The Challenges and Opportunities of Using ZOOM App in the Teaching and Learning of Mathematics in Higher Education Institutions (HEIs) During COVID-19 Pandemic: Lecturers' and Students' Perspective

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***Abstract*: The COVID-19 pandemic has affected educational systems worldwide, leading to the near-total closure of various institutions of learning such as: schools, colleges, and universities. Prior to the outbreak of the COVID-19 pandemic, Web-based information services (WIBS) such as ZOOM app, WebCT, Desire@Learn, Coursework, Atutor and Interact, Google Hangout, Google Meet, Google Classroom, Blackboard, Moodle, Olat, Sakai, Kallidus On Demand, and WebEx are being used by institutions in the teaching and learning of mathematics. ZOOM app allows students and lecturers to share the whiteboard, share the screen, add participants, mute participants in case of noise distortion, and upload lecture notes during the teaching and learning process. The study investigated the challenges and opportunities of using ZOOM app in the teaching and learning of mathematics during COVID-19: lecturers' and students' perspective. The study sought to establish challenges lecturers' and students' encounter when using ZOOM app in the teaching and learning of mathematics during COVID-19 pandemic and determine opportunities lecturers' and students' encounter when using ZOOM app in the teaching and learning of Mathematics during COVID-19 pandemic. Fifty (50) students taking Mathematics courses and ten (10) lecturers who teach mathematics courses at five (5) institutions in the Lusaka district of Zambia participated in this study. A mixed method approach which followed a descriptive survey study design, was used. Data was collected using a semi-structured questionnaire and a semi-structured interview schedule. Data was analysed descriptively and thematically. The challenges of using ZOOM app in the teaching and learning mathematics included: ZOOM app has limited capacity to accommodate more participants during the teaching and learning process; lack of good network connection; ZESCO power outages; lack of technological knowledge; high bundle consumption; and lack of devices for online learning such as smart mobile phones, computers, tablets, desktop, and smart televisions. In terms of the opportunities of using ZOOM app in the teaching and learning of mathematics, the study has established that: ZOOM app allows lecturers and students to teach and learn from anywhere; ZOOM app is cost effective than physical learning; ZOOM app facilitates group work; and ZOOM App options are easy to use; ZOOM app allows lecturers to schedule mathematics lessons in advance; and ZOOM app allows participants to join before the host. In view of these findings, it was recommended that government through the Ministry of Higher Education (MoGE) should promote the use of ZOOM app in the teaching and learning of mathematics. It was further recommended that government through the Ministry of Higher Education (MoGE) should ensure that more training should be given to lecturers as well as students in order to reinforce the change and support the new innovation due to COVID-19 to overcome ZOOM app challenges in teaching and learning of mathematics.**

***Keywords*: Mathematics, COVID-19, Web-based information services (WIBS), ZOOM app, challenges, opportunities**

I. INTRODUCTION

COVID-19 is a disease which is caused by a virus called corona. It was first detected in Wuhan, China. According to WHO (2019), the common symptoms of COVID-19 include: fever, dry cough, tiredness, a loss of taste or smell, shortness of breath or difficulty in breathing, muscle aches, chills, sore throat, runny nose, headache, and chest pain among others. The disruption in education due to COVID-19 has been unprecedented. At the point of this study, the COVID-19 pandemic has led to the closure of schools, colleges, and institutions in 188 countries, affecting more than 1.5 billion students and 63 million primary teachers, secondary teachers, and lecturers worldwide (UNESCO Institute for Statistics, 2020). This has staggered development for school-going children, with long-term consequences for their potential. Nevertheless, the barriers caused by COVID-19 pandemic have encouraged (HEIs) to use Web-based information services (WIBS) such as ZOOM app, WebCT, Desire@Learn, Coursework, Atutor and Interact, Google Hangout, Google Meet, Google Classroom, Blackboard, MOODLE, OLAT, Sakai, Kallidus On Demand, and WebEx in the teaching and learning of courses in general and mathematics courses in particular. Among the aforementioned Web-based information services (WIBS) being used in the teaching and learning of Mathematics, ZOOM app has appeared to be the most popularly used Video Broadcasting Tool (VBT) in the teaching and learning of Mathematics courses in higher education institutions (HEIs) in Zambia following the outbreak of COVID-19. ZOOM app is an American communications Technology Company headquartered in San Jose, California. It provides video telephone and online chat services through a cloud-based

peer-to-peer software platform and is used for teleconferencing, telecommuting, full-time education, part-time education, distance education, and social relations (UNESCO Institute for Statistics, 2020). It is an open source as it is readily available for use on the market (UNESCO Institute for Statistics, 2020).

Among other factors, many could have chosen the ZOOM app because it has now become the leader in modern enterprise video and audio communications, with an easy, reliable cloud platform for video and audio conferencing, chat, and webinars across mobile, desktop, and room systems (UNESCO Institute for Statistics, 2020). Besides, ZOOM app provides a learning environment that is social-constructivist in nature, instructors to plan and designate appropriate activities for the students on time, and it integrates a wide range of resources and assessment strategies (UNESCO Institute for Statistics, 2020).

Another compelling reason of choosing ZOOM app is that it allows students and lecturers to; share the whiteboard that can be used to solve, writes the notes, and draw or illustrate mathematical problems; ask questions during the teaching and learning process by raising the hand; and share the screen to broadcast the notes (UNESCO Institute for Statistics, 2020). In addition, ZOOM app allows students and lecturers to add participants, mute participants in case of noise distortion, and upload lecture notes during the teaching and learning process amidst COVID-19 pandemic (UNESCO Institute for Statistics, 2020). From the foregoing, it is of no doubt that ZOOM has become an increasingly important part of our academic systems in higher institutions of education in Zambia.

In view of Web-based information services (WIBS) used in the teaching and learning, there are many papers devoted to Moodle and not ZOOM app in HEIs. For example, Zakaria and Daud (2013) did a study on the role of technology which highlighted Moodle as a teaching tool in a graduate mathematics education course. The authors found that students had positive perception towards the use of Moodle. In another investigation of teaching and learning of mathematics using Moodle, Lopes (2011) found that if Moodle was used appropriately and systematically, both lecturers and students would benefit accordingly. Also, Handayanto, Supandi, and Ariyato (2018) looked at the teaching using Moodle in mathematics education. They found that there was a significant increase in exam results on the final exam of the semester.

While these studies have provided beneficial information on Moodle as a tool that is used in the teaching and learning of mathematics, most of these studies have looked at the teaching and learning of mathematics using Moodle and not ZOOM app. Moreover, the current study looked at the challenges and opportunities of using ZOOM app in the teaching and learning of mathematics during COVID-19 pandemic: lecturers' and students' perspectives**.** In particular, this study was guided by the following research questions: 1. What challenges do lecturers' and students' encounter when using ZOOM app in the teaching and learning of mathematics during COVID-19 pandemic? 2. What opportunities do lecturers' and students' encounter when using ZOOM app in the teaching and learning of Mathematics during COVID-19 pandemic?

II. THEORETICAL FRAMEWORK

The study was informed by Social Constructivism theory (Vygotsky, 1986). Social constructivism is a sociological theory of knowledge according to which human development is socially situated and knowledge is constructed through interaction with others. The Social Constructivism theory also holds that an individual's interactions with the environment create the cognitive structures that enable us to understand the world. In view of this, we therefore, argue that social constructivism theory increases student motivation, collaborative skills, increasing students' opportunity to talk with one another and discuss their ideas increases their ability to support their thinking, develop reasoning skills, and to argue their opinions persuasively and respectfully.

Since ZOOM app allows students and lecturers to audio and video conference, and therefore gives them more flexibility to learn and interact with other students and lecturers, social constructivism theory provided the researchers with a special language to understand challenges and opportunities lecturers' and students' encounter as they interact, share the whiteboard that can be used to solve, draw or illustrate mathematical problems, ask questions by raising the hand, share the screen to broadcast the notes, add participants, mute participants in case of noise distortion, upload lecture notes, and audio and video record the lecture lessons that allow both lecturers' and students' to interact during the teaching and learning of mathematics during COVID-19 pandemic.

III. METHODOLOGY

The descriptive case study design on investigating the challenges and opportunities of using ZOOM app in the teaching and learning of mathematics during COVID-19 among lecturers and students was accomplished through a mixed method approach. Fifty (50) students taking mathematics courses and ten (10) lecturers who teach mathematics courses at five (5) universities namely: institution A, institution B, institution C, institution D, and institution E in Lusaka District of Zambia participated in this study. Students were coded as A_1 to A_{10} (Students from institution A), B_1 to B_{10} (Students from institution B), C_1 to C_{10} (Students from institution C), D_1 to D_{10} (Students from institution D), and E_1 to E_{10} (Students from institution E). Lecturers have been coded as A (Lecturer from institution A), B (Lecturer from institution B), C (Lecturer from institution C), D (Lecturer from institution D), and E (Lecturer from institution E).

Data was gathered using semi-structured questionnaire and semi-structured interview schedule. The semi-structured questionnaire was used primarily for its ability to elicit and generate data on the perspectives of lecturers and students on the challenges and opportunities of using ZOOM app in the teaching and learning of Mathematics in HEIs during COVID-19 pandemic. Researchers employed the semi-structured questionnaire because it has an advantage over the interview in that it allows one to sample more units, at lower or no cost.

The semi-structured interview schedule was used because it is a more natural way of collecting data (McMillan and Schumacher, 1993). It helps to simultaneously solicit for opinions and experiences of participants in the natural settings (Cohen, Manion, and Morrison, 2007). Personal interviews are also a useful means of exploring someone else's ideas or thinking (Creswell, 2014). Scholars across the globe contend that interviews are said to be the best way to collect data because it helps the researcher to have feelings, opinions, gestures, tone of voice, reactions, attitudes, views, and are useful in gathering in-depth data (Kvale, 1996). Talking to the participants during interviews also helped to have an in-depth understanding of the challenges and opportunities of using ZOOM app in the teaching and learning of mathematics during COVID-19 to lecturers and students. Audio recordings were used to capture interviews in their totality (Meriam, 1998). During analysis, data recorded from interviews and questionnaires were transcribed verbatim, edited, coded, categorized, tabulated and where necessary graphed (Kothari and Garg, 2014).

IV. RESULTS AND DISCUSSION

In this section, researchers present results and discussions on the challenges and opportunities of using ZOOM app in the teaching and learning of Mathematics during COVID-19:lecturers' and students' perspective.

General perception of online learning in mathematics

The respondents were requested to give their general perception of online learning in mathematics. The findings are summarized in figure 1.

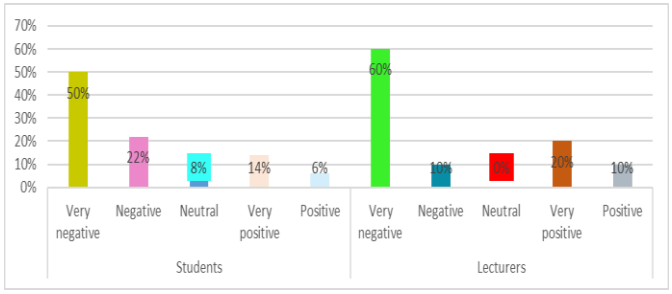

Figure 2: Respondents perception of online learning in mathematics

Source: Survey data, 2020

With regards to respondents perception of online learning in mathematics, figure 1 above indicates that 50% of the students and 60% of the lecturers had a very negative perception, 22% of the students and 10% of the lecturers had a negative, 8% of the students and 0% of the lecturers were not sure, 14% of the students and 20% of the lecturers had a very positive perception, and 6% of the students and 10% of the lecturers had a positive perception. Therefore, results show that that both students and lecturers share a negative view toward online learning in mathematics.

Using ZOOM app before as part of your previous education

The respondents during interviews were further asked if they have used ZOOM app in the teaching and learning of mathematics. The findings were shown figure 2 below:

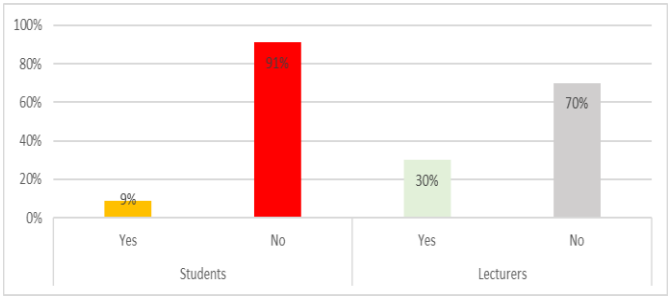

Figure 3: Used ZOOM app in Previous Education

Source: Survey data, 2020

Figure 2 above shows that 9% of the students and 30% of the lecturers had used ZOOM app before in their previous education whilst 91% of the students and 70% of the lecturers had never used ZOOM app before in their previous education. Therefore, results of the study suggests that both students and lecturers had never used ZOOM app before in their previous education

Types of Web-based information services (WIBS) used before apart from ZOOM app in Mathematics

First, respondents were asked whether apart from ZOOM app they had used any other Web-based information services (WIBS) in the teaching of mathematics before. The findings were as shown in figure 3.

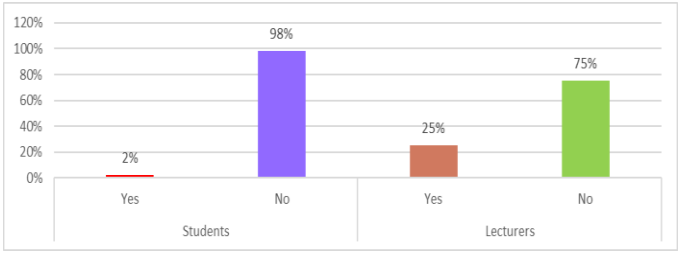

Figure 3: Whether the respondents had used other types of WIBS before apart from ZOOM app

Source: Survey data, 2020

Results in figure 3 showed that 2% of the students and 25% of the lecturers had used other Web-based information services (WIBS) in mathematics before apart from ZOOM app whilst

98% of the students and 75% of the lecturers had never used other Web-based information services (WIBS) in mathematics before apart from ZOOM app. Findings therefore indicated that both students and lecturers have not used other Web-based information services (WIBS) in mathematics before apart from ZOOM app.

Types of devices used by respondents to access ZOOM app in the teaching and learning of mathematics

Respondents were further asked to mention the types of devise they used to access ZOOM app in the teaching and learning of mathematics. The Findings were as shown in figure 4 below.

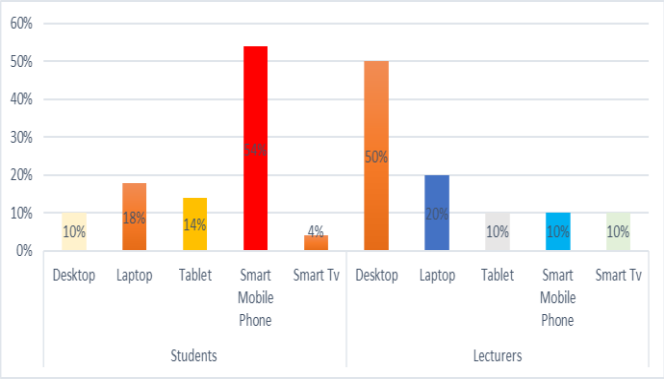

Figure 4: Types of devices used by respondents to access ZOOM app in the teaching and learning of mathematics

Source: Survey data, 2020

In terms of the types of of devices used by respondents to access ZOOM app in the teaching and learning of mathematics, figure 4 above indicates that 10% of the students and 50% of the lecturers used desktops, 18% of the students and 20% of the lecturers used laptops, 14% of the students and 10% of the lecturers used tablets, 54% of the students and 10% of the lecturers used smart mobile phones, 4% of the students and 10% of the lecturers used smart televisions. Results of the study revealed that students used smart mobiles phones and lecturers used desktop to access ZOOM app in the teaching and learning of mathematics.

Challenges of using ZOOM app in the teaching and learning of Mathematics

While the preceding section presented findings on the general perceptions of online learning in Mathematics, using ZOOM app before as part of your previous education, other types of WIBS they have used before apart from ZOOM app, and devices respondents use to access ZOOM app in the teaching and learning of Mathematics, this section presents and discusses the revealed challenges of using ZOOM app in the teaching and learning mathematics. Six (6) challenges were revealed:

ZOOM app capacity

When asked about the challenges lecturers and students encountered when using ZOOM app in the teaching and learning of mathematics, (54 out of 60) representing 90% spoke mentioned that ZOOM app lack the capacity to accommodate more participants during the process of teaching and learning mathematics as supported by the following passage for student A_3 from institution A is a typical example:

> *"……..ZOOM app only allow 100 participants, for that reason most students couldn't learn because we are over 300 plus students from each tutorial group. Especially us from lecture group B we are about 400 first year students doing MBChB. I remember at one point, our lecturers also tried combining two tutorial groups which couldn't work as well because we were over 500 plus. That made a lot of students to be left behind".*

Similarly, Student C_2 from institution C narrated that:

> *"……..One of the challenge is that ZOOM app only accommodate 100 students and you'll find that in our group we were more than 300 hence more students were left out during the process of teaching and learning Mathematics".*

Furthermore, lecturer B from institution B had also this to say:

> *"……..We faced quite a number of challenges, the first one would be that a lot of students were left behind when using the ZOOM app……. ZOOM app could only accommodate about 100 people per online lesson and for my lecture Group C, my first year students were put into smaller groups consisting of 2 tutorial groups i.e. 200 per group so that more students could access the lesson but it still couldn't accommodate everyone. Some would try to log in and the class would already be full……."*

Lack of good network connection

Results from the telephone interviews showed that about (50 out of 60) of the respondents representing 83% ardently cited about poor network when using ZOOM app in the teaching and learning of mathematics. For instance, the following passages by Students A from institution A and Student D from institution D aforesaid:

> *"……..As we know mathematics deals with a lot calculations. It was really difficult to understand especially when one experiences bad network. Mathematics needs students to be participating as the lecturer is lecturing but with ZOOM app that is close to impossible. Let me give an instance of calculus, it involves a lot of derivation and as such students must be writing as the lecture is underway but due to time and how poor the network is in Zambia, it is very difficult to do that as a result students might just be listening without writing in the end it will be very difficult to revise".* **(Students A_7 institution A, 2020).**

> "……..*Online learning is a type of learning that needs or requires Internet connection. When there is no internet connection then you can't access it and this was the case*

when we were learning Mathematics via ZOOM app. What do I mean? Well, you can access internet connection through WiFi or data connection. If you are using data connection then there is need for one to buy bundles so that they can have internet connection to access online learning. **(Students D from institution D, 2020).**

With regards to lecturers' views if poor network affected the teaching and learning of Mathematics via ZOOM app, lecturer A from institution A and lecturer D from institution D shared these views as revealed below in form of verbatim:

"……On the learning part I bet a few will say they understood when they were subjected to ZOOM app due to poor network. I remember one time the network was really bad that we had to cut the lesson……At times, technological difficulties such as Bandwidth was one of the drawback in the teaching and learning of mathematics via ZOOM app effectively because when the Bandwidth is poor, the sound drops in and out, forcing main students to ask a lecturer to repeat". **(Lecturer A from institution A, 2020).**

"……*Network problem in some parts of the country is very poor. Students come from different places and homes, urban and rural areas. As such, students from remote areas where network is down and poor failed to access the ZOOM app to learn Mathematics. For instance, almost 90 percent of institution A students come from rural areas, homes that are outside coverage on network. As such, students from those places and homes find it difficult to access the online learning. Approximately 1,250 students failed to write the end of term test which was conducted via Zoom in August, 2020 (***Lecturer D from institution D, 2020)**.

