Lecturers' Experiences in Teaching STEM Courses Online During COVID-19: Case of a Zimbabwean University

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Abstract
This paper explains the university lecturers' experiences of teaching Science, Technology, Engineering, and Mathematics (STEM) courses during the coronavirus (COVID-19) pandemic. The 210 research participants were drawn from a single university in Zimbabwe, a developing country in southern Africa. While there exists literature on the online teaching approaches during COVID-19, this paper argues that there is limited literature on lecturers' experiences in teaching STEM courses online because focuses literature discusses the experiences of lecturers in developing countries with different contextual conditions. Other existing literature focuses on learners, whose online learning experiences may be different from those of the lecturers. Furthermore, much existing literature focuses on a similar subject uses data collected using qualitative methods. Lastly, focuses literature did not apply any theory for guidance. It was therefore, imperative to fill this gap in the literature by conducting this quantitative research. That was guided by Giddens' Structuration theory, which focussed on the lecturers of a university in a developing country context. The findings of this research support Structuration theory's observation that human activities are bound by space and time. Poor economic conditions and the restrictive period of COVID-19 constrained online teaching activities. Furthermore, the traditional teaching methods, misallocation of online teaching resources, and reliance on the prevailing teaching culture corresponding to structures of signification, domination, and legitimation respectively, also constrained teaching of STEM courses online. The paper concludes with a causal loop diagram of factors influencing the lecturers' teaching of STEM courses online.

Keywords: STEM, Teaching, Online, Lecturers, COVID-19

1. Introduction

This study explains the experiences of the lecturers in teaching STEM courses during the Corona Virus (COVID-19) pandemic. The outbreak of COVID-19 pandemic, which was first experienced at the end of the year 2019, and stretched for at least three years, disrupted much of human social and business activities including the physical teaching and learning process. Physical contact was restricted, which meant that neither lecturers nor students could attend physical classes or participate in in-person interactions as per the norm of traditional teaching and learning (Orlov et al. 2021; Lapitan et al. 2021). For the education process to continue undisrupted, new ways of teaching and learning had to be devised, which included the introduction of virtual classes conducted through online tools and technologies (Bruggeman et al. 2022). Lecturers from different university institutions must have had different experiences while teaching STEM courses online. For a better understanding of these experiences, it was imperative to conduct this study.

2. Purpose of the study

Several studies have been conducted regarding the benefits and problems of teaching and learning online during COVID-19 pandemic. For example, Özüdoğru (2021) investigated the problems faced by the Turkish state university teachers who migrated to online distance education during COVID-19. Using a different approach, Orlov et al. (2021) examined the effects of introducing online learning approaches on students during COVID-19 pandemic. While there are studies that were conducted on the teaching of STEM courses online (Lapitan et al. 2021), there are limited similar studies conducted in the context of developing countries, Zimbabwe in particular. Much of these studies either focussed on developed countries, learners or teachers of other courses than STEM courses. Questions on the experiences of lecturers in the developing countries' online teaching of STEM courses remain unanswered. This research was therefore aimed at providing answers to the following research questions, which sought to explain the experiences of university lecturers in their endeavor to apply online teaching approaches to teach STEM courses.

1. What benefits were enjoyed by lecturers while teaching STEM courses online during COVID-19 pandemic?
2. What were the challenges faced by lecturers while teaching STEM courses online during COVID-19 pandemic?
3. What factors influenced the smooth transition from physical to online classes during constraining situations like COVID-19 pandemic?

3. Related Work

Literature exists that discusses the transition from face-to-face to online teaching and learning during COVID-19 pandemic. There are many publications on the topic of online teaching and learning during COVID-19. Some of the publications are listed in Table 1.

Publication	Purpose	Collected Data	Findings
Orlov et al. (2021)	Examined the effects of COVID-19 pandemic on student learning of economic courses	Quantitative	Students' performance in the pandemic semester was very poor
Lapitan et al. (2021)	Surveyed the impact of online instruction on undergraduate students' Chemistry lecture courses	Quantitative	The authors identified challenges like stability of internet connection and instructor's familiarity with readily available internet-based teaching tools, such as video conferencing software
Bruggeman et al. (2022)	Investigated the online education experiences of Belgium university teachers during COVID-19 pandemic	Qualitative	The study shows that teachers were stressed due no-connection with students and colleagues, lack of control of students' learning processes, poor online interaction, changing teacher roles, (5) tension due to time pressure and support issues.

Table 1: List of a sample of reviewed literature

Table 1 has a sample of reviewed literature relating to online teaching during COVID-19. Adding to the literature is Lukas and Yunus (2021) who examined the limitations of eLearning in teaching English language at a Malaysian primary schools. The findings revealed that limited readiness, access to mobile phones and poor connectivity, classroom management, and assessment hindered use of eLearning in those Malaysian schools. The findings from a study by Aladsani (2022) indicated that local culture prevented the success of online learning at six Saudi Arabian universities that were examined.

An investigation on the impact of online teaching at South Korean universities revealed that the adoption of online methods was influenced by the shortage of resources and other academic dilemmas (Lee et al., 2022). Kim et al. (2021) examined physical education teachers'perceptions about teaching online during COVID 19. Their findings show that all the participants agreed that online classes deprived them of in-person relationships and interactions with their students. A similar study was conducted by Cruickshank, Pill, and Mainsbridge (2021), who also investigated the Australian teachers'experiences of teaching physical education online and they concluded that the move to online provision resulted in diminished educational purpose. ÖZÜDOĞRU (2021) investigated the problems faced by pre-service teachers of a state university in Turkey during COVID-19. They found that lack of time for course implementation; failure to communicate with friends, internet connectivity, lack of technical support, etc., were the major problems of ICT-supported distance education.

Almahasees, Mohsen, and Amin (2021) examined lecturers and students'perceptions about online learning and they found that deaf and hard of hearing students had challenges relating to a lack of interaction and motivation, technical, and Internet issues, data privacy, and security issues. Mutunhu et al. (2022) explains Zimbabwean university students' experiences of learning online during COVID-19 pandemic. Their findings revealed that students were

stressed by high costs of mobile data, boredom, lack of resources, and limited training. In an earlier study, Dube (2020) identies the structural mechanisms for adopting the ICT-supported education in Zimbabwe's higher education institutions. The findings from this study demonstrate that there were domination, signification, and legitimation structures influenced the success of ICT-supported education. in an earlier study, Dube and Scott (2018) reported limited resources, lack of management and technical support, electricity power outages, and resistance to change as the organisational constraints of online education.

Much of the reviewed literature was based on qualitative data collected through interviews and focus group discussions. None of the reviewed literature was guided by a theoretical framework except one study by Lee et al (2022), whose study was informed by the lens of an activity theory. In addition, most of the reviewed articles were based on qualitative data, which lacks the insight and richness provided by the qualitative data.

4. Structuration theory

Giddens (1984) proposed Structuration theory, which is a social theory that depicts the duality or interplay of structure and agency. While structure refers to rules and resources, agency refers to human actions. Both structure and agency interact such that structure can either enable or constrain human activities. The duality, is in the interplay between structure or structural properties and human action as bound by space and time (Giddens 1984). According to Structuration theory, structural properties are a result of social practices, which in-turn are either enabled or sanctioned by the same social practices that formed them. In other words, structure is both the medium and the outcome of the reproduction of practices. As such, structure is created by agency, and simultaneously, agency is facilitated or sanctioned by the same structures it creates. Structure is divided into; signification, domination, and legitimation structures that influence the human activities of communication, power and sanction through the modalities of interpretive scheme, facility and norm, as shown in a model in Figure 1.

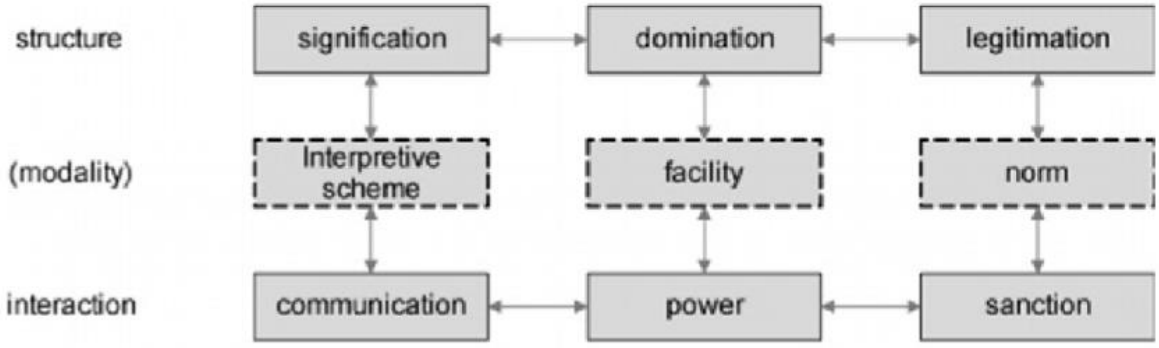

Figure 1: Structuration Theory M*odel (adopted from Giddens [1984, p. 29]*)

Figure 1 shows the three structures of signification, domination, and legitimation as well as the three human activities (interaction) that include communication, power, and sanction, which all interact with the corresponding structures through the modalities of interpretive scheme, facility, and norm, respectively. According to Structuration theory social practices (human activities) are bound by both space and time (Giddens 1984). This implies that both the conditions of the university case in a developing country context, (**space)** and the particular point in (**time)** of the prevalence of COVID-19 pandemic had an important role to play in the advancement or sanctioning of the adoption and usage of online methods in the teaching of STEM courses.

Accordingly, according to **structures of signification**, lecturers of STEM courses can determine the significance of teaching STEM courses online by verbally or non-verbally communicating knowledge drawn from the interpretive scheme (stored in memory or observed from the environment) about available teaching methods, which could be of significance. This means that if online methods of teaching STEM courses are considered significant if they add value, such methods tend to be adopted, otherwise, if they are not of any significance, they will be rejected. Similarly**, domination structures** enable or hinder the adoption of online methods of teaching STEM courses if the management is considered to appropriately use their power to allocate resources that can facilitate the teaching of STEM courses online. Consequently, the **structures of legitimation** mean that the lectures in STEM courses tend to legitimize only those teaching methods that are not sanctioned by the prevailing cultural norms. In this regard, this study collected data to explain the lecturers' experiences of teaching STEM courses online during COVID-19 era.

5. Methods of data collection

Quantitative data were collected from a survey of professors, lecturers, and teaching assistants, which was conducted through a Google Form sent to the research participants via email. This was a purposive sample of research participants involved in the teaching of STEM courses at a single university in Zimbabwe, a developing country in Southern Africa. In a population of four hundred lecturers, 210 responded and completed the emailed Google Form. This was a favourable response rate since it exceeded the threshold sample size of 196 in accordance with Yamane's formula: $n = N/(1+N(e)^2$ where the confidence level is 95% and the margin of error is 5%. The questionnaire was divided into 5 sections, which included demographic data, teaching devices, tools, techniques, benefits of online teaching, challenges of online teaching, and recommendations for future improvements. An analysis of the collected data revealed results discussed in the section on findings and discussion.

6. Findings and Discussions

The data analysis revealed that there was an unequal distribution of participants by gender. Figure 2 shows that there was 50% male representation, 47.1% female representation, and 0.9% non-disclosed gender representation. The results confirm the status quo of the institution, which is male dominated, a situation that could be attributed to the idea that females usually shy away from STEM subjects.

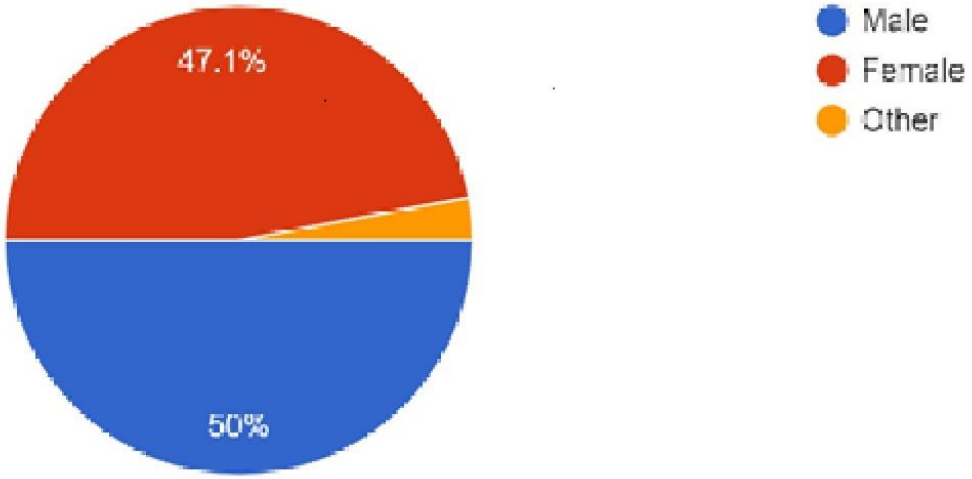

Figure 2: Research participants' distribution by gender

The research participants were also required to choose from the provided set of devices that they used in the teaching of the STEM courses during COVID-19 pandemic. The responses are depicted in Figure 3.

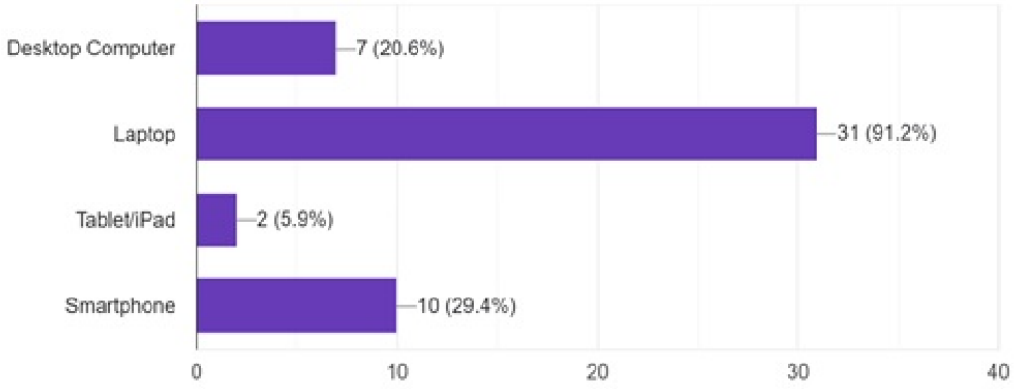

Figure 3: ICT devices used for teaching during COVID-19 pandemic

Depicted in Figure 3 are the devices used by lecturers in teaching during COVID-19 pandemic. It is evident that most lecturers used their personal laptops to both prepare and deliver the lectures. Smart phones had a minimum usage rate, which makes sense since such mobile devices are usually used for communication and gaming rather than as tools for teaching. Surprisingly, desktop computers and tablet PCs / iPads were not popular among lecturers. Figure 4 shows the distribution of online teaching platforms that were accessible to the lecturers during COVID-19.

The platforms included both proprietary and purchased platforms and free online platforms. Google Classroom had the highest ranking, followed by Google Meet and WhatsApp. The popularity of these platforms could be attributed to both their ease of access and their useful features, such as document sharing, video conferencing, real-time participation, meeting, recording etc. Furthermore, unlike ZOOM, which requires installation, Google Meet and Google Classroom can be used online without installing them on the user's device, which is an advantage as it saves the device storage space. Learning management systems (LMS) and Facebook were rarely used, probably due to the fact that while LMS are rigid, Facebook was

not designed for teaching and learning. Telegram and Skype were not used by the research participants for teaching purposes, which could be an issue of a lack of familiarity with those platforms as tools for teaching.

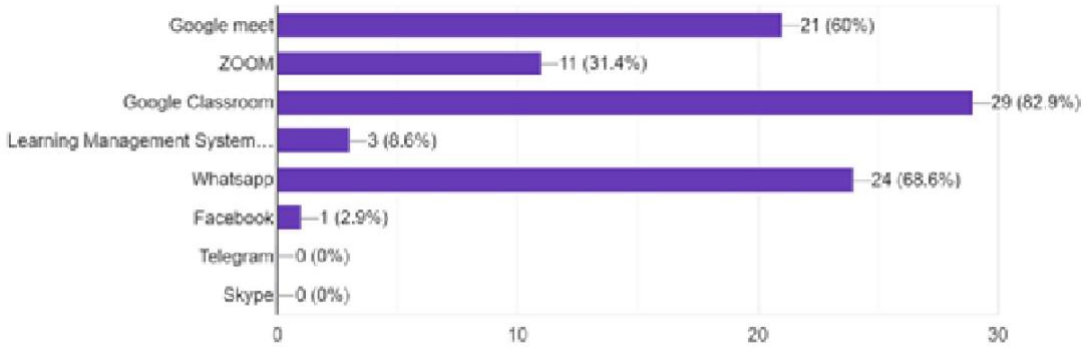

Figure 4: Common online teaching platforms used during COVID-19 pandemic

This study sought to answer three research questions relating to the benefits of teaching STEM courses online, challenges faced while teaching STEM courses online, and the strategies for improving the transformation from physical to virtual classes during life-threatening pandemics similar to COVID-19. The results of this study revealed that the research participants enjoyed many benefits from teaching STEM courses online. Some of the identified benefits are shown in Figure 5.

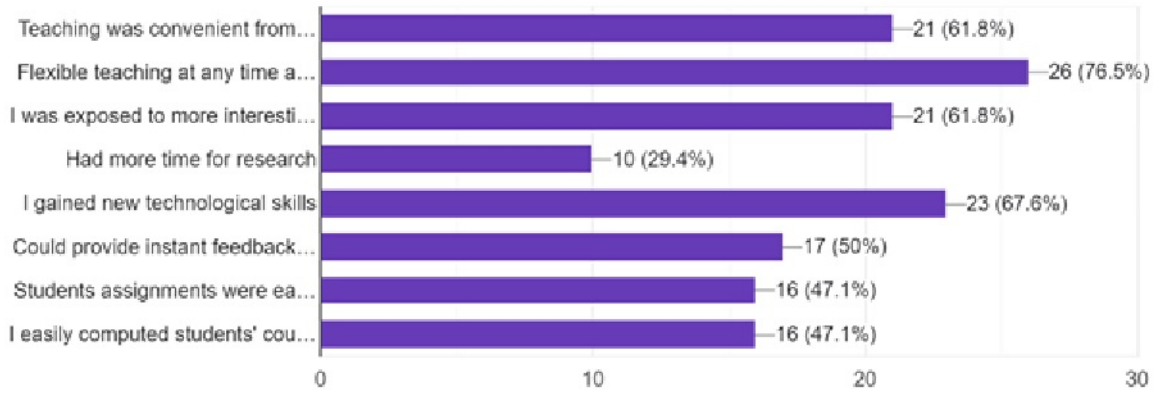

Figure 5: Sample benefits for teaching STEM courses online during COVID-19

The identified benefits of teaching STEM courses online included the following:

- Easy access to course content
- Increased collaboration
- Enhanced knowledge and skills on the use of electronic devices and online tools
- Reduced transport costs to and from campus
- Teaching flexibility
- In the difficult era students were taught
- Instant feedback
- Course content sharing

The findings of this research also revealed that there were challenges associated with teaching STEM courses online. A sample of these challenges is depicted on Figure 6. And they include:

- Lack of access to electronic devices
- Lack of management support
- Limited funding for data
- Low student turn-out for virtual classes
- Lack of personal touch (students and lecturer)
- Lack of access to paid tools or apps 2)
- Timeous and tedious preparation of course content
- Lack of training on how to teach with online tools and devices
- Lack of online plagiarism checking tools: insufficient data bundles
- Internet connectivity challenges
- Difficulty of assessing and monitoring students' participation during the lecture

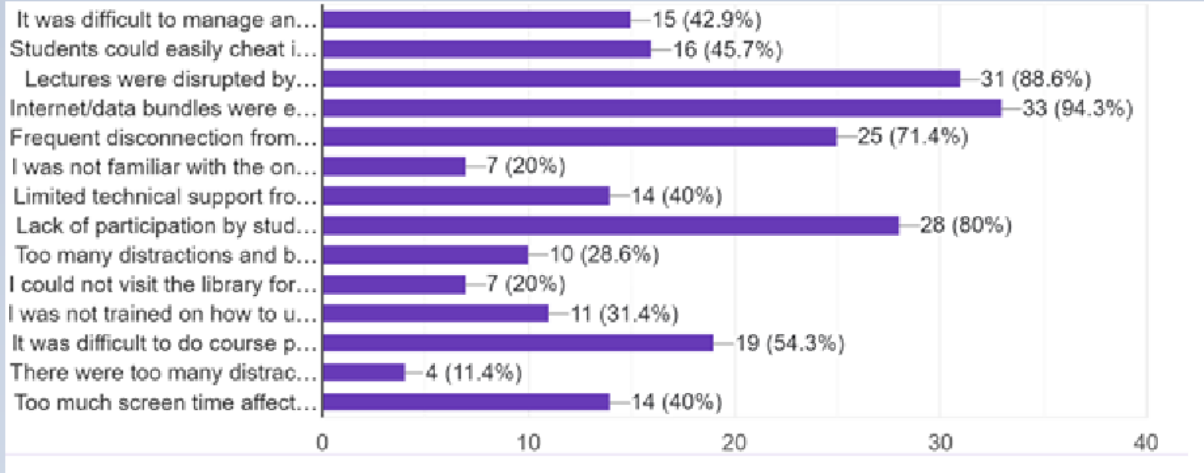

Figure 6: Challenges of teaching STEM courses online during COVID-19

The research participants concluded by recommending some practical strategies for improving the teaching of STEM courses online, particularly during restraining spaces and times as it was experienced by lecturers during the life-threatening COVID-19 pandemic. A summary of the challenges of teaching STEM courses online is depicted in Figure7.

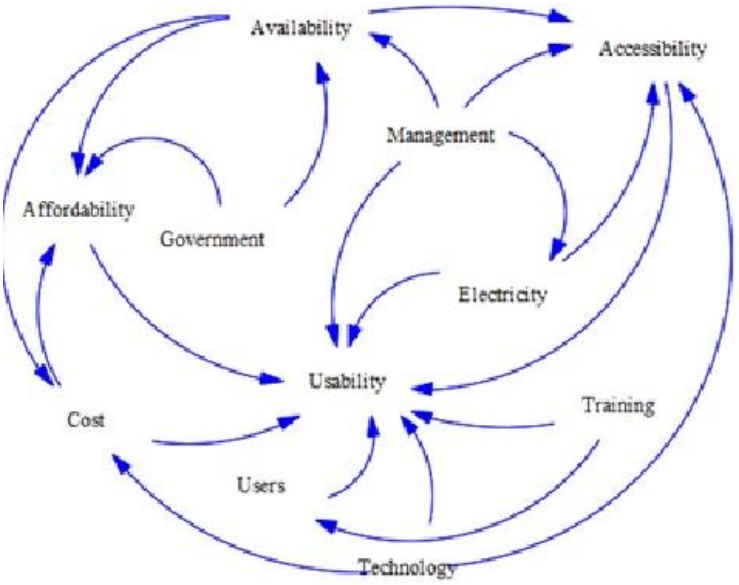

Figure 7: Causal Loop Diagram of factors influencing teaching of STEM courses online

Figure 7 presents the factors that influence the adoption of ICT technologies in teaching STEM courses online. These factors include the availability, accessibility, affordability and the usability of resources for teaching STEM courses online. For instance, if the resources are neither available, accessible, affordable nor usable, they cannot be adopted in the teaching of STEM courses. Both the government of a country in question and the management of the specific universities have a major role in availing the tools and technologies for teaching STEM courses online. Both parties could ensure that the concerned tools and technologies are affordable by either subsidising the costs or relaxing importation duty fees for such resources. If the relevant ICT resources are affordable, they will automatically become easily accessible to both the lecturers and students. If the lecturers and students are both equipped with the necessary knowledge for using the accessible ICT resources, they will enjoy maximum utilisation of the accessible ICT resources, and actively participate in the online teaching and learning of STEM courses. The lecturers proceeded to recommend strategies for improving the teaching of STEM courses online, which are shown in Figure 8.

