Journal for Educators, Teachers and Trainers
The PROFESIOLab electronic, peer-reviewed, open-access Magazine

ISSN 1989 – 9572

DOI: 10.47750/jett.2023.14.01.019

Evaluation of Undergraduate Remote Learning in STEM Fields: The COVID-19 Prognosis

Olalekan Taofeek Badmus[1]*

Loyiso C. Jita[2]

Journal for Educators,Teachers and Trainers, Vol. 14 (1)

https://jett.labosfor.com/

Date of reception: 28 Oct 2022

Date of revision: 18 Jan 2023

Date of acceptance: 21 Jan 2023

Olalekan Taofeek Badmus , Loyiso C. Jita (2023). Evaluation of Undergraduate Remote Learning in STEM Fields: The COVID-19 Prognosis.*Journal for Educators, Teachers and Trainers*,Vol. 14(1). 216-227.

---

[1]Ph.D, School of Mathematics Natural Science and Technology Education, Faculty of Education, University of the Free State, South Africa.
[2]Ph.D, School of Mathematics Natural Science and Technology Education, Faculty of Education, University of the Free State, Republic of South Africa.

Journal for Educators, Teachers and Trainers
The LabOSfor electronic, peer-reviewed, open-access Magazine

Journal for Educators, Teachers and Trainers, Vol. 14 (1)
ISSN 1989 – 9572
https://jett.labosfor.com/

Evaluation of Undergraduate Remote Learning in STEM Fields: The COVID-19 Prognosis

Olalekan Taofeek Badmus[1]*, Loyiso C. Jita[2]
[1]Ph.D, School of Mathematics Natural Science and Technology Education, Faculty of Education, University of the Free State, South Africa.
[2]Ph.D, School of Mathematics Natural Science and Technology Education, Faculty of Education, University of the Free State, Republic of South Africa.
*Corresponding Author
Email: badmus.OT@ufs.ac.za[1], jitalc@ufs.ac.za[2]

ABSTRACT
Comparison have been drawn in the literature for and against the efficacy of face-to-face instruction against remote learning especially during Covid-19. However, the positions drawn are often not discipline related especially in the developing nations where access to requisite infrastructure is limited. An investigation into the platforms used, challenges and impact of remote learning among STEM undergraduates is the focus of this study. Descriptive research was employed in the form of survey. Snowballing technique was employed in the sampling of 250 respondents drawn from STEM fields. STEM Undergraduate Remote Learning Questionnaire (SURLQ) was researcher designed with Cronbach's alpha value of .86 from inter-rater reliability. Three research questions raised were answered using the mean value of responses with subsequent hypotheses tested using One-way ANOVA. From the result, Zoom application was the most prominent for remote learning among respondents. Inadequate preparation, concentration deficit, absence of motivation, lack of account for individual differences in lesson planning and impeded assimilation were among the challenges experienced by STEM undergraduates. Finding on the impact and effectiveness of remote learning were also reported. The study concludes among others that there was limited adaptive features to accommodate practical sessions remotely during the pandemic and recommend discipline specific updates to accommodate the lapses identified.

Keywords: Prognosis, undergraduates, remote learning, STEM, Covid-19

INTRODUCTION

Arising from the global outbreak of SARS-CoV-2 known as Covid-19 earlier in 2020, the World Health Organisation declaration of public health emergency on the 11th of March 2020, paved way for the priorly existing technological infusion into classroom practices. This unfortunate incident forced a global transition from face-to-face to online classrooms, and virtual learning platforms due to its endemic depth across 195 nations by April of 2020 (Al-Karaki, et al., 2021; United Nations Educational Scientific and Cultural Organization [UNESCO], 2020; World Health Organization [WHO], 2020). The forced transition compelled a switch that left teachers, students and school management in unprecedented gap which necessitated adaptations (Aduba & Mayowa-Adebara, 2022; Tsabedze & Ngoepe, 2020; Whalen, 2020). A rationale for alternative to face-to-face classroom became a necessity, and virtual classroom became the new order as encouraged by the Centre for Disease Control and Prevention [CDC] in the same year through the issuance of guidelines to acclimatise and cut physical and geographical barriers with the usage of internet enabled devices (computer, smartphones), electronic means of communication [radio, television] and other non-contagious channels (Al Shammari, 2021; CDC, 2020; Stone, 2020). Teaching via technologically enhanced media have limitations especially in Science, Technology, Engineering and Mathematics [STEM] fields (Pesnell, 2020; Kesavan, et al., 2020; Tosun, et al., 2020; Mounjid, et al., 2021).