ZESCO power outages

Another challenge cited by lecturers and students was power outages when teaching and learning mathematics via ZOOM app. For instance, about (52 out of 60) of the respondents representing 87% during telephone interviews mentioned that Zambia Electricity Supply Corporation (ZESCO) power outage due to load shedding was one the biggest challenges they encountered when teaching and learning mathematics via ZOOM app as evidenced by the following passages for student D_7 from institution D and student E_1 from institution E who expressed that:

"……..As a result of ZESCO power cut when the mathematics lesson was going on, the lesson was always disturbed. Students could miss a lesson if the gadget was not charged due to ZESCO power outage. (**Student D_7 institution D, 2020).**

"……..There were some instances where there were power cuts at the institution due to load shading when learning mathematics via ZOOM app. These power cuts resulted into losing internet connection on the computers for the lecturers as they were using the institution WiFi because these routers for them to function are supposed to be connected to a power source". (**Student E_1 from institution E, 2020).**

Similarly, lecturer C from institution C during interviews observed that load shedding affected the teaching and learning of mathematics via ZOOM app because gadgets like laptops, tablets, mobile smart phones are power dependant as evidenced by the following excerpts:

"…….Load shedding has being a great challenge countrywide here in Zambia which has being hindering main students and lecturers from learning and teaching via ZOOM app respectively. Therefore, many students have being negatively affected because in some areas especially ZAMTEL subscribers, when power goes, network becomes poor".

Lack of technological knowledge

Study findings indicate that lecturers and students deemed lack of technological knowledge one of the challenges they encountered when using ZOOM app in the teaching and learning of mathematics. Majority of the respondents (55 out 60) representing 92% during telephone interviews cited having difficulties on how to use ZOOM app in the teaching and learning of mathematics as evidenced by the following verbatim for student C_{10} from institution C as a typical example:

"……..This ZOOM app is new to most of us students. I for one I never knew about this app and that it can be used to teach and learn Mathematics. Even up to now I still have difficulties on how to use it. I don't know how to download the app and install it; ".

Similarly, lecturer B from institution B during interviews observed that students and lecturers experienced difficulties with technical problems when installing ZOOM app on their gadgets and how to use it as evidenced by the following excerpts:

"……..Main Zambian students and lecturers faced a lot of challenges just in installing ZOOM app meeting and how to use it. This took a bit longer in learning and teaching mathematics via ZOOM app respectively……..Not only was installing ZOOM app was the problem, how to share the notes and how to add students to the meeting was a big problem".

Additionally, lecturer A from institution A narrated that;

"……Many lecturers have had faced a lot of challenges in conducting lessons of mathematics via ZOOM app effectively due to lack of knowledge on how to effectively

use technology for denotation of mathematical symbols. As a results of this, students have being facing challenges in learning mathematics on this platform. ".....Some lecturers are not yet well acquainted with technology therefore, the manner in which they deliver information to the students doesn't seem to motivate them. This a serious problem in this COVID-19 era where we are slowly moving away from the traditional classroom face-to-face to digital learning. Some lecturers who are not so friendly with technology need some serious orientations on how to use zoom platform as a way of teaching or lecturing effectively.

High bundle consumption

High bundle consumption was also one of the challenges both students and lecturers encountered when using ZOOM app in teaching and learning of mathematics. For instance, (50 out of 60) representing 83% of the respondents during interviews stated that high bundle consumption especially MTN, Airtel, and Zamtel bundles posed a great challenge when using the ZOOM app as evidenced by the following verbatim by student C_8 from institution C and E_2 from institution E as a typical example:

"Using ZOOM app require a lot of bundles. High bundle consumption by the app costed many students because a lot of us were missing the lessons. The thing is, when one run out of the bundles, the app logs you out automatically. This was my major challenge when it comes to using ZOOM app". (**Student C_8 from institution C, 2020).**

"……High bundle consumption especially MTN, Airtel, and Zamtel bundles have being posing a great challenge before students especially in this COVID-19 era where we have experienced economic backlash. Due to this, many students have been missing some classes because they can't manage to find money for bundles". (**Student E_2 from institution E, 2020).**

Lack of device for online learning

Responses from the students (49 out of 60) representing 82% during interviews revealed that lack of device such as mobile phones, computers etc. by lecturers and students affected the teaching and learning of mathematics via ZOOM app as evidenced by the following verbatim:

".....In terms of the financial challenge, one needs to have enough data bundles, good gadgets such as mobile phones, and computers when using ZOOM app to avoid disruptions when teaching and learning is going on. **(Student C_6 from institution C, 2020)**

".....In a case where one doesn't have bundles or money to buy bundles, proper gadgets like phones, or computers, teaching and learning mathematics becomes very difficult ". (**Lecturer E from institution E, 2020)**

Opportunities of using ZOOM app in the teaching and learning of mathematics

While the use of ZOOM in the teaching and learning of mathematics has the challenges mentioned in the above section, a number of students and lecturers find an opportunity in it's use. This study revealed four (4) opportunities in the use of ZOOM app in the teaching and learning of mathematics. Six (6) opportunities were revealed:

ZOOM app allows lecturers and students to teach and learn from anywhere

Lecturers and students (47 out of 60) representing 78% during interviews spoke highly about ZOOM app as it allows students to even study at the comfort of their homes. The following verbatim are typical example for student A_{10} from institution A and D_9 from institution D:

