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Research Article

Is COVID-19 the Gateway for Digital Learning in Mathematics Education?

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Abstract

Digital learning has reshaped education in many ways. The purpose of this study is to respond to the question of whether COVID-19 is the gateway for digital-learning in mathematics education. To this end, this study explores some uptakes of social media platforms by prospective secondary school teachers. Data was collected from 102 prospective mathematics teachers from the Copperbelt University (CBU). Cluster analysis approach was used. Results revealed that participants' scores for digital learning in mathematics in cluster 2 were higher than those in both cluster 1 and 3. This is a clear indication that prospective teachers in clusters with low scores are more likely to exhibit low skill levels in the use of mobile technology and the adoption of social media in relation to mathematics pedagogy during the COVID-19 crisis. Results show different patterns. However, overall results show that digital learning could be a positive response to COVID-19 closure period.

Keywords: COVID-19, digital learning, social media, students, mathematics education, Zambia

INTRODUCTION

In the wake of the COVID-19 global pandemic that has affected most parts of the world with high death rates recorded in Italy, Spain, United States of America, France, United Kingdom… and other parts of Europe and Africa, the death toll continues to rise. Although there was no confirmed case of COVID-19 yet, the government of Zambia through the minister of health announced that all schools, colleges and universities would be closed prematurely by Friday 20th March 2020 and expected to re-open depending on how the pandemic evolves. This was done as a preventive measure to protect students, teachers and lecturers. In order to combat and contain the spread of the coronavirus disease, further measures were later added by the president during his national address and effected on 26th March 2020. In view of COVID-19 pandemic which has resulted into several countries locked down, there is a paradigm shift in terms of learning world-wide. Most institutions around the word are moving away from the traditional classroom face-to-face to digital learning. Majority of the students who are presently enrolled in various educational institutions around the world are shifting their mode of learning from physical classroom to digital learning education. Amidst all this transformation, Zambia has not been left out. However, this is not the case for public and private secondary schools in Zambia. Interestingly, only colleges and universities are the ones caught up in the web of digital learning.

COVID-19 and Digital-learning Platforms in Zambia

The premature closure of all learning institutions in Zambia was a direct and immediate response by the government of Zambia to take proactive measures to protect all learners from possible risks of contracting COVID-19 because school environments are places where a lot of students meet, interact and touch surfaces such as desks, boards and chairs. Additionally, they use communal toilets and taps for drinking water. This pauses a great danger and an outbreak like COVID-19 can rapidly spread. This is consistent with (Sintema, 2020) who also posited that schools are the breeding grounds and dangerous places for the spread of the virus. Because of this most students or learners are forced to be in their homes. Despite this unfortunate situation, students are expected to learn with the use of web 2.0 tools.

Promptly accessible computers, phones, laptops and tablets either at home or school at affordable costs have come within reach of the great majority, and policy makers and significant partners are anticipating hopes to see learning go in a different direction in Zambia during the COVID-19 crisis. Perienen (2020), argued that with the coming of technology impacting almost all areas of life, the education sector too is witnessing a paradigm shift. Due to restrictions imposed by the ministry of healthy as a result of COVID-19 crisis, nearly all higher learning institutions in Zambia have shifted to digital learning with immediate effect. To this end, most universities published press statements for immediate release to inform students on the increased awareness and adoption of technologies for digital learning. For example, the University of Zambia (UNZA) Senate also resolved that in this closure, learning will proceed through e-learning platforms like Moodle and Astria. Subsequently, academic staff were requested to expeditiously secure learning support material for them to facilitate teaching and learning using the e-learning platforms. Similarly, students were also guided to make sure that they register and get connected to the e-learning platforms to avoid missing out on learning.

Similarly, Rusangu University (RU) followed suit and informed all its students who were supposed to report for a block release period that all courses for block release will be offered through the e-learning platforms such as YouTube and other platforms that the university would provide in due course. This was done to ensure that learning continues in the comfort of their homes. Many other Zambian universities such as Mulungushi, Eden, Copperbelt, Mukuba university… have also migrated to digital-learning platforms to ensure that students do not miss out on learning or remain behind on the coverage of the course outlines since they are still expected to write their final exams towards the end of the academic year. This is not surprising as (e.g., Basilaia & Kvavadze, 2020) also investigated the capacities of the country and its population to continue the education process at the schools in the online form of distance learning with different digital platforms. Thus, due to the COVID-19 outbreak, teachers and lecturers have been forced to learn digital methods of teaching and delivering content to students. COVID-19 has become a catalyst to appreciating digital devices, online resources, social media technology and e-learning activities. Literature reveals that no paradigm shift in the educational settings can be successfully projected without first including teachers as partakers of the intention. Today there is mounting pressure on them to tap into the affordances of technology to bridge learning gaps (Perienen, 2020).

Many studies in the medical field related to COVID-19 have been recently conducted such as on the use of technology in medical education, COVID-19 and medical education and Cancer Research Ethics and COVID-19 while another examined the rate of infections among healthy adults, elderly and children with respect to their immunological pathways (Abdulamir & Hafidh, 2020; Ahmed et al., 2020 ; Chinazzi et al., 2020; Hopman, Allegranzi, & Mehtar, 2020; Poh-Sun Goh & Sandars, 2020; Shuman & Pentz, 2020).

Research exclusively focusing on COVID-19 global pandemic and digital learning are on the increase in the present year 2020. Several researchers have conducted studies on the knowledge that is required for the adoption of digital technology during the COVID-19 crisis. For example, Iwai (2020), conducted a study on online learning during the COVID-19 Pandemic. He argued on what students stand to gain or lose when classrooms go virtual. Agnoletto and Queiroz (2020), in their paper “COVID-19 and the challenges in Education”, they posited that the logic of going “digital” is not simple but there is an ongoing outcry to launch tools of emergency measures, mostly, “adopting” the use of digital-technologies for learning. Another study

in China where the outbreak begun (e.g. Zhao & Xu, 2020) looked at how social media technology like Sina Microblog can be used to arrest the attention of the public to COVID-19 epidemic. It was revealed that social media platforms (e.g., Sina Microblog) can be used to disseminate information and measure public attention to public health emergencies. Through social media platforms, the government could communicate important information to the public, reviewing the health guidelines and sensitizing citizens. While a study by Roy (2020) in Australia, presented some tips that could help children learn from home during the COVID-19 period. In one of the tips, he suggested that teachers need to download some teleconferencing facilities (e.g., Skype, Zoom, Lifesize…) that may be used to deliver lessons remotely.

Baytiyeh (2019), argued that maintaining learning and communication during a school closure by any means possible is important. In supporting this claim Burke (2020), strongly posited that in an effort to reshape education, there are certain measures that need to be implemented during the COVID-19 school closure period. Such measures include; maintaining communication with students, parents, teachers and other staff members through e-mails and phone calls, maintaining access to learning materials like Google Apps (e.g. Google drive, dropbox, cloud…) for education, Moodle Cloud, Edmodo, or social media tools (e.g., WhatsApp, Twitter, YouTube, Facebook, Instagram, Yahoo…) and maintaining access to data via cloud computing for servers and back up in a location other than the school (Burke, 2020).

Currently, there is a dearth of research conducted on the use of digital platforms for learning mathematics. However, one such a recent study indicates that students learn mathematics better with effective and appropriate technology (Perienen, 2020), while another previous study highlights that the adoption of technology in mathematics education improves learning (Niess, 2006). It is not yet known exactly what type of digital technological tools that mathematics students may use during the COVID-19 closure period. As they will be required to learn remotely in their respective homes. It is against this gap of knowledge that this study wishes to narrower.

At the time of writing this paper, over 1, 511, 104 people globally had tested positive for the COVID-19, 88, 338 deaths and 328, 661 had recovered. In Zambia, there were only 39 reported confirmed cases, 1 death and 5 recovered with the virus continuing to spread. Thousands of influx of people unable to leave a specific area after screening, a large number of people are now required to spend fourteen or more days under quarantine, self-isolation or unable to leave home, flights have been suspended and there are a lot of restrictions at the borders. Other preventive measures taken by the Zambian government includes closure of schools, colleges and universities because the number of reported COVID-19 cases suggests that the gathering of people in a crowded place for a period of time increases the risk of contracting the virus. Millions of children country-wide have already had their education disrupted by the spread of COVID-19, with nation-wide social distancing and restriction of movements, digital learning is an increasing response to these closures. Digital learning is being used as a response to the COVID-19 crisis. Colleges and universities country-wide which are looking at the developing situation are also exploring digital learning as one response, some for the first time.

In Zambia, digital learning is not well established and not many courses and programs are offered digitally especially mathematics. For example, there is no Zambian college or university presently that offers mathematics courses online. The purpose of this study is to give a quick response to how students engage in mathematics learning activities via digital platforms. Thus, digital learning as an educational response to COVID-19 crisis also raises some interesting questions:

1. Will the adoption of digital learning as a response to COVID-19 stimulate the growth of digital learning in mathematics, especially in Zambia which has been historically resistant to the use of digital learning?
2. Will the use of digital learning lead institutions which have not made use of digital learning in the past see the value of pedagogy and make it a permanent feature of their portfolio?
3. Will policy makers and governments re-evaluate digital learning and its place in mathematics education across all levels of learning during and after COVID-19 resolves?

Theoretical Frameworks

In the present study, Activity Theory (AT) and Technology Acceptance Model (TAM) are the lenses used to guide the data analysis and data interpretation to investigate the components that influence undergraduates' interests in online interactions through Web 2.0 tools.

RESEARCH METHODOLOGY

This study is a part of a larger ongoing project that employed a mixed-methods approach. However, the results reported in this study are just a part of the quantitative analysis that was performed with a few excerpts from qualitative analysis for illustration purposes only. Therefore, this present study just scratches the surface of an area where little information exists, and there is much more to be learned.

Participants and Settings

Convenience sampling method was used to determine the sample for this study. Thus, 102 prospective secondary school mathematics teachers participated in this study. These were students studying at the Copperbelt University in their 3rd and 4th year of their training programs and were already in the School of Mathematics and Natural Sciences during the 2019-2020 academic year and have to complete four years in order to receive a bachelor`s degree in Mathematics Education.

Instrument

To measure knowledge of the prospective secondary school teachers' use of digital media technology in their teaching and learning experiences, the author adapted a validated scale by Moll and Nielsen (2017), from a science learning context to a mathematics learning context. The scale comprised of three main parts namely; demographics, social media use in mathematics courses and social media use in university mathematics learning. Reliability and validity were calculated with the Cronbach's alpha value being 0.76 for the whole scale. Participants rated their level of agreement on the usage of social media platforms on a likert scale. They were also requested to respond to statements about specific social media activities they engage in for learning mathematics by indicating how frequently (never, sometimes and regularly) particular digital learning platforms were used. The last part of the scale asked 10 open-ended questions. At the time of data collection, schools were not yet closed and there were no confirmed cases of COVID-19 in Zambia. Health intervention measures had not yet been put in place to restrict movements. Thus, delivery mode was face-to-face in lecture room settings and in the presence of the researcher. The survey was administered during a regular class day meeting of a mathematics-education class that included the entire faculty of prospective secondary teachers.

Data Analysis

K-means cluster analysis was used to analyze data by using SPSS version 24.0. Since Cluster analysis is an exploratory analysis that tries to identify structures within the data. In this study, our goal was to organize data into clusters such that there is high intra-cluster similarity, low inter-cluster similarity and informally find natural groupings among students on how they use social media technology in the teaching and learning of mathematics. Thus, we first wanted to find out how many groups the data will be clustered into and discover the patterns in the data, and which student groups need special attention in the utilization of digital learning. Second, we wanted to envision the number of students who would participate in online mathematics discourses and in mathematics virtual classrooms during the foreseeable COVID-19 outbreak period.

RESULTS AND DISCUSSIONS

One hundred and two questionnaires (102) were distributed to students pursuing a Bachelor of Science in Mathematics Education at the Copperbelt University (CBU). All the 102 questionnaires were returned, giving a response rate of 100%. About 70% of the students were aged 22-25 years, 14.7% were aged 25-28 years,

Table 1. Demographic characteristics of the participants

Variable	Description	Frequency	Percent (%)
Institution	CBU	102	100
Study program	B.Sc Math Ed	102	100
Year of study	3rd year	42	41.2
	4th year	60	58.8
Gender	Male	81	79.4
	Female	21	20.6
Age	18-22	14	13.7
	22-25	71	69.6
	25-28	15	14.7
	28-31	2	2.0
Devices used	Smartphone	54	52.9
	Laptop	36	35.3
	Home PC	2	2.0
	iPad/Tab	5	4.9
	Campus PCs	5	4.9