Scholars have argued for and against the adoption of remote learning, as well as its usage at various levels of education, especially in tertiary institutions (Aykan & Yildirim, 2022; Seabra et al., 2020; Masuku, 2020). It is imperative to acknowledge the existence of classroom imitational applications prior to COVID-19, however, its prevalence came in handy during the pandemic as applications like Google Classroom, Moodle, Blackboard Collaborate, Zoom and many other Learning Management Systems (LMS) had the opportunity to test and

provide succour to the interruption being experienced at the time. Hussain (2018) argued that e-learning platform is better used by university students to facilitate their engagement (Aduba & Mayowa-Adebara, 2022; Buheji, et al., 2020; Ferri, et al., 2020). Learners have been reported to experience less stress, higher confidence and are more empathic while teachers have posited that remote learning is more interactive when laced with engaging visual aids (López-Catálan, 2018; Marutschke, 2019). On the contrary, other researchers expressed reservations in the use of remote learning owing to concerns raised by learners and instructors in its mode of integration in STEM fields for effective and qualitative outcome (Elumalai, et al., 2021; Ibrahim, et al., 2021; Kim, 2019; Thibaut, et al., 2018).

Availing 21st century solutions to human challenges remain the essence of STEM education through the development of competitive, cognitively smart, critical, creative and innovative workforce in today's world (Ataberk & Mirici, 2022; Badmus & Omosewo, 2020; Thibaut, et al., 2018; Rifandi, et al., 2019). Difficulties have been reported in various STEM fields due to remote learning during COVID-19 pandemic: chemistry students have been documented to struggle with motivation and engagement (Petillion & McNeil, 2020); unfavourable space, issue of time management and inadequacy in knowledge and experience to transition into remote/online learning was reported by Ahmet and Bekir (2021); significant reduction in emotional engagement and attitude to science by students was argued by Wester et al (2021); university students finding online learning unsatisfactory and lecturers being advise to adopt Universal Design for Learning (UDL) to benefit all types of learners is existent (Chen et al., 2018). Yet, report of positive influence on perception and career choice stemming from remote/virtual learning was reported by Baucum and Capraro (2021). Furthermore, limited access to the internet, inadequate understanding of technology in the delivery of instruction among other challenges was brought to the fore by Pesnell (2020) and Badmus and Jita (2022); report of gender disparity in the perception of remote learning in higher education was reported also by Elumalai et al (2021).

Necessity arose in the implementation of remote learning across the world during COVID-19 pandemic to reduce interruption and sustain all-inclusive education (UNESCO, 2020; Whalen, 2020; WHO, 2020). The urgency of this development however resulted in several challenges such as lack of awareness, knowledge, experience and preparation of teachers to conduct remote teaching, students and teachers' inadequate digital competence to manage online resources, lack of interaction and motivation among students (Ferri et al., 2020). It became imperative to research the effect of the challenges which affected students' ability to learn effectively during this period among STEM undergraduates. Reports for and against remote learning at all levels of education and instruction, as well as along measurable variables before, during and after COVID exists in the literature (Ahmet & Bekir, 2021; Chen et al., 2018; Thibaut et al., 2018; Widya et al., 2019). The challenges STEM undergraduates encounter during COVID-19, what learning platforms are prevalent among undergraduate in STEM field during this period? The effect of remote learning as well as its effectiveness are still areas with little or no significant probing in the literature especially in developing countries. Hence, we investigate prognosis of undergraduate's remote learning in STEM related fields.

THEORETICAL FRAMEWORK

Universal Design for Learning (UDL) is the framework adopted in this study for its applicability in terms of technological deployment for learning and inclusiveness in both synchronous and asynchronous modes for diverse learners. COVID-19 created an emergency that left no time in the preparation of needs of regular students, as well as students with special needs. Catering for individual differences was not the priority of authorities at this period. However, UDL avails a framework that takes care of peculiarities of individuals and environment. During the pandemic, this framework allows for support and engagement to improve learning and instruction owing to the uniqueness of the technique which afford educators the requisite guide in aligning curriculum to optimise teaching and learning as well as multiple means of engagement using technology. Undergraduates through this framework can self-regulate to improve skills and strategies to cope with the medium of instruction. Remote learning through UDL can guide the perception of learners with alternatives to both auditory and visual representations to improve comprehension (Center for Applied Special Technology [CAST], 2022).

LITERATURE REVIEW

The safety of the schools, preventive measures and risk mitigation were among the concerns of stakeholders during Covid-19 (DBE, 2020a; Bengu & Nair, 2020). Arnou et al (2020) explained that collaborative efforts by school leaders, staff, learners and parent in ensuring safety in learning was the priority. Most guidelines were more of universal positions rather than domestic efforts practicable in various communities. Reimers et al (2020) posited that adaptive and collaborative measures in the implementation of the various guidelines were required to stem the tide of the pandemic while focusing on technology aided learning for safety. Additionally, schools have principal roles in ensuring the safety of teachers and learners (UNICEF, 2020; DBE, 2020). Although, the importance of a safe and conducive environment for learning existed before Covid-19 as relayed in the works of Arslan (2018), Clapper (2010) and California PTA (2016), however, with the peculiarity of the

Covid situation, extra measures are required to prevent, manage and care for both teachers and learners (DBE, 2020; UNICEF, 2020). Other media for learning were explored at the time to mitigate the disruption in the school activities at all levels of education.

