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Exploring low-tech opportunities for higher education mathematics lecturers in an emergency techno-response pedagogy

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The education sector, among others, was severely affected by the coronavirus disease 2019 (COVID-19) pandemic. Because mathematics has always been singled out as a subject that needs more verbal communication and interaction, rapid adjustments had to be made by mathematics lecturers in higher education institutions to try and facilitate normal teaching and learning remotely through emergency open distance methods. Lecturers were forced to examine prevailing practices with a view to creating innovative and workable solutions to the emergency challenges without compromising the quality previously experienced during face-to-face classroom interactions. The article developed through a simple technology a conceptual framework for emergency remote teaching (ERT) in an emergency techno-response pedagogy (ETRP). The key was to demonstrate an innovative instructional strategy for teaching mathematics using a simple technology instead of an advanced or complicated mathematics software in the move from face-to-face to fully online teaching during a crisis. A development qualitative virtual case study was conducted that involved observing live and recorded mathematics lectures and interviewing an innovative lecturer of mathematics in the delivery of complex numbers at a graduate school in South Africa. The facilitation of the lesson through a simple and inexpensive technology (Microsoft OneNote) guided the development of a conceptual framework for ERT within an ETRP. The Context, Input, Process, and Product (CIPP) evaluation model was used as a theoretical framework to guide the analysis and conceptualisation of the lessons. Results provided guidelines through a conceptual framework for ERT that included a unique model of a lesson plan and advantages of using a simple technology in ERT instead of advanced mathematical software. The article contributes to the knowledge base in planning future ERT interventions.

Keywords: mathematics; emergency remote teaching; Microsoft OneNote; online learning; emergency techno-response pedagogy; lecturer.

Introduction

The world was struck by the coronavirus disease 2019 (COVID-19) pandemic in 2020, which changed the way many people operated in the business world. The education sector was no exception as the traditional way of learning, which involved learners being seated in an enclosed space while the teacher delivers the lesson, was a thing of the past. The COVID-19 pandemic 'created the largest disruption to education systems in history … affecting nearly 1.6 billion learners in more than 190 countries and all continents' (UN Policy Brief, 2020, p. 2). Due to COVID-19 regulations, which required social distancing and prevented large gatherings, the traditional way of teaching was significantly affected and not all higher education institutions had the skills to cope with remote learning needs. Therefore, lecturers had to quickly find new ways of teaching that would be as effective as face-to-face classroom interactions. Institutions that already gained some strength in online and open distance education before the pandemic lockdowns had a considerable advantage in offering emergency remote operations (Skulmowski & Rey, 2020). These advantages stemmed from institutional knowledge of online programming and the virtual operations in which many online units operated (Bouchey, Gratz, & Kurland, 2021). However, other higher education institutions were not prepared for the advent of the pandemic, and teaching became a swim or sink endeavour.

Mathematics is typically easy to teach in a face-to-face environment because most mathematical issues are physically managed by the lecturer within the classroom environment (Castle &

Note: Teaching and learning mathematics during the COVID-19.

McGuire, 2010; Lewandowski, Rosenberg, Jordan Parks, & Siegel, 2011). For example, the pronunciations of symbols in differentiation and integration need to be verbalised for mathematical communication to be possible. Real-life modelling is required to illustrate on-the-spot examples, which are not always easy to simulate. Therefore, lecturers had to find alternative strategies to effectively teach in an environment similar to a face-to-face scenario, to enhance the effectiveness of lecturers' current efforts to improve students' success in emergency remote teaching (ERT).

Lecturers who were skilled facilitators in face-to-face classrooms were unsure about how to implement student-centred practices in a remote context. Their greatest challenge was communicating and effectively interacting with their students in the remote environment (Skulmowski & Rey, 2020). They also did not have financial resource support, including the availability of data and Wi-Fi. At the start of the pandemic, lecturers would send content using email, and audio and video recordings, but the students' results were very unsatisfactory. Students showed no interest by ignoring such communication or they submitted sub-standard work. They were clearly not coping. Ultimately, lecturers who were considered excellent disseminators of knowledge were left in the deep end. Therefore, the purpose of this article was to provide through a simple technology a conceptual framework for ERT in an emergency techno-response pedagogy (ETRP). The objective was to provide guidelines for ERT in an ETRP through observing a real-life scenario of a lecturer facilitation.

Emergency techno-response pedagogy

An ETRP (Figure 1) is dependent on ERT, which is a temporary shift from the normal modes of teaching that happens in a crisis when teaching becomes remote or distant managed (Murphy, 2020). This transforms what would have otherwise been face-to-face or hybrid teaching into digital education. For many, ERT happens without warning, illustrating the importance of having a quick contingency plan to solve the problems created by the crisis, either temporarily or permanently. When a crisis occurs that necessitates all universities to shut down their classroom or use blended teaching modes, ERT and learning may be presented in the form of online lessons, radio, or blended learning solutions (Zimmerman, 2020). Online learning is a method of instruction presented over the internet and is sometimes called 'e-learning'. While it can be defined as a way of delivering content to students over the internet using various online platforms, it is a form of education that happens at a distance rather than within a classroom setting (Czerniewicz, 2020). Online learning was created to leverage technology and allow students to earn degrees or attend school without having to physically attend an academic setting.

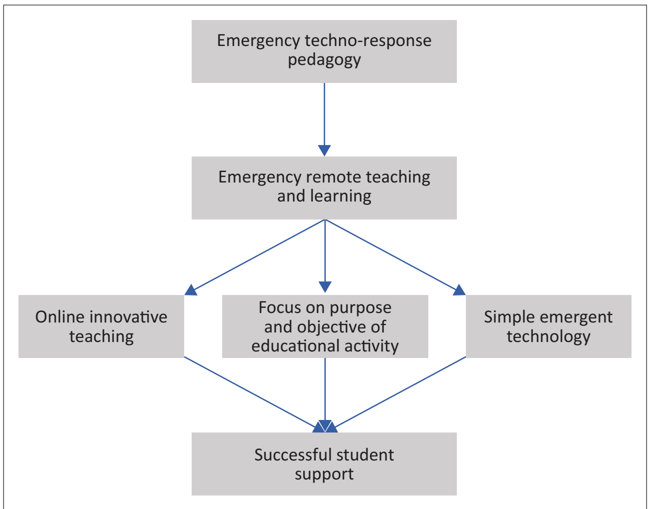


FIGURE 1: Emergency techno-response pedagogy.

Face-to-face learning is the traditional mode of instruction, where students and lecturers attend an in-person session at the same time. The lecturer leads the class, manages the classroom, and provides different ways of motivating a diverse student audience. For example, within the teaching of mathematics, the lecturer normally presents illustrations and demonstrations of problems and problem-solving on the board while students follow along. Students can participate if the lecturer poses questions or asks students to demonstrate some mathematical problem-solving on the board. Therefore, in a face-to-face environment, there is live interaction between the lecturer and the students. The purpose of this article was to provide through a simple technology a conceptual framework for ERT in an ETRP. This article demonstrates how a mathematics lecturer attempted to simulate a face-to-face classroom setting during the pandemic using simple forms of technology.

Challenges in the initial emergency transition

Emergency remote teaching and learning at colleges and universities primarily consisted of moving face-to-face courses into a 'virtual environment using learning management systems, real-time or recorded web conference meetings, and other internet-based tools' (Garrett, Legon, Fredericksen, & Simunich, 2020, p. 2). Many lecturers were unfamiliar with the virtual space and the available technology and software for online students. Universities quickly developed plans, but they all fell into the trial-and-error space, leaving the lecturers to find innovative ways to start engaging with learners. Lecturers working from home encountered problems related to a lack of computers or laptops and inadequate bandwidth, in addition to the lack of remote support structures and student tools (Garrett et al., 2020). The quality of instruction therefore suffered during the emergency transition.

Students have always had unequal access to reliable high-speed internet and other academic technologies due to underlying inequalities in household income and regional infrastructure (Ludeman & Schreiber, 2020). Moreover, while moving into ERT, lecturers lost confidence in their ability to successfully convey their subjects to students. Based on this background, the research questions were: What innovative teaching methods did lecturers develop during the COVID-19 pandemic to try and achieve the same purpose and objectives that students gained in a face-to-face or blended mode of teaching, and what support services were required during the pivot to remote learning? Therefore, this article provides guidelines from a conceptual framework that was derived from how a lecturer implemented a set of evidence-based ERT practices to effectively communicate and interact with his mathematics students through an ETRP.

Initial lecturer responses to ERT

When strict lockdown measures were implemented during the pandemic, lecturers initially responded by using the WhatsApp platform to send students audio and video lectures containing information required for learning. Some lecturers replaced face-to-face interaction with 'busy work' assignments and, as a result, their students spent more time and effort on coursework that does not typically improve their actual learning or performance in mathematics (Bouchey et al., 2021). It was a counterproductive step, but the lecturers were not trained for global emergencies that require remote teaching. Applications like the MATLAB software were difficult to master instantly in an emergency, and some lecturers used the common Microsoft Skype software to deliver lessons. One drawback of this platform was the limited number of participants who could use it when the pandemic struck. Some lecturers used Microsoft Teams and Zoom applications, which can accommodate more students in the class, but they could not be completely interactive, and illustrations were difficult to present. There was a need for a board to write on and present illustrations. Older lecturers who were unfamiliar with the latest technological trends were stranded. And while most of the education fraternity expected this emergency to be temporary, it continued even as vaccines were distributed across the globe. This article thus analyses the instructional strategies employed by some lecturers in the delivery of ERT to facilitate the development of the ETRP. The focus is on teaching mathematical content in an emergency in ways that take advantage of simple and accessible technology to promote enhanced student understanding (Bouchey et al., 2021).

The context of mathematics students during COVID-19

Students were thrown into a space of uncertainty due to COVID-19. Suggestions to learn online were immediately presented to the students in their unprepared mental state, without regard for some students succumbing to a sense of panic. People adapt to the way they live as well as their home environment; however, if there is a crisis, new practical realities suddenly surface. This was the case for most students. For example, students were accustomed to going to school or a library at an online distance learning institution early in the morning, where there was always electricity, Wi-Fi, and a warm, comfortable space to sit and work. There was the additional bonus of the community of learners who were always present for emotional and spiritual support, and typical teenage engagement. During the pandemic, and based on their background of poverty, the students suddenly realised they did not have their own space to work from, and that access to electricity and Wi-Fi was challenging. Some students realised that their cell phone was not an educationally user-friendly model (e.g. no WhatsApp, low battery model, etc.) or that their cell phone bills were not within their means. Therefore, in a crisis scenario caused by the pandemic, support was needed for students' specific needs.

Problem statement and research question

Generally, mathematics teaching is better done in a face-to-face environment. However, due to COVID-19, mathematics had to be taught in a remote setting that required an online platform. Mathematics lecturers were not ready for the emergency online teaching, resulting in the need for a quick-thinking model that would allow those lecturers to achieve results in an emergency setting. The research question was, therefore: How can mathematics lecturers use simple technology in higher educational institutions to teach mathematics during this period of disruption caused by COVID-19? Therefore, this article develops a conceptual framework for ERT which proposes guidelines for lecturers facing a crisis to conduct and deliver a mathematics lesson within an ETRP.

Methodology

A development qualitative virtual case study was conducted that involved observing live and recorded mathematics lectures and interviewing an innovative lecturer of mathematics in the delivery of complex numbers at a graduate school in South Africa. The facilitation of the lessons through a simple and inexpensive technology (Microsoft OneNote) guided the development of a conceptual framework for ERT within an ETRP. In the first research stage, the researcher interviewed the lecturer at the graduate school on the challenges that prompted him to use Microsoft OneNote through Zoom for the teaching of complex numbers during COVID-19. In the second stage, the researcher observed each of the selected lessons at least twice, noting areas of interest from a researcher's perspective. Observations were made of similarities and differences between and among teaching methods employed in a face-to-face lesson. The participant was approached in a natural setting so that the researcher could analyse and understand the ERT phenomenon during the teaching of mathematics in an ETRP. Interviews conducted by the researcher lasted approximately 1 hour, and were conducted via Zoom web conferencing. The interviews were conducted at the beginning and at the end of the case research lessons. A semi-structured interview protocol was used to capture the strategies used by the lecturer to achieve ERT of complex numbers in mathematics. As part of college algebra, a complex number, that is, the sum of a real number and an imaginary number, was chosen for the lesson to be observed. A complex number is expressed in standard form when written as $a + bi$ where a is the real part and bi is the imaginary part.

The theoretical framework

In this article Stufflebeam's (2003) Context, Input, Process, and Product (CIPP) evaluation model was used as a theoretical framework to systematically guide the analysis of the lecturer's activities during the delivery of the ERT during COVID-19 (Appendix 2). According to Stufflebeam and Zhang (2017), the objective of context evaluation is to assess the overall environmental readiness of a project, examine whether existing goals and priorities are attuned to needs, and assess whether proposed objectives are sufficiently responsive to assessed needs. The input evaluation component helped prescribe a responsive strategy and technological tool to best address the identified needs of ERT in an ETRP. The process evaluation component then monitors the strategic process and potential procedural barriers and identifies potential process adjustments. Finally, the product evaluation component interