Studies (51.6%), University of Cape Coast (28%), and Kwame Nkrumah University of Science (20.4%) (See table 1).

**Table 1: Demographic Characteristics of Students**

Demographic Characteristic	Value	n (%)
<b>Age</b>		
21-30	596	(76.0)
31-40	167	(21.3)
41+	37	(4.7)
<b>Gender</b>		
Males	537	(68.4)
Females	247	(31.6)
<b>Name of University</b>		
University for Development Studies	404	(51.6)
University of Cape Coast	220	(28)
Kwame Nkrumah University of Science and Technology	160	(20.4)

Academic Level of students		
Level 100	207	(23.0)
Level 200	211	(26.0)
Level 300	224	(28.0)
Level 400	142	(18.0)

**RQ1: Students Awareness of DTs and Mobile Apps Use for Online Learning**

**Table 2: Students Awareness of DTs and Mobile Apps use for Online Learning**

	Frequency	%	Valid %	Cumulative %
Yes	605	77.1	77.1	77.1
No	179	22.9	22.9	100.0
Total	784	100.0	100.0	

In this study, the research also sought to determine health professionals' awareness of digital mobile technologies and apps in online learning.

**Table 3: The Specific DTs and Apps used by Students for Online Learning during the COVID-19**

	Frequency	%	Valid %	Cumulative %
Online collaboration platforms (GoTo Meeting, Google Docs, Google Classroom)	34	4.3		4.3
Smarts phones and software mobile applications (classIn, Zoom, skype, Instagram live stream, WhatsApp / Telegram, Facebook, Twitter)	444	56.6	56.6	56.6
Cameras and digital recorders	100	12.7	12.7	73.3
Laptop computers	206	26.4	26.4	100.0
Total	784	100.0	100.0	

**RQ3: The Perceived Usefulness of the DTs and Mobile Apps for Online Learning by Students during COVID-19**

This objective sought to determine the perceived usefulness of the DTs and mobile apps for online learning by Students during COVID-19. "During COVID-19, I used digital technologies and mobile applications to participate in online classes organized by my school" with a mean of ( $\mu = 4.94$ ) and an SD 2.44, "I used digital technologies and mobile apps to

In aggregate, 605 of the respondents (students and teachers) representing 77.1% are aware of the various types of digital mobile technologies and apps in higher educational institutions and 179 representing 22.9% are not aware of the innovation.

**RQ2: The Specific DTs and Mobile Apps did Students used During COVID-19**

Also, respondents were asked to indicate which of the specific DMTs and apps students use for online learning, especially during the COVID-19. 444 (56.6%) use smarts phones and applications (WhatsApp, Facebook, Twitter, Instagram live stream, classes, Zoom, Skype) digital mobile technologies, 206 (26.4%) use Laptop computers, 100 (12.7%) use Cameras and digital recorders, and 34 (4.3%) use Online collaboration platforms (GoToMeeting, Google Docs, Google Classroom), (see table 3);

carry out my assignments" ( $\mu = 4.38$ ) and SD = 2.18, "I use DTs and mobile apps for group discussions with my classmates" ( $\mu = 2.24$ ) with SD = 1.49, "I use DTs and mobile apps to do follow up and ask questions and clarification on my courses areas from my professors" ( $\mu = 4.21$ , SD = 2.55), "During the COVID-19 period, I used DTs and mobile apps to participate in online seminars and training organized by my school and other institutions" ( $\mu = 3.27$ , SD = 1.24), (See Table 4);

**Table 4: The Perceived Usefulness of the DTs and Mobile Apps to Students during COVID-19**

Item	Mean	SD
During COVID-19, I used DTs and mobile apps to participate in online learning classes organized by my school	4.94	2.44
I used DTs and mobile apps to carry out my assignments	4.38	2.18

I use DTs and mobile apps for group discussions with my classmates	2.24	1.49
I use DTs and apps to do follow up and ask questions and clarification on my course's areas from my Professors	4.21	2.55
During the COVID-19 period, I used DTs and mobile apps to participate in online seminars and training organized by my school and other institutions	3.27	1.24

Note: 1 = (strongly disagree), 2 = (somewhat disagree), 3 = (neither disagree nor agree), 4 = (somewhat agree), 5 = (Strongly agree)

#### RQ4: The Perceived Challenges University Students Face using DTs and Mobile Apps for Online Learning During COVID-19

The fourth research question was intended to solicit students' views of some of the challenges the students encountered while using DTs and mobile apps for online learning. The following are some of the average scores of concerns on the limitations of using DTs and mobile apps for online learning by students in Ghana; "many students lack the required media literacy is skills to enable them to participate fully in online learning during COVID-19" (Mean=2.80, SD=1.40), "laptops and smart mobile devices are

very expensive, hence preventing a good number of students from participating in the online classes (M=3.89, SD=1.40); the internet service is unreliable in Ghana, hence limiting us from using DTs and apps for online learning" (Mean=3.89, SD=1.46), "The internet service is unreliable in Ghana, hence limiting us from using DTs and apps for online learning (Mean=4.02, SD=1.9), and internet data is very expensive hence preventing many students from using DTs and apps (Mean=3.92, SD=1.30), and challenge of unstable electricity continues online learning (Mean=3.98, SD=1.49), (See Table 5);