Distance learning/online learning as well as remote learning have been used in the literature interchangeably to describe learning taking place when there is considerable distance between the learner and the instructor with the aid of technology through audio, visual or audio-visual means. These media had been in existence for some time, but it became prominent because of the pandemic. Studies have posited on its effectiveness, the technical competence, teaching models, as well as the rationale, especially during Covid-19 (Al-karaki, et al., 2021; Caputo et al., 2021; Viegas et al., 2018). These studies have considered remote learning as a credible alternative to face-to-face learning with better options in autonomy of learning, flexible pedagogy (synchronous and asynchronous) and virtual laboratory in instances of absent physical laboratory equipment in teaching STEM courses. Limitations in term of students' engagement, limited infrastructure like computer/tablet/phone and internet are some of the discussed associative hindrances. Other studies in science and mathematics have also reported minimal engagement in science content among students, as well as inadequacy in terms of guideline and expectation as reported by teachers (Pesnell, 2020; Clemons et al., 2021; Elumalai et al., 2021; Vuran et al, 2020). In higher/tertiary education, Aykan and Yildirim (2022) utilised Lesson Study Model (LSM) in distance learning for STEM education. Improvement in pedagogy and content knowledge was reported in the study, however, unfavourable environment, issue of time management and poor lesson planning were the challenges encountered. What platforms were employed, and which is the mostly preferred? What are the challenges and impact of remote learning among STEM undergraduates during Covid? These issues form the foci of this study.

Research Questions

The following questions were raised to guide the study:

1. What platforms were employed by STEM undergraduates for remote learning during Covid?
2. What are the challenges and impact of remote learning in STEM fields during Covid?
3. How effectiveness was remote learning to STEM undergraduates during Covid?

Research Hypotheses

The following hypotheses were formulated and tested in this study:

1. There is no significant difference in the platforms used for remote learning among STEM undergraduates during Covid.
2. There is no significant difference in the challenges experienced by STEM undergraduates using remote learning during Covid.
3. There is no significant difference in the impacts of remote learning among STEM undergraduates during the Covid.

METHODOLOGY

For this study, we employed descriptive aspect of quantitative research using survey method. The population for this study comprised STEM undergraduates studying in Nigeria Universities. The target population were STEM undergraduates from public universities in the South-western and North-central part of the country. A non-probability sampling technique of snowballing was employed in the selection of the samples. Snowballing technique allows participants to refer eligible participants to make a sample group. As a result, a total of two hundred and fifty (250) undergraduates studying STEM related courses formed the sample.

The instrument used in collecting data for this research is a researcher-designed closed ended questionnaire. The instrument was titled STEM undergraduates Remote Learning Questionnaire (SURLQ). Section A of SURLQ contained the demographic information of the respondents which are gender, level/ academic year, department, course of study, faculty and the platforms employed for remote learning. Section B had sub-sections on platforms used for remote learning, challenges, impact and effectiveness in the methodology components. SURLQ elicited information on the experiences of STEM undergraduates during Covid to aggregate data for the needed adjustments and check the effectiveness of remote learning. SURLQ was based on 4-points Likert scale of Strongly Agreed (SA), Agreed (A), Disagreed (D) and Strongly Disagreed (SD). The researchers rely on expert judgement for validation of the instrument which meant that the instrument was subjected to both content and face validity by experts. The concerns of experts were used to improve the instrument after which 5 experts rated the items with overall reliability index of .86 before its administration to the respondents.

RESULT

Table 1:Distribution of the Respondents by Gender, Level and Faculty

Variables		Frequency	Percent
Gender	Male	123	49.2
	Female	127	50.8
	Total	**250**	**100.0**
Level	100 Level	14	5.6
	200 Level	39	15.6
	300 Level	66	26.4
	400 Level	119	47.6
	500 Level	12	4.8
	Total	**250**	**100.0**
Faculty	Education (Math, Science & Tech)	123	49.2
	Environmental Science	2	.8
	Physical Science	46	18.4
	Life Science	45	18.0
	Agricultural Science	9	3.6
	Natural Science	2	.8
	Basic Medical sciences	8	3.2
	Engineering	15	6.0
	Total	**250**	**100.0**

Table 2: Mean Rating of Responses to the Research Questions

Mean Rating of Platforms Used for Remote Learning by STEM Undergraduates during Covid

S/N	Platforms used for remote learning	Mean	Ranking
1	Zoom	3.28	1st
2	Google Meet	3.14	2nd
5	WhatsApp Video	3.09	3rd
6	Telegram	3.06	4th
4	WhatsApp audio	3.05	5th
3	Microsoft Teams	2.95	6th
7	Miro	2.93	7th

Mean Rating of the Challenges of Remote Learning among STEM Undergraduates during Covid

S/N	Challenges of remote learning during Covid	Mean	Ranking
1	Inadequate preparation for proper adjustment to the usage of remote learning systems	3.18	1st
2	Lack of concentration due to ill-acclimatisation of the new medium of instruction	3.08	2nd
3	Lack of motivation towards academic responsibilities owing to the devastating effect of Covid-19	2.98	3rd
4	Reduction in assimilation level due to online method learning compared to the pre Covid-19 era	2.88	4th