*"……ZOOM app meeting made most of us the students learn from the comfort of our homes. This made me enjoy learning mathematics this app. What is needed just is good gadget to access the lesson".***(Student A_{10} from institution A).**

".....Digital learning 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 adequate supply of electricity, they can enjoy digital learning". **(Student D_9 from institution D).**

ZOOM app is cost effective

In view of experiencing challenges with teaching and learning mathematics via ZOOM app, lecturers and students (53 out of 60) representing 88% during interviews cited that teaching and learning mathematics via ZOOM app is cost effective than physical learning as evidenced by the following excepts for students (A_2 and B_5) from institution A and institution B acts as typical examples:

"Learning mathematics via ZOOM app is cost effective for some of us students because the money I was supposed to use for transport to move from home to school was used for bundles…… Also, because of learning mathematics via ZOOM app, the money for boarding house rentals was saved for school fees because we were learning from home". (**Student A_2 from institution A).**

".....I found learning Mathematics via ZOOM app to be very cost effective because it helped me a lot in terms of saving money for keep up, rentals for accommodation. Last term my parents did not spend a lot because of learning Mathematics via ZOOM app". **(Student B_5 from institution B).**

ZOOM app facilitates group work

Majority of the lecturers and students (56 out of 55) representing 93% during interviews recommended that teaching and learning mathematics via ZOOM app provides a click and connect conferencing solution. For instance, the following excerpts act as a typical example by student A from institution A:

> *"ZOOM app is a video collaboration tool that provides a click and connect conferencing solution. You can use it for classroom teaching and learning, and group discussions. "ZOOM app is an easy application one can create a video meeting conference, invite students, solicit participation and share resources. It is close to being in the same lecture hall as you can while working and learning from home".*

ZOOM App features are easy to use

Lecturers and students (49 out of 60) representing 82% during telephone interviews spoke passionately about ZOOM app features being easy to use in the teaching and learning of mathematics. For instance, the following verbatim by student C_2 from institution C and lecturer D from institution D act as typical examples:

> *"……Easy features on ZOOM app offers our lecturers an efficient way to deliver lessons to us the students. Our lecturers can use screen sharing option for instance to share lecture notes, PowerPoint presentations. They can also use the whiteboard option to write lecture notes and solve some mathematical problems".***(Student C_2 from institution C , 2020).**

> *"……ZOOM app has proven to be efficient, easy and reliable app despite some of the challenges we encounter when using the app. The features such as audio and video recording are awesome. When teaching I was recording all the lessons and I could also encourage my students to audio and video record me when I am teaching. Also, on ZOOM app, you can share the notes and you can also share the screen so that your students are able to see what has been shared.* **(Lecturer D from institution D, 2020).**

Similarly, lecturer B from institution B during telephone interviews expressed that:

> *"……..ZOOM app has easy features that allows lecturers to screen sharing. It also allows a lecturer to annotate the shared screen, making lessons more interactive. You can record your lessons to the cloud or locally and students can do this too, and turn the recording on and off as many times as they like to understand the covered topic of interest……..Students can choose the time and length of their lessons because they have full control of their learning especially if they have access to the lessons' recording.*

ZOOM app allows lecturers to schedule lessons in advance

A large portion of the lecturers and students (54 out of 60) representing 90% during the interviews expressed that ZOOM app allows lecturers to schedule mathematics lessons in advance classes as evidenced by the following excerpts act as a typical example by student C_{10} from institution C and lecturer A from institution A:

> *"ZOOM app allows our lecturers to schedule our mathematics courses on time. I personally I have seen that option on the app, it's there."* **(Student C_{10} from institution C, 2020)**

> *"……ZOOM app allows lecturers to schedule classes before lesson starts in mathematics. For instance, if tomorrow I have M412 (Complex Analysis) at 12:hours, I will schedule the lesson on time and when that day come, there will be no need of scheduling the meeting because it was already scheduled."* **(Lecturer A from institution A, 2020)**

Similarly, lecturer E from institution E during interviews narrated that:

> *"ZOOM app allows lecturers to schedule classes before lesson starts in advance. When a particular course has been scheduled on time, it sends a message to the students that the lesson for that course will be there on that fateful day".*

ZOOM app allows participants to join before the host

At least 77% (46 out of 60) of the lecturers and students expressed that ZOOM app allows participants to join before the host as evidenced by the following verbatim for student D_5 from institution D as a typical example:

> *"……We always join the meeting before our lecturer joins in. This is a very good option. At least our lecturers find us already in a meeting and this makes us settle in advance too".*

Similarly, lecturer B from institution said:

> *"……One thing I like about ZOOM app is that when scheduling a meeting, there is an option where when you click on it (allow participants to join before host), you will find your students have already joined and waiting for their lecturer".*

V. DISCUSSIONS

Perception of using ZOOM app

Findings reveal that most lecturers and students had a negative perception regarding the use of ZOOM app in the teaching and learning of mathematics. One possible reason why lecturers and students had a negative perception toward the use of ZOOM app in the teaching and learning of mathematics could be that most of them have never used Web-based Information Services (WIBS) such as Google meet, Google

classroom, Blackboard, Moodle, Olat etc. before in their previous education. This finding is in line with the study done by Alkhanak and Azmi (2011) who found that both lecturers and students had a negative attitudes towards e-learning. Besides, it was established that lecturers and students used different types of devices such as laptops, tablets, smart mobile phones, smart televisions, and desktops to access ZOOM app in the teaching and learning of mathematics. This finding conforms to the assertions of Adayana (2015) and McIntosh (2016) who in their study found that laptops, computers, desktops, and smart mobile phones were mostly used in e-learning.

Challenges

Study findings indicate that lecturers and students deemed lack of technological knowledge as one of the challenges they encountered when using ZOOM app in the teaching and learning of mathematics. In respect of this finding, researchers therefore, infer that for the effective use of ZOOM app in the teaching and learning of mathematics, both lecturers and students should have the technological knowledge on how to install ZOOM app on devices such as smart mobile phones, computers, tablets, smart televisions, and desktops; how to mute and un-mute participants, how to upload the learning materials on ZOOM app; how to share lecture notes and presentations on the screen on ZOOM app; and how to audio and video record on ZOOM app. These findings agree with the assertions of Marban (2020), where he says, "e-learning require technological knowledge. For instance teachers need to have technological content knowledge on how to install apps on computers, how to operate a computer, how to uninstall an app, how to teach using a computer or projector (Marban, 2020). However, researchers, therefore, argue that both lecturers and students lacked technological knowledge because they have never used ZOOM app before in their previous education.

This study also established that power outages due to load shedding affected the teaching and learning of mathematics via ZOOM app. It was discovered that ZESCO power cut disturbed a lot of mathematics lessons and as a result, majority of the students missed the lessons because their devices such as smart mobile phones, computer, tablets etc. could not be charged. Researchers argue that load shedding is a major threat to e-learning in Zambia which hinders many students and lecturers from learning and teaching on Web-based information services (WIBS) such as ZOOM app, Google meet, Google class, Moodle etc. In the same view, Allen and Seaman (2017) confirm that to access Web-based information services (WIBS), devices such as smart mobile phones, computers, tablets, and smart televisions must be charged.

With regards to capacity on ZOOM app, the study established that ZOOM app has a limited lack capacity to accommodate more participants during the process of teaching and learning mathematics. Lecturers and students expressed that during the teaching and learning process of mathematics, ZOOM app only accommodated 100 participants, for this reason, majority of the students could not learn because they were over 300 plus students from each lecture group. The findings of this study are consistent with the study done by Guzacheva (2020) which found out that ZOOM app especially for the unlimited package has limited capacity and limited time limit. The researchers, therefore, deduce that the capacity of adding 100 students at a time is not a good option because if the number of the students is over 100, it means those who are not added will not learn.

The study also established that lack of good network problem was another challenge both lecturers and students encountered when teaching and learning mathematics via ZOOM app. The led to disconnection of the Mathematics lessons, interruption of the Mathematics lessons, and poor audio and video quality. Based on this finding, authors postulate that good network plays an important role in the online Mathematics lessons via ZOOM app or any other learning management system so that lecturers are able to teach and students are able to learn without interruption or disruptions. The study also found that some students did not have access to the internet as they were in far flung areas where accessing internet was a very big challenge. In line with this finding, authors, therefore, infer that in Zambia, internet network systems and electricity supply were not always reliable. Thus internet connections and electricity shortages had actually interfered with the access to the teaching and learning of mathematics via online platform (Abad-Segura and Ruipérez, 2020).

Furthermore, the study has established that both lecturers and students lack of devices such as computers, smart mobile phones, tablets, desktop in the teaching and learning of mathematics via ZOOM app meeting. In view of the above findings, researchers in this study argue that ZOOM app can only be installed and operational on devices like smart mobile phones, computers, tablets, and smart televisions which are so expensive to some lecturers and students to get one for teaching and learning of mathematics. The researchers assertion is supported by Brigs (2019) who postulated that the challenges of e-learning involve lack of computers with high speed internet or internet connections, lack of computer peripherals, lack of smart phones, lack of tablets and or other related ICT incompetence amongst students and lecturers.

High bundle consumption affected the teaching and learning of mathematics via ZOOM app. Based on this finding, researchers, therefore, argue that accessing ZOOM app is not free of charge. Lecturers and students must have megabytes (Mbs) to be able to access online mathematics lessons, but Mbs in Zambia can cost a lot of funds. It was discovered that one mathematics lecture on ZOOM app consumed almost about 800 to 1GB which is equivalent to K10 Zambian currency. Which means that if a lecturer or student has 5 lectures a day, he/she will spend about K50 per day, K250 a week and K1000 a month. With this in mind,

teaching and learning mathematics using ZOOM app is costly for both lecturers and students especially underprivileged (ASK, 2019).

Opportunities

The study has also established that teaching and learning mathematics via ZOOM app allows lecturers and students to teach and learn at the comfort of their homes. In view of this finding, the researchers therefore submit that as long as lecturers and students have the necessary digital devices, access to internet, affordable internet costs, and adequate supply of electricity, teaching and learning of mathematics can take place from anywhere. In fact, as the content is generally being reloaded on ZOOM app, lecturers and students can download the lectures / videos and watch them at their convenience time and again. Researchers further argue that the option for recording on ZOOM app can help lecturers record lessons and watch them again to assess mathematics students' strengths and weaknesses and students can self-assess their skills by watching recorded lessons at any-time and anywhere. The findings of this study are generally supported by Holmes and Gardner (2006) who contended that due to e-learning, students can learn at anytime and anywhere, thereby developing new skills in the process leading to life-long learning.

Besides, findings also showed that teaching and learning mathematics via ZOOM app is cost effective and cheaper than physical learning. Students and lecturers expressed that there are no movements required when teaching and learning mathematics via ZOOM app because each and every lecturer and learner can teach and learn from their homes. In view of this finding, researchers can claim that COVID-19 has led to both lecturers and students to teach and learn from anywhere and at any time. This also imply that teaching and learning mathematics does not require learning to take place from the classroom, it can also take place outside the classroom environment. This claim is also supported by Toquero (2020) who said that the goodness about online learning platforms is that majority of them are cost effective but requires good internet services.

Research findings have shown that ZOOM app has easy options such as the share screen option that allows lecturers and students to upload lecture notes, mathematical videos, and PowerPoint presentations and whiteboard option that allows both lecturers and students to write formulas, draw or illustrate mathematical diagrams or shapes. In view of this finding, researchers argue that ZOOM app options such as sharing the white-board that can be used to write mathematical problems, write mathematical formulas, solve mathematical problems, draw or illustrate mathematical shapes, ask questions by raising the hand, share the screen to broadcast the notes, add participants, mute participants in case of noise distortion, upload lecture notes, and audio and video record the lecture lessons are important features that allows both lecturers and students to interact during the teaching and learning of mathematics. ZOOM app options for screen sharing can give mathematics lecturers a great opportunity to develop mathematics students' intercultural skills by sharing engaging materials such as videos and articles, and presentations. Researchers arguments are supported by Kahn (2001) who pointed out that online lectures can be recorded, archived, and shared for future reference. This allows students to access the learning material at a time of their comfort.

Results of the study indicates that ZOOM app meeting facilitates group work among the students in the teaching and learning mathematics. In this respect, researchers argue that ZOOM app is a great tool for collaboration that provides a click and connect conferencing solution that can be used for classroom teaching and learning and group discussions. Mathematics students can use the chat box with another students, with their mathematics lecturer or with the group. They can see everyone's camera and listen to everyone. The findings of this study are in consistent with Guzacheva (2020) who found out that instructors can use the breakout rooms on ZOOM app to group students in pairs of three, four, or in whatever size group they want. It is a great way to encourage pair work or group work and allow medical students to work independently (Guzacheva, 2020).

It has been further established that ZOOM app allows mathematics lecturers to schedule lessons in mathematics in advance. Researchers argue that scheduling a meeting in advance save lecturers time because once you schedule a meeting there is no need to schedule another one. Researchers further argue that scheduling a meeting in advance helps the students to settle as they wait for their lecturer to join. The finding of this study is in line with the UNESCO Institute for Statistics (2020) which reported that ZOOM app allows instructors to plan and designate appropriate activities for the students on time.

Another impressive fact that was found out in this study was that ZOOM app allows participants to join before the host. In view of this finding, researchers argue that the option "join before host" is a very good option on the part of the lecturers that allows students to carry on with a meeting when their lecturer is not able to start the lesson at the exact scheduled time. This tie with the findings of (Guzacheva, 2020) that teachers when scheduling a meeting can click on "join before host" to allow the students join before their teacher.

VI. CONCLUSION AND RECOMMENDATIONS

The study investigated the challenges and opportunities of using ZOOM app in the teaching and learning of mathematics during COVID-19 pandemic from lecturers' and students' perspective. Teaching and learning of Mathematics via ZOOM app by both lecturers and students were constrained by: ZOOM app capacity; lack of good network connection; ZESCO power outages; lack of technological knowledge; high bundle consumption; and lack of devices for online learning such as smart mobile phones, computers, tablets, desktop, and smart

televisions. Besides, the study has also established that the opportunities of teaching and learning mathematics via ZOOM app include: ZOOM app allows lecturers and students to teach and learn from anywhere; ZOOM app is cost effective than physical learning; ZOOM app facilitates group work; and ZOOM App options are easy to use; ZOOM app allows lecturers to schedule lessons in advance; and ZOOM app allows participants to join before the host.

Based on the study findings, researchers in this study recommends that:

- Government through the Ministry of Higher Education (MoGE) should promote the use of ZOOM app in the teaching and learning of mathematics.
- Government through the Ministry of Higher Education (MoGE) should ensure that more training should be given to lecturers as well as students in order to reinforce the change and support the new innovation due to COVID-19 to overcome ZOOM app challenges in teaching and learning of mathematics.
- There is need for researchers to conduct a large scale study of different types of open source learning management systems on the market that can be used by universities apart from ZOOM app.
- There is need for researchers to also further research is needed to get opinions of students from different universities within a particular district on the use of ZOOM app in term of effectiveness and the weakness of the app.

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