**Table 5: The Perceived Challenges University Students Face using DTs and Mobile Apps for Online Learning during COVID-19**

Item	Mean	SD
Many students lack the required media literacy is skills to enable them to participate fully in online learning activities during COVID-19	2.80	1.40
Laptops and smart mobile devices are very expensive, hence preventing a good number of students from participating in the online classes	3.89	1.46
Poor WiFi connections and internet service is unreliable in Ghana, hence limiting us from using DTs and mobile apps for online learning	4.02	1.9
Internet data is very expensive hence preventing many students from using DTs and mobile apps for online learning	3.92	1.30
The electricity in Ghana is relatively unstable for continues online learning	3.98	1.49

Note: 1 = (strongly disagree), 2 = (somewhat disagree), 3 = (neither disagree nor agree), 4 = (somewhat agree), 5 = (Strongly agree)

#### Discussion

COVID-19 pandemic undoubtedly has posted so much destruction to the educational practices in most counties of the world. The educational systems within most developing countries, especially Ghana, which were already facing challenges, have been further damaged. From this study, it very clear the adoption of DTs and mobile apps has greatly reduced the impact of the COVID-19 on educational practices. In finding possible answers to the four

main research questions of this study, the following were some of the key responses and issues.

The first research question was to ascertain whether students were aware of some of the DTs and mobile apps used in educational practices (online learning). The study revealed that a considerable number of students that participated in the study were so much aware and had knowledge of the DTs and mobile apps used for online learning in higher educational institutions in Ghana. Out of the

total of 784 students sampled for this study, 655 respondents, representing 77.1%, indicated that yes, they were aware of the various DTs and apps used in their educational institutions. The researcher concludes that the level of awareness of DTs and mobile apps among students for online learning in higher educational institutions in Ghana may help ease use and hence improve educational outcomes. This finding from our study is in line with a previous study by (Pillai et al., 2021; Bloom et al., 2020 and Ngampornchai & Adams, 2016).

The second research questions address the specific DTs and mobile apps used by students for online learning during COVID-19. This study reports that the specific DTs and mobile apps used by students for online learning are; Smarts phones and applications (class In, zoom, skype, WhatsApp, Facebook, Twitter, Instagram live stream), and constitute 56.6% of the sampled students. The second specific DTs used by students for online learning in higher educational institutions according to this study are; laptop computers, which is 26.4% of the sample for the study.

The next research question was to find out the perceived usefulness of the DTs and mobile apps to Students for online learning during COVID-19. The study reports that students indicate the DTs and apps were very useful to them. With a mean of ( $\mu = 4.94$ ) and SD of 2.44, most of the students reported that DTs and mobile apps aided them to participate in online classes and other educational activities organized by their various schools. The students also indicated that DTs and mobile apps have greatly aided them in completing the research assignments online on time.

Finally, the researcher again wanted to find answers to the research question on the challenges of DMTs and apps for online learning in higher educational institutions during COVID-19. Evidence from this study shows that respondents identified poor WiFi connections, internet service as unreliable, expensive smartphones, and high cost of inter bundle as a critical challenge to the use of DTs and apps for educational activities of online learning during the peak of COVID-19 in Ghana.

Another Challenge reported by students in this study is the challenge of unstable electricity for

continuous online learning, especially for those students in rural areas in Ghana. This finding is a study in line with Demuyakor (2020) Adarkwah, (2020), and Arkorful, et al., (2021), who did a similar study on the use of technology in education. Ghana and many other developing countries lack the needed internet infrastructural supports to implement emergency online learning as a result of the COVID-19.

As reported in this study, the high cost of the internet remains a challenge to many higher educational institutions in Ghana. Also, smart cell phones are being utilized to enhance the delivery as well as the reception of educational practice via online learning is also very expensive. The findings from this study again show that many students in higher educational institutions could not participate in all the educational activities organized by their schools. Hence the cost of participating in any off-campus educational activities by the students will require them to bear the cost.

### **Conclusion**

From the discussions and analysis of this study, it is worth noting that the finding from this study point to the fact that, COVID-19 pandemic has revolutionized the use of digital technologies and mobile apps in the higher education system in Ghana. Digital technologies and mobile apps have proven to be essential tools for students to continue online learning educational activities without much destruction.

### **Limitation of Study and Suggestions for Future Research**

This study was carried out at three universities in Ghana; the University for Development Studies, the University of Cape Coast, and the Kwame Nkrumah University of Science. Shortly, other researchers could conduct studies on higher education, COVID-19, and DTs and mobile apps on a large scale to include more universities, students, and teachers, and school administrators. Findings from this study indicate that DTs and mobile apps can benefit educational stakeholders and policymakers, which could ensure accessibility, security, reliability, and sustainability of educational programs in post-

COVID-19. It is important to note, however, that, these limitations do not in any way impact negatively on the overall findings of the study.

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### Declaration of Competing Interest

The author declares that there is no conflict of interest.

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