13.7% were aged 18-22 years and only 2% were aged 28-31 years. Furthermore, 20.6% of the participants were female while 79.6% were male. Consistent with Wickramanayake & Jika (2018), the results of the current study disclosed that female enrollment in higher education in Zambia was lower compared with males. This gender variation could be caused by different phenomena, such as pass rate, sponsorship, ethnicity, devotional, geographical location, cultural, traditional beliefs and tribal issues. Higher education institutions in Zambia do not have enrollment age limits for students, which encourages more qualified older persons to register in Bachelor's degree programs. However, the overall results confirmed that Zambian students usually enroll in universities immediately after they complete their Senior Secondary General Certificate Examination at the age of 18. Majority (58.8%) of the participants were 4th years and 41.2% were 3rd years. The main reason for selecting third year students was that they were already done with their teaching practices and fourth years were almost ready to graduate and to take teaching positions in government or private schools throughout the country. Slightly above half (52.9%) owned Smartphones and 35.3% owned personal laptops. A small number of students were also using home computers (2%), iPads/tablets (4.9%) and 4.9% of the respondents access campus computers. The results in the present study seem to powerfully agree with the results in the study conducted by Wickramanayake and Jika (2018), who also found that the slight majority of the respondents used mobile phones and laptops to access social media. Furthermore, respondents used Smartphones more to access social media. Home PCs use of students to access social media was very low (2%) compared with Smartphones, laptops and other digital devices, such as tablets, Campus PCs and iPads. Since CBU has also advised students to go digital during the COVID-19 crisis, it is evident that students are likely to use Smartphones and laptops more for digital learning to connect with their respective lecturers for lessons delivery. A few with home computers are on the advantage. **Table 1** illustrates all the demographic characteristics.

Table 2 shows the minimum and maximum scores for each social media application used by each cluster. Three clusters were formed after multiple iterations. Cluster 1 had 52 cases, cluster 2 had 8 cases and cluster 3 had 42 cases respectively. The minimum Social networking (e.g., Facebook) score was 1(Cluster 1, 2 and 3) while the maximum Social networking (e.g., Facebook) score was 4 (Cluster 1, 2 and 3). As for Communication (e.g.., MSN chat, email, text messaging), Cluster 1and 2 posted the minimum score of 2 while 4 was the maximum score for Cluster 1 and 2. The minimum Video sharing (e.g., Youtube) score was 1 (Cluster 1 and 2) while the maximum Video sharing (e.g., Youtube) score was 4 (Cluster 1 and 2). Generally, the minimum score across the clusters for all the test factors was 1 and the maximum was 4. Based on the technology acceptance model and the activity theory of this study, it can be seen by the forgoing mean scores that the level of social networking proficiency for pre-service teachers in cluster 2 is higher than those in both cluster 1 and 3 while those in cluster 1 scored higher mean scores than those in cluster 3. This implies that prospective teachers in Cluster 3 are more likely to exhibit low skill levels in the use of mobile technology and the adoption of social media in relation to mathematics pedagogy. They are also likely to exhibit a negative

Table 2. Results of the auto-clustering for pre-service mathematics teachers by cluster for each test factor

Test Factors	Cluster	N	Mean	Std	Minimum	Maximum
Social networking (e.g.., Facebook)	1	52	2.60	.846	1	4
	2	8	2.75	.886	1	4
	3	42	1.88	.803	1	4
	Total	102	2.31	.901	1	4
Communication (e.g.., MSN chat, email, text messaging)	1	52	2.83	.585	2	4
	2	8	3.13	.641	2	4
	3	42	1.57	.703	1	3
	Total	102	2.33	.905	1	4
Blogs (e.g., Tumblr)	1	52	1.13	.397	1	3
	2	8	1.75	.463	1	2
	3	42	1.10	.370	1	3
	Total	102	1.17	.424	1	3
Microblogging (e.g.., Twitter)	1	52	1.13	.345	1	2
	2	8	2.13	.641	1	3
	3	42	1.12	.395	1	3
	Total	102	1.21	.474	1	3
Document managing and editing tools (e.g., Google documents, Dropbox)	1	52	2.21	.825	1	3
	2	8	2.63	.518	2	3
	3	42	1.55	.832	1	4
	Total	102	1.97	.884	1	4
Social bookmarking (e.g.., delicious)	1	52	1.08	.269	1	2
	2	8	2.13	.835	1	3
	3	42	1.05	.309	1	3
	Total	102	1.15	.454	1	3
Social news (e.g., Reddit)	1	52	1.40	.664	1	3
	2	8	2.50	.756	1	3
	3	42	1.31	.604	1	3
	Total	102	1.45	.712	1	3
Wikis (e.g., Wikipedia, Wikispaces)	1	52	2.42	.750	1	4
	2	8	3.00	.000	3	3
	3	42	1.93	.867	1	4
	Total	102	2.26	.832	1	4
Video sharing (e.g., YouTube)	1	52	2.83	.513	1	4
	2	8	2.50	.926	1	4
	3	42	1.79	.842	1	3
	Total	102	2.37	.855	1	4
Live casting (e.g., Skype, Lifesize)	1	52	1.15	.364	1	2
	2	8	2.63	.916	1	4
	3	42	1.02	.154	1	2
	Total	102	1.22	.556	1	4
Photography sharing (e.g., Flickr)	1	52	1.25	.556	1	3
	2	8	2.75	.463	2	3
	3	42	1.17	.537	1	4
	Total	102	1.33	.680	1	4
Discussion forums (e.g., Yahoo answers, ask.com)	1	52	1.73	.795	1	3
	2	8	2.88	.641	2	4
	3	42	1.45	.739	1	4
	Total	102	1.71	.839	1	4
UoW Learning Management System (SMP)	1	52	1.04	.194	1	2
	2	8	1.63	.916	1	3
	3	42	1.02	.154	1	2
	Total	102	1.08	.336	1	3

attitude towards the use of social media platforms in mathematics. This could be because they do not perceive this 'social software technology' user friendly or ease of use and consequently do not perceive social media technology to be useful in mathematics virtual classrooms. Such gaps in knowledge of perceived usefulness and ease of use are a worrying factor that might easily affect their future intention to integrate

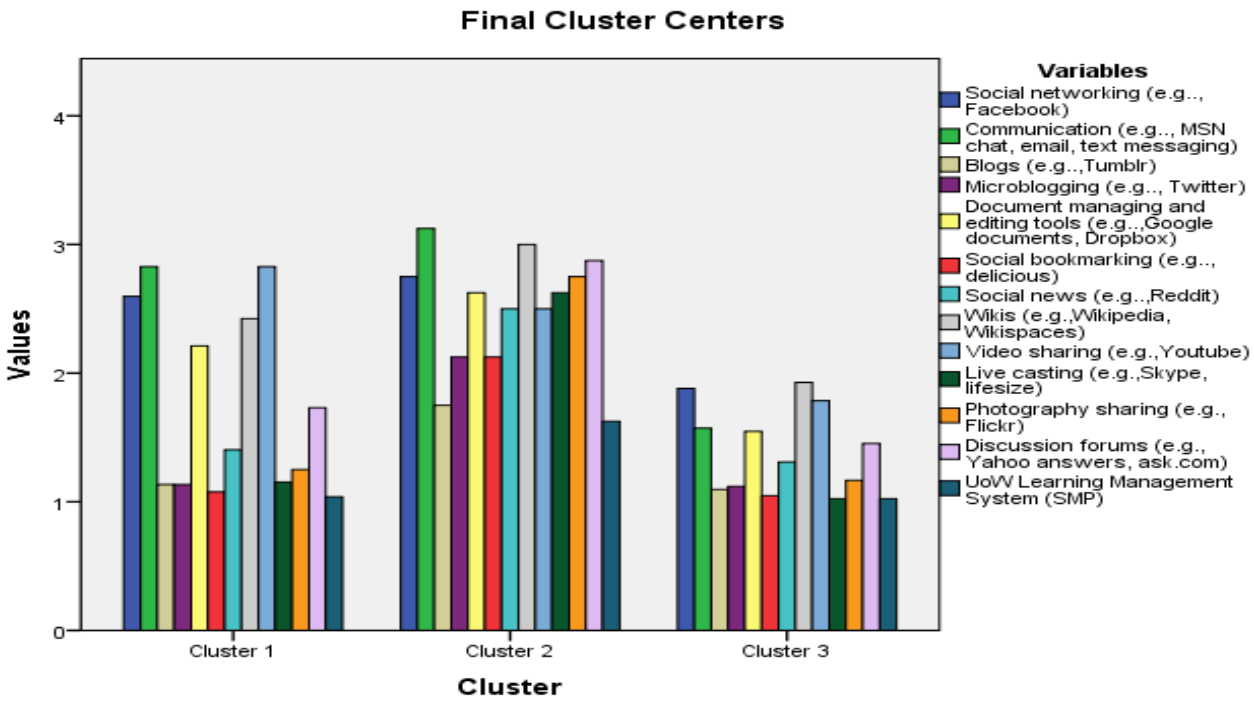

Figure 1. Homogeneous within, Heterogeneous across based on social media platforms used

social media technologies into the teaching of secondary school mathematics. Moreover, this pauses a great challenge for prospective teachers to engage in digital learning during the COVID-19 closure period. Subsequently, many students may miss out on the e-learning aspect especially if the proposed digital platforms are somewhat unfamiliar and difficult to use. Based once more on the theoretical frameworks of this study, it can be argued that both cluster 1 and 2 comprised of participants who had some challenges in the actual use of social media technology in mathematics transactions. Overall, both clusters perfomed well. Participants in both cluster 1 and 2 realized the need for the online community to cooperate and collaborate to participate in course activities (Cross, 2002). However, the participants' intention to use social media technologies based on each cluster could be affected by external factors such as professional development and accessibility of technological tools. Other external factors could be inadequate supply of electricity, internet costs and unreliable internet connections.

A visual representation of the three clusters on **Figure 1** shows these clusters naturally grouped based on how prospective teachers use social media platforms to support their mathematics digital learning. By inspection, the figure also shows that students with similar characteristics (homogeneous within) in cluster 2 had the highest mean score values but very dissimilar (heterogeneous across) with the other two clusters. That is, based on the input variables (17 variables on different social media platforms used by students in mathematics teaching and learning); the observation of the response of any student in cluster 1 is very dissimilar to any student in cluster 2 and cluster 3 respectively. Suffice to say that these observed grouped responses of students need special attention. For this reason, the authors of this paper present the excerpts from qualitative content analysis which examined how this group of students who needed special attention have used different social media platforms in their respective mathematics courses to support their lectures and everyday learning activities. These excerpts might help us understand much better what is behind some of the general figures reported on **Table 2**. However, content analysis of the answers provided by participants from these clusters is far beyond the coverage of this article. Participants provided several general answers to using social media Apps in mathematics. Quotes included in the next section are presented verbatim.

Video Sharing (e.g., YouTube)

For example, when asked whether or not prospective teachers had one online or social media application that they could not live without while studying mathematics, out of the total number of respondents, specifically twelve students mentioned that they use YouTube for watching mathematics tutorial videos online. Three other students explicitly said the following in this order:

> *"I post videos of M320 on YouTube…, I download videos on a certain topic in M310… and I also frequently use YouTube to learn more about calculus".*

Live Casting (e.g., Skype, Life size)

Based on frequencies of responses to the open-ended questions, only a handful of students expressed using live casting (e.g., Skype, Life size) in their mathematics courses. The top five uses of live casting (e.g., Skype, Life size) by mathematics students includes: live video chatting with maths colleagues, having online lectures/discussions, chatting and sharing answers with others, connecting with distant friends and sharing information with classmates. These telecommunication facilities will be highly appreciated during the COVID-19 crisis since students may need to have live streaming conference videos for learning.

Social Networking (e.g., Facebook)

Students cited several broad reasons for using social networking sites (e.g., Facebook). First, almost all the students appreciated the features found on the Facebook application. Participants fell into three clear categories: (1) approximately three quarters of students use it for communication (2) slightly above half use it for sharing information and (3) the rest use it for collaboration. One student said:

> *"I capture questions in M320 that are difficult for me to answer and send them to my Facebook friends so that I get answers from people who know."*

As one other student also said:

> *"I frequently read information on mathematical Facebook pages and sometimes search for solutions to mathematics problems."*

The authors summarized these responses as follows. Some frequently felt that Facebook allows them to share mathematics problems, solutions, data, pictures, videos and links.

Communication (e.g., MSN Chat, Email, Text Messaging)

Slightly above three quarters of students use social media platforms for communication (e.g., MSN chat, email, text messaging). As one student noted:

> *"I frequently receive mails from sites that are related to mathematics, I receive notes and books of my course via emails from my lecturers."*

Another group of 4 students respectively said:

> *…I frequently mail people I know that have the information am looking for…, I frequently email Universities about my program for inquiry…, I email questions to my lecturers that I don't know and … I infrequently send emails of the project to my supervisor…*

Five other students in the third year specifically stated the following details as the first one said:

> *"Lecturers use emails to send lecture notes to students. It is beneficial because we as students receive notes at a better time and anywhere".*

The second student out of those five noted that:

> *In university, the lecturers send notes and questions on the WhatsApp classroom group and it has really helped. Some they update them on our student portals for easier access. The use of WhatsApp is regular for lecturers to give us lecture notes for topics taught in class so that we have extra time to study and understand them*

The third student out of those five felt that lecturers used social media applications only in third year when giving them "tutorial questions and course outlines" as she noted that:

> *"The lecturer used social media Apps in posting the documents for the course material. It was right for those who have Smartphones and those without were asked to get them from their colleagues".*

The fourth respondent out of those five felt that lecturers have been using social media Apps to "give assignments" to students. This is considered beneficial because it enables students become familiar with the "use of technology for educational purposes". He further narrated that:

> *Lecturers have been using social media Apps to deliver content because personally, I have been able to receive emails containing documents that have been of great help to me academically. I was at some point receiving internet extracts which helped me understand certain concepts.*

Finally, the fifth respondent acknowledged that lecturers use social media Apps "almost all the time". In confirmation with the previous four mentioned students already, he further felt that lecturers use social media Apps to post "handouts" and "assignments", this is beneficial because sometimes "I may not have money to photocopy handouts, so its better I have them on softcopy". In addition to the structural reasons given already, he concludes his narration by highlighting that:

> *"University lecturers use social media like WhatsApp and email to send educational content to students".*

All these students' answers mean one thing in general. Most of them have the knowledge and the skill needed to use the named digital platforms for learning mathematics. However, it is up to them to connect with their mathematics lecturers during the COVID-19 closure period and proceed with learning digitally from the comfort of their respective homes.

Learning Management System (SMP)

It was not surprising that none of the students explained anything about using this virtual platform. The rest of the digital platforms recorded low scores also. The authors' conclusions are that students were very unfamiliar with the technological networking platform. This may be due to lack of exposure to such learning systems by their lecturers. The Copperbelt University administration has never integrated the Learning Management System (LMS) into the University's teaching and learning process. Thus, lecturers have never created online classrooms or virtual campuses for sharing the learning materials in advance for downloading and viewing by students. These findings seem to suggest that the use of digital learning lead institutions which have not made use of digital learning (e.g., LMS) in the past must see the value of pedagogy and make it a permanent feature of their portfolio.

Implications for Further Studies

This study has highlighted that the adoption of digital learning as a response to COVID-19 stimulates the growth of digital learning in mathematics education in Zambia. The priviledge of the current situation for students engaged in digital learning is to position this transformation not just as a "quick response" but as a way of combating the spread of COVID-19 and the next transferable disease. The sooner we help mathematics students master the needed skills of being an effective and efficient digital learner, the better. The findings of this study motivate new areas of research. Other researchers could carry out studies on the effects of COVID-19 on Education. Others could investigate on some useful digital resources for students

during the COVID-19 crisis and lockdown. It may also interest other researchers to examine if digital learning will eventually replace physical classroom in future. While digital learning is a life-long process for many students caught in the consequences of the spread of the deadly virus but may also be a way of coping with home confinement for all. There is a lot that can be learned during the COVID-19 closure period. COVID-19 will continue to spread and cause disruption. Therefore, it is hoped that CBU would make digital learning a permanent feature of their portfolio even if coronavirus resolves.

CONCLUSIONS AND RECOMMENDATIONS

Digital learning in mathematics allows students to even study at the comfort of their homes. As long as students have the necessary digital devices, access to internet, affordable internet costs and adquate supply of electricity, they can be able to obtain front seats in the mathematics virtual classroom. Results seem to suggest that prospective teachers believe that digital learning will enable them to have a mathematics pedagogical shift to a less formalized method of teaching that is entertaining and interesting rather than rigorous and traditional. In the wake of the COVID-19 school closure period, digital learning in mathematics education appears to be the immediate positive response. Authors wish to first recommend that CBU management creates an official online virtual platform [class] for mathematics for students to freely access all the information they need beforehand. Secondly, we recommend that policy makers and the government of Zambia re-evaluate digital learning and its place in education across all levels of learning during and after COVID-19 resolves. As the teaching strategies are evolving in this technological era around the world, prospective teachers at CBU do not wish to be left behind during the COVID-19 crisis. Thus, the findings of this study form a basis for recommending CBU to offer online courses in Mathematics Education via online instructors and tutors. Results have shown that the adoption of digital learning as a response to COVID-19 would stimulate the growth of digital learning in mathematics, especially in Zambia which has been historically resistant to the use of digital learning. Findings of this study converge with other studies.

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