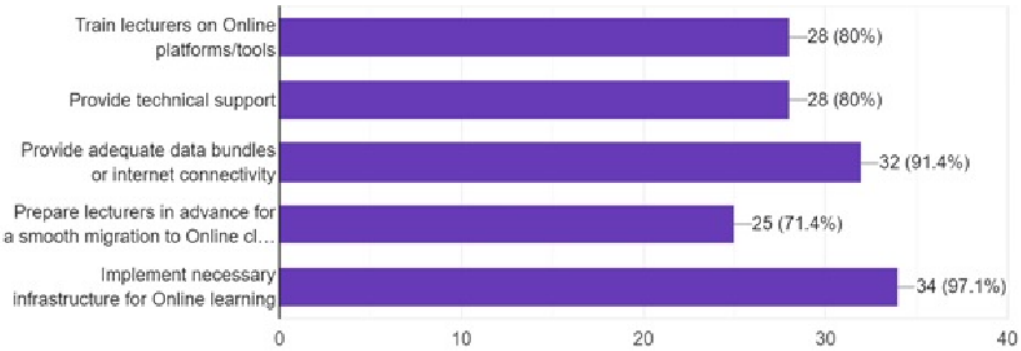

Figure 8: A list of recommendations for improving teaching STEM courses online

The strategies recommended by the research participants can be summed up as:

- Increase student support online facility
- More training would be beneficial especially on better security measures when doing online tests etc.

- Hands on training preferable to a pdf
- Ensure that students have access to ICT
- Familiarization with online tools is important

7. Discussion

This study acknowledges that much of these findings exist in literature, it is worthwhile to note that much of such existing studies were conducted qualitatively with a small sample size as it was shown in Table 1 and much of such studies were not focussed on STEM courses, were not informed by concepts and relationships of any theory. It was therefore imperative to understand the lecturers' experiences from a quantitative data's view point for generalisability, and using the lens of Giddens' Structuration theory to gain an insight into the structures that either enable or prevent the successful teaching of the STEM courses online. According to Giddens (1984), space and time can bind any human activity.

The findings of this research confirm the truthfulness of this claim because it was shown that during the time of COVID-19 pandemic, in the context of a university in a developing country, there existed structures of signification, domination, and legitimation, which either enabled or sanctioned the teaching of STEM courses online. For example, the poor economic conditions in Zimbabwe made it very difficult for lecturers to teach online since both the lecturers and students lacked the important resources such as the internet, computing devices, electricity power etc. for online teaching and learning. This shows that there were domination structures that prevented the relevant authorities from exercising their power to allocate tools and technologies that promote the teaching of STEM courses online. Furthermore, the prevailing teaching culture has continued to promote traditional physical classes while sanctioning the use of emerging educational technologies such as Google Meet, Zoom, Telegram, Skype, etc. More-so, the findings of this research revealed that the transition to some online classes was instantaneous and not prepared for. However, Bruggeman et al (2022) emphasize the importance of preparation prior to engaging in online teaching and learning.

The findings of the study have shown the need for affordable and usable resources that must be readily available to the intended users, who in this case are lecturers and students. For example, resources, such as computing devices must be available on the market for them to be adopted for online teaching. Furthermore, the resources, such as computing devices and internet or mobile data, must be affordable for them to be accessed for online teaching. Lastly, online tools and technologies like zoom, Google Meet, Skype, LMS, and others must be user-friendly for them to be utilized as the medium for online teaching and learning. The feasibility of teaching STEM courses online depends on the collaboration and cooperation of such major stakeholders as the government, university management, parents, and users (lecturers/students).

8. Conclusion

This study sought to investigate the lecturers' experiences of teaching STEM courses online. The research participants revealed that they had both positive and negative experiences with teaching STEM courses online. The findings also acknowledge Structuration theory's realization that space and time influence the success of an activity such as teaching STEM courses online. For example, the research cohort was drawn from a poor, developing country that lacks basic resources such as electricity and computing devices for teaching STEM

courses online. The process was further influenced by the timing because, during the COVID pandemic era, it was impossible to import computing devices, and physically accessing resources from education institutions or libraries was also restricted. The study findings also confirmed Structuration theory's claim that human agency/action, in this case teaching STEM courses online, is both enabled and constrained by structures of signification, domination, and legitimation.

The results of the study further showed that according to structuration theory, these structures are both a means and an end of human agency/action. For instance, the research cohort revealed that the success of their teaching STEM courses online was defined by the existing structures of signification (what is important), domination, (power to allocate resources), and legitimation (sanctioning/enabling norms) all of which were created by the actions of major stakeholders involved in the teaching practice, such as the government, university management, parents, students, and the lecturers themselves. It was then concluded that the collaboration and cooperation of these stakeholders can either promote or sanction the smooth transition from physical to virtual STEM classes. The causal loop diagram depicted in Figure 7 provides an insight that the collaborative efforts of the major stakeholders could result in the development of a framework that could guide the transition from physical to virtual classes including the STEM courses.

9. Limitations and recommendations for future work

The study was limited to a single university case, for improved generalisability of the findings, we recommend that a multiple case study be conducted that may involve several universities sampled from several countries. Furthermore, since the study was limited to lecturers only, it would be interesting to perform a comparative study involving both lecturers and students to result in more informed decisions regarding the teaching and learning of STEM courses via online tools and technologies. The study was also limited to quantitative methods, a mixed approach, which includes the collection of qualitative data, could result in better insight based on the lived-experiences and narrative stories of the lecturers. Finally, the study was conducted on a cross-sectional time frame, the collection of data over an elongated period of time would cater for the changes that might happen over time and ensure that the decisions made incorporate the dynamicity of the contextual conditions of the research case, space, and time.

References

Aladsani, Hibah Khalid. 2022. "A Narrative Approach to University Instructors' Stories about Promoting Student Engagement during COVID-19 Emergency Remote Teaching in Saudi Arabia." *Journal of Research on Technology in Education* 54(S1): S165–81. https://doi.org/10.1080/15391523.2021.1922958

Almahasees, Zakaryia, Khaled Mohsen, and Mohammad Omar Amin. 2021. "Faculty's and Students' Perceptions of Online Learning During COVID-19." *Frontiers in Education* 6(May): 1–10.

Bruggeman, Bram et al. 2022. "Exploring University Teachers' Online Education during COVID-19: Tensions between Enthusiasm and Stress." *Computers and Education Open* 3(June): 100095. https://doi.org/10.1016/j.caeo.2022.100095

Cruickshank, Vaughan, Shane Pill, and Casey Mainsbridge. 2021. "'Just Do Some Physical Activity': Exploring Experiences of Teaching Physical Education Online during Covid-19." *Issues in Educational Research* 31(1): 76–93.

Dube, Sibusisiwe. 2020. "A Paradox of the Second Order Digital Divide in Higher Education Institutions of Developing Countries: Case of Zimbabwe." University of Cape Town.

Dube, Sibusisiwe, and Elsje Scott. 2018. "The Organisational Constraints of Blending E-Learning Tools in Education: Lecturers' Perceptions." In *Information Technology-New Generations*, USA: Springer, 305–10.

Giddens, Anthony. 1984. *The Constitution of Society: Outline of the Theory of Structuration*. Los Angeles: University of California Press. http://link.springer.com/article/10.1007/BF01173303

Kim, Minhyun et al. 2021. "Physical Education Teachers' Online Teaching Experiences and Perceptions during the Covid-19 Pandemic." *Journal of Physical Education and Sport* 21(3): 2049–56.

Lapitan, Lorico DS et al. 2021. "An Effective Blended Online Teaching and Learning Strategy during the COVID-19 Pandemic." *Education for Chemical Engineers* 35(May 2020): 116–31. https://doi.org/10.1016/j.ece.2021.01.012.

Lee, Kyungmee, Mik Fanguy, Brett Bligh, and Xuefei Sophie Lu. 2022. "Adoption of Online Teaching during the COVID-19 Pandemic: A Systematic Analysis of Changes in University Teaching Activity." *Educational Review* 74(3): 460–83. https://doi.org/10.1080/00131911.2021.1978401

Lukas, Brenda Anak, and Melor Md Yunus. 2021. "ESL Teachers' Challenges in Implementing e-Learning during COVID-19." *International Journal of Learning, Teaching and Educational Research* 20(2): 330–48.

Mutunhu, Belinda, Sibusisiwe Dube, Sinokubekezela Princess Dube, and Sharon Mpofu. 2022. "A Framework for Transitioning to Virtual Classes During Life-Threatening Pandemics Like COVID-19." *European Conference on e-Learning* 21(1): 279–87.

Orlov, George et al. 2021. “Learning during the COVID-19 Pandemic: It Is Not Who You Teach, but How You Teach.” *Economics Letters* 202: 109812. https://doi.org/10.1016/j.econlet.2021.109812

ÖZÜDOĞRU, Gül. 2021. “Problems Faced in Distance Education during Covid-19 Pandemic.” *Participatory Educational Research* 8(4): 321–33.

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