Mean Rating of the Impacts of Remote Learning among STEM Undergraduates during Covid

S/N	Perception of remote learning among STEM undergraduates during Covid	Mean	Ranking
1	Learning remotely (you and your screen) is perceived to aid engagement with the teachers.	3.08	1st
2	Improved concentration during online classes compare to the physical classroom	2.96	2nd
3	Remote learning approach is less efficient compared to physical classroom for effective teaching and learning	2.93	3rd
4	Remote learning during the pandemic affects my academic performance positively	2.92	4th

Mean Rating of the Methods Applied for Effective Remote Learning among STEM Undergraduates during

Covid			
S/N	**Effectiveness of remote learning among STEM undergraduates during Covid**	**Mean**	**Ranking**
1	Level of student-student contact in an online class minimizes their experience of learning	3.03	1st
2	In remote classrooms, there was effective usage of instructional aides to facilitate teaching and learning	3.03	1st
3	There was proper student-teacher relationship with the use of remote learning during Covid compare with pre Covid-19 era	2.91	3rd
4	there was necessary evaluation and assessment by my lecturers in the online classes	2.90	4th
5	Remote learning is a better approach to teaching and learning	2.81	5th

Hypotheses Testing

The three research hypotheses postulated were tested using One-way ANOVA statistics tool at 0.05 level of significance.

H_{O1}: There is no significant difference in the platforms used for remote learning among STEM undergraduates during Covid.

To test null hypothesis one, participants' responses to the platforms used for remote learning during Covid were collated. The data collected from the study was analyzed as shown on Table 3.

Table 3: One-way ANOVA Summary Difference in the Platforms Used for Remote Learning by STEM Undergraduates during Covid

Source of Variance	Sum of Squares	df	Mean Square	F	Sig.	Decision
Between Groups	132.33	7	18.91	2.49	.02	**H_{O1}- Rejected**
Within Groups	1834.16	242	7.58			
Total	**1966.49**	**249**				

$\rho < 0.05$

Table 3 indicates an F-value of 2.49 with calculated significance value of .02 at .05 alpha level. Since calculated significance .02 is lower than .05 alpha level, hypothesis one is thus rejected. This implies that, there is a significant difference in the platforms used for remote learning by STEM undergraduates during Covid.

Table 4: Scheffe's post hoc Test of Difference in the Platforms Used for Remote Learning by STEM undergraduates during Covid

Subset for alpha = .05										
STEM Fields	**N**	**1**	**2**	**3**	**4**	**5**	**6**		**7**	**8**
Basic Medical Sciences Environmental Science Agricultural Science	82 9	18.75	19.50	19.89						
Engineering	15				20.60					
Life Science	45					21.27				
Education (Math, Sci. & Tech.)	123						21.87			
Physical Science	46								21.89	
Natural Science	2									22.50

Table 4 shows the Scheffe's post hoc for difference in the platforms used for remote learning by STEM undergraduates during Covid. It is observed that of the eight STEM fields, Natural Science students had the highest mean score of 22.50 in subset 8, followed by Physical Science students with a mean score of 21.89 in subset 7, Education (Math, Sci. & Tech.) students with a mean score of 21.87 in subset 6, Life Science students with a mean score of 21.27 in subset 5, Engineering students with a mean score of 20.60 in subset 4, Agriculture Science students with a mean score of 19.89 in subset 3, Environmental Science students with a mean score of 19.89 in subset 2, while Basic Medical Sciences student has the least mean score of 18.75 in subset 1. This implies that the Natural Science undergraduates used various platform for remote learning in STEM during the Covid compared to other STEM fields in this study.

H_{O2}: There is no significant difference in the challenges experienced by STEM undergraduates using remote learning during Covid.

In order to test hypothesis two, participants' responses to the challenges of remote learning in STEM fields during Covid were collated. The data collected from the study was analyzed as shown on Table 5.

Table 5: One-way ANOVA Summary of the Challenges of Remote Learning among STEM Undergraduates during Covid

Source of Variance	Sum of Squares	df	Mean Square	F	Sig.	Decision
Between Groups	147.68	7	21.11	7.24	.00	**H_{O2}- Rejected**
Within Groups	705.61	242	2.92			
Total	**853.29**	**249**				

ρ < 0.05

Table 5 indicates an F-value of 7.24 with calculated significance value of .00 at .05 alpha level. Since calculated significance .00 is lower than .05 alpha level, hypothesis two is thus rejected. This implies that there is a significant difference in the challenges of remote learning to STEM undergraduates during Covid.

Table 6: Scheffe's post hoc Test of Difference in the Challenges of Remote Learning among STEM Undergraduates During Covid

Subset for alpha = 0.05									
STEM fields	**N**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Basic Medical Sciences Engineering Agricultural Science	8 15 9	9.63	10.13	10.67					
Life Science	45				11.44				
Natural Science	2					12.00			
Physical Science	46						12.13		
Education (Math, Sci. & Tech.)	123							12.41	
Environmental Science	2								13.00

Table 6 shows the Scheffe's post hoc of difference in the challenges of remote learning among STEM undergraduates during the Covid. It was observed that the eight STEM fields groups were significantly different. Environmental Science students had the highest mean score of 13.00 in subset 8, followed by Education (Math, Sci. & Tech.) students with a mean score of 12.41 in subset 7, Physical Sciences students with a mean score of 12.13 in subset 6, Natural Science students with a mean score of 12.00 in subset 5, Life Science students with a mean score of 11.44 in subset 4, Agriculture Science students with a mean score of 10.67 in subset 3, Engineering students with a mean score of 10.13 in subset 2, while Basic Medical Sciences student has the least mean score of 9.63 in subset 1. This implies that Environmental Science students faced most the challenges of remote learning in STEM fields during Covid compared to other STEM fields in this study.

H_{O3}: There is no significant difference on the impact of remote learning among STEM undergraduates during the Covid.

To test hypothesis three, participants' responses to the impact of remote learning among STEMS undergraduates during Covid were collated. The data collected from the study was analyzed as shown on Table 7.

Table 7: One-way ANOVA Summary of Difference on the impact of Remote Learning among STEM undergraduates during Covid

Source of Variance	Sum of Squares	df	Mean Square	F	Sig.	Decision
Between Groups	80.52	7	11.50	2.77	.01	**H_{O3}- Rejected**
Within Groups	1000.62	241	4.15			
Total	**1081.14**	**248**				

ρ < 0.05

Table7 shows an F-value of 2.77 with calculated significance value of .01 at .05 alpha level. Since calculated significance .01 is lower than .05 alpha level, hypothesis three is thus rejected. The implication is that there is a significant difference on the impact of remote learning among STEM undergraduates during Covid.

Table 8: Scheffe's post hoc Table of Difference on the impact of Remote Learning to STEM Undergraduates during Covid

Subset for alpha = 0.05									
STEM fields	**N**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Natural Science Environmental Science Agricultural Science	2 2 9	8.00	9.00	11.11					
Basic Medical Sciences	8				11.75				
Life Science	45					11.84			
Engineering	15						12.00		
Physical Science	46							12.15	
Education (Math, Sci. & Tech.)	123								12.45

Table 8 shows the Scheffe's post hoc of difference in the impacts of remote learning to STEM undergraduates during Covid. Subsequently, eight STEM fields were significantly different. Education (Math, Sci. & Tech.) students had the highest mean score of 12.45 in subset 8, followed by Physical Science students with a mean score of 12.15 in subset 7, Engineering students with a mean score of 12.00 in subset 6, Life Science students with a mean score of 11.84 in subset 5, Basic Medical Science students with a mean score of 11.75 in subset 4, Agriculture Science students with a mean score of 11.11 in subset 3, Environmental Science students with a mean score of 9.00 in subset 2, while Natural Sciences student has the least mean score of 8.00 in subset 1. This implies that the Education (Math, Sci. & Tech.) students felt most the impact of remote learning in STEM fields during Covid compared to other STEM fields in this study.

DISCUSSION

From the first finding, it is deducible that Zoom was the most prominent application platform used by STEM undergraduates in this study. However, Blackboard has been around for more than ten years, unlike Zoom, Microsoft Teams and Google Meet, which are more recent and newer to lecturers and students. While Zoom is primarily a video-conferencing platform with some learning capabilities like whiteboards, screen sharing, polling, and chatting, Blackboard is an all-inclusive learning management system which presented more of classroom features to both teachers and students. It may be assumed that zoom appears to be a more user-friendly application than its counterpart for it to gain such popularity within a short period of time. This finding is similar to those of Al Shammari (2021) reported that students favoured Zoom in the first place (53.3%), followed by Blackboard (44.3%), and finally came Microsoft Teams and Google Meet (1.3% and 0.7%, respectively). Ibrahim et al (2021) in a similar study also expressed preference for Zoom platform by students. The study of Jacques et al (2020) exposed several reasons why students prefer Zoom. These reasons range from ease of use, accessibility, popularity and design layout. Also, Aduba and Mayowa-Adebara (2022) reported that major online platforms used for teaching and learning during the COVID-19 by LIS students in Delta State University, Abraka were WhatsApp audio, WhatsApp files attachment, Telegram and WhatsApp chat unlike the findings of this study.

The second finding indicates that the main impact of remote learning in STEM related fields during the Covid was learning remotely being a one on one (you and your screen) teaching and learning process aids in proper engagement with the teachers. Aduba and Mayowa-Adebara (2022), Alkaraki et al (2021), Pesnell (2020), Chen et al (2018) have all posited that receiving lectures through online platforms makes lecturers always available in the classroom, gives them the chance to store lectures and files for later use at convenience, allows for collaborative learning, learning anytime, anywhere is one major benefit from receiving lectures through online platforms, and sharing learning materials is one benefit. However, the challenges associated with electronic learning were inaccessibility to smartphone, computer, internet among other devices crucial to receiving lectures. Additionally, information overload was a challenge to students due to unfiltered access the internet provides which leads to confusion as learners are not equipped with the competence to filter such amount of information for domestic use. Also, Paschal and Mkulu (2020), Elumalai et al (2021) and Ferri et al (2020) reported that lecturers were also having challenges with the imposition of e-learning in their universities because it costs energy, money and time from training to the implementation which are not necessarily provided for by

the institutions. Many lecturers were also reported to be facing challenges in developing teaching materials as well as uploading these materials to the learning platforms due to lack of training, poor network connectivity, expensive data bundles, lack of computers and computer facilities among other (Jacques, et al., 2020; Jamal, et al., 2021; Lindner, et al., 2020).

Furthermore, the effectiveness of remote learning among STEM learners and beyond during Covid was the limited student-student contact/physical interaction which often result to distractions. Such interactions often are not academic and neither moderated (Tosun, 2021; Nokukhanya, et al., 2020; Paschal, et al., 2022). In addition, a significant difference experienced in the platforms used for remote learning by STEM undergraduates during Covid is not unusual. Preference plays a major role in the choice of application. Lecturer and students are more conversant with one platform than the other and at this period stability was key as the willingness to explore other at the time was not existent (Stone, 2020; Wester, et al., 2021; Whalen, 2020). Also, the difference experienced on the impacts of remote learning by STEM undergraduates during Covid may be expected. The studies of Presnell (2020), Paschal et al (2020) and Masuku (2020) substantiates the findings of this study that the impact and challenges of Covid are different and learner dependent.

CONCLUSION

Adequate training and capacity building is required on remote learning for lecturers and instructors for effective usage of the available LMS platforms and other mobile applications usable in teaching and learning. Preservice teachers may benefit a great deal if such capacity is integrated into their training. Understandably, pandemic remains unprecedented and has dramatically changed the way the higher education was designed and delivered. Activities that involve practical experience were formally jettisoned for online and remote activities at the time. However, emergency adaptation for Covid period was a necessity. The available platforms at the time were adopted regardless of their efficiency and effectiveness due to non-domesticated guidelines and generalisation of instruction. Zoom platform was the most used among STEM undergraduate and does not necessarily interpret as the most appropriate. However, adaptive feature for suitability were at the time inadequate to cater for STEM peculiarities, nonetheless, it facilitated learning among other platforms used for remote learning. The challenges and impact of Covid differ from student to student and experiences of platform were not uniform as reported. The limitation experienced due to lack of face-to-face classes which afford students interaction, practical session as well as the rigour of access were among the challenges STEM undergraduates encountered during Covid.

RECOMMENDATIONS

This study recommends that the challenges raised by STEM undergraduates should be remediated by relevant authorities. Additionally, discipline specific platform for remote learning is encouraged to cater for peculiarities in STEM learning and instruction. Furthermore, adequate training of lecturers and personnel should be prioritised to equip lecturers, technicians and students with the required competency to better cope with emergency learning situation. Governments and other stakeholders should support universities and faculties by resolving limitations experience with power, internet connectivity and necessary infrastructure so that students can study without difficulty regardless of their location, family background and abilities.

REFERENCES

1. Aduba, D. E. & Mayowa-Adebara, O. (2022). Online platforms used for teaching and learning during the COVID-19 era: The case of LIS students in Delta State University, Abraka. International Information & Library Review, 54(1), 17–31. https://doi.org/10.1080/10572317.2020.1869903
2. Al-Karaki, J. N., Ababneh, N., Hamid, Y., & Gawanmeh, A. (2021). Evaluating the Effectiveness
3. of Distance Learning in Higher Education during COVID-19 Global Crisis: UAE Educators' Perspectives. Contemporary Educational Technology, 13(3). https://doi.org/10.30935/cedtech/10945
4. Al Shammari, M. H. (2021). Devices and platforms used in emergency remote learning and teaching during Covid-19: A case of English major students in Saudi Arabia. Arab World English Journal (AWEJ) Special Issue on Covid 19 Challenges, 1, 80 – 94.
5. Ataberk, B. Mirici, İ. H. (2022). An investigation of the 21st century skills in English language teaching (ELT) programs in Turkey. International Online Journal of Education and Teaching (IOJET), 9(4), 1513-1544.
6. Aykan, A., & Yıldırım, B. (2022). The Integration of a lesson study model into distance STEM
7. education during the Covid-19 pandemic: Teachers' views and practice. Technology, Knowledge and Learning, 27(2), 609-637. https://doi.org/10.1007/s10758-021-09564-9
8. Badmus, O. T. & Jita, L. C. (2022). What is Next for Africa's Youthful and Useful Population?

9. STREAM Education for Global Inclusivity. Journal of Culture and Values in Education, 5(2), 32-46. https://doi.org/10.46303/jcve.2022.18
10. Badmus, O. T., & Omosewo, E. O. (2020). Evolution of STEM, STEAM and STREAM Education
11. in Africa: The Implication of the Knowledge Gap. International Journal on Research in STEM Education 2(2) 99-106. https://doi.org/10.31098/ijrse.v2i2.227
12. Baucum, M. N., & Capraro, R. M. (2021). A system for equity: enhancing STEM education during
13. a pandemic. Journal of Research in Innovative Teaching & Learning 14(3). 365-377. https://doi.org/10.1108/JRIT-12-2020-0087
14. Brown, R., Brown, J., Reardon, K., & Merrill, C. (2011). Understanding Stem. Current Perceptions. Technology & Engineering Teacher, 70(6), 5-9.
15. Brown, J., Brown, R. & Merrill, C. 2012, "Science and Technology Educators' Enacted Curriculum: Areas of Possible Collaboration for an Integrative STEM Approach in Public Schools", Technology and Engineering Teacher, 71(4), 30-34.
16. Buheji, M., Ahmed, D., Abdulkareem, T., Buheji, B., Eidan, S., & Perepelkin, N. (2020). Emergency remote education in Bahrain, Iraq, and Russia During the COVID-19 pandemic: A comparative case study. Human Systems Management, 39(4), 473-493.
17. Burdina, G. M., Krapotkina, I. E., & Nasyrova, L. G. (2019). Distance learning in elementary school classrooms: An emerging framework for contemporary practice. International Journal of Instruction, 12(1), 1-16.
18. Caputo, J. L., Mel, A. E., Stenson, M. C., Fleming, J. K., Johnson, S. L., & Spillios, K. E. (2021).
19. Faculty perceptions of the exercise science student learning experience during the coronavirus pandemic. Advances in Physiology Education, 45(4), 829-834. https://doi.org/10.1152/advan.00114.2021
20. Chen, B., Bastedo, K., & Howard, W. (2018). Exploring design elements for online STEM courses: Active learning, engagement & assessment designe. Online Learning, 22(2), 59-75.
21. Elumalai, K. V., Sankar, J. P., Kalaichelvi, R., John, J. A., Menon, N., Alqahtani, M. S. M., &
22. Abumelha, M. A. (2021). Factors affecting the quality of e-learning during the COVID-19 pandemic from the perspective of higher education students. COVID-19 and Education: Learning and Teaching in a Pandemic-Constrained Environment, 189.
23. Ferri, F., Grifoni, P. & Guzzo T. (2020). Online Learning and Emergency Remote Teaching: Opportunities and Challenges in Emergency Situations. Societies, 10, 86. https://doi.org/10.3390/soc10040086
24. Hussain, M., (2018). Student engagement predictions in an e-learning system and their impact on student course assessment scores. Computational Intelligence and Neuroscience, 1, 21. https://doi.org/10.1155/2018/6347186
25. Ibrahim, N. K., Al Raddadi, R., AlDarmasi, M., Al Ghamdi, A., Gaddoury, M., AlBar, H. M., & Ramadan, I. K. (2021). Medical students' acceptance and perceptions of e-learning during the Covid-19 closure time in King Abdulaziz University, Jeddah. Journal of infection and public health, 14(1), 17-23. https://doi.org/10.1016/j.jiph.2020.11.007
26. Jacques, S., Ouahabi, A., & Lequeu, T. (2020). Remote Knowledge Acquisition and Assessment During the COVID-19 Pandemic. International Journal of Engineering Pedagogy, 10(6), 120 – 138.
27. Ilesanmi, P.F., Bello O. L & Afolabi, A. A. (2020). The effects of the COVID-19 pandemic on food losses in the agricultural value chains in Africa: The Nigerian case study. Journal of Public Health in Practice 2, 10- 11. https://doi.org/10.1016/j.puhip.2021.100087
28. Jamal, N. A., Nedal, A., Yasir H. & Amjad, G. (2021). Evaluating the Effectiveness of Distance
29. Learning in Higher Education during COVID-19 Global Crisis: UAE Educators' Perspectives. Contemporary Educational Technology, 13(3), 311.
30. Kim, M. S. (2019). A systematic review of the design work of STEM teachers. Research in
31. Science & Technological Education. https://doi.org/10.1080/02635143.2019.1682988
32. Lindner, J., Clemons, C., Thoron, A., & Lindner, N. (2020). Remote instruction and distance education: A response to Covid-19. Advancements in Agricultural Development, 1(2), 53-64. https://doi.org/10.37433/aad.v1i2.39
33. Catálan, L. L., Catálan, B. L., & Vázquez, Á. M. D. (2019). Web promotion, innovation and postgraduate e-learning programs. IJERI: International Journal of Educational Research and

Innovation, (11), 47-59. https://www.upo.es/revistas/index.php/IJERI/article/view/2935
34. Marutschke, D. M., (2019). Smart education in an interconnected world: Virtual, collaborative, project-based courses to teach global software engineering. Smart Education and e-Learning, 39–49. https://doi.org/10.1007/978-981-13-8260-4_4
35. Masuku, M. M. (2021). Emergency remote teaching in higher education during COVID-19: challenges and opportunities. International Journal of Higher Education.
36. Mounjid, B., El Hilali, E., Amrani, F., & Moubtassime, M. (2021). Teachers' Perceptions and the Challenges of Online Teaching/Learning in Morocco during Covid-19 Crisis. Arab World English Journal (AWEJ) Special Issue on CALL, (7). https://ssrn.com/abstract=3904439
37. National Academies of Sciences, Engineering, and Medicine. (2020). Teaching K-12 Science and Engineering During a Crisis. Washington, DC: The National Academies Press.
38. Han, S., Rosli, R., Capraro, M. M., & Capraro, R. M. (2016). The Effect of Science, Technology, Engineering and Mathematics (STEM) Project Based Learning (PBL) on Students' Achievement in Four Mathematics Topics. Journal of Turkish Science Education (TUSED), 13. http://doi.org/10.12973/tused.10168a
39. Paschal, M. J., Pacho, T. O. & Adewoyin, O. (2022). Teaching methods applied in higher education during C0VID-19 pandemic in Africa. International Journal of Educational Policy Research and Review, 9(1), 27 – 40. https://doi.org/10.15739/IJEPRR.22.003
40. Pesnell, B. (2020). Elementary teachers' experiences with remote learning and its impact on
41. science instruction: multiple cases from the early response to the COVID-19 pandemic. University of Arkansas.
42. Petillion, R. J. & McNeil W. S. (2020). Student experiences of emergency remote teaching: impacts of instructor practice on student learning, engagement, and well-being. Journal of Chemistry Education 97, 2486–2493. https://doi.org/10.1021/acs.jchemed.0c00733
43. Pitan, O. S. & Muller, C. (2019). University reputation and undergraduates self-perceived
44. employability: mediating influence of experiential learning activities, Higher Education Research & Development, 38(6), 1269-1284. https://doi.org/10.1080/07294360.2019.1634678
45. Rifandi, R., & Rahmi, Y. L. (2019). STEM education to fulfil the 21st century demand: a literature
46. review. In Journal of Physics: Conference Series, 1317(1), 012208). IOP Publishing. https://doi.org/10.1088/1742-6596/1317/1/012208
47. Seabra, F., Teixeira, A., Abelha, M., & Aires, L. (2021). Emergency remote teaching and learning in Portugal: preschool to secondary school Teachers' perceptions. Education Sciences, 11(7), 349. https://doi.org/10.3390/educsci11070349
48. Sims, S. K., & Baker, D. M. (2021). Faculty Perceptions of Teaching Online during the COVID-19 University Transition of Courses to an Online Format. Journal of Teaching and Learning with Technology, 10, 337-353.
49. Stone, K. (2020). Zoom for educators: How to set up virtual classrooms for distance learning
50. Thibaut, L. Ceuppens, D & Depaepe Y. (2018). Integrated STEM education: A systematic review of instructional practices in secondary education. European Journal of STEM Education, 3(1).
51. Tosun, N., Mihci, C., & Bayzan, Ş. (2021). Challenges encountered by in-service K12 teachers at the beginning of the Covid-19 pandemic period: The case of Turkey. Participatory Educational Research, 8(4), 359-384.
52. Tsabedze, V., & Ngoepe, M. (2020). A Framework for Archives and Records Management Education in an Open Distance E-Learning Environment in Swatini. Education for Information, 36(2),157-175. https://doi.org/10.3233/EFI-190294
53. Unger, C., Lane, B., Cutler, E., Lee, S., Whitney, J., Arruda, E., & Silva, M. (2008). How Can State Education Agencies Support District Improvements? A Conversation Amongst Educational Leaders, Researchers, and Policy Actors. Education Alliance, Brown University.
54. Viegas, C., Pavani, A., Lima, N., Marques, A., Pozzo, I., Dobboletta, E., ... & Alves, G. (2018).
55. Impact of a remote lab on teaching practices and student learning. Computers & Education, 126, 201-216. https://doi.org/10.1016/j.compedu.2018.07.012

56. Vuran F. E., Çiğdemoğlu C. & Mirici S., (2020). The effect of genetic engineering activities on students' achievement evaluations. International Online Journal of Education and Teaching (IOJET), 7 (1). 373-388.
57. Wester, E. R., Walsh, L. L., Arango-Caro, S., & Callis-Duehl, K. L. (2021). Student engagement
58. declines in STEM undergraduates during COVID-19–driven remote learning. Journal of microbiology & biology education, 22(1), https://www.doi.org/ev22i1-2385.
59. Whalen, J. (2020). Should teachers be trained in emergency remote teaching? Lessons learned from the COVID-19 pandemic. Journal of Technology and Teacher Education, 28(2), 189-199. https://www.learntechlib.org/primary/p/215995/.
60. WHO. (2020). COVID-19 Weekly Epidemiological Update 35. World Health Organization, 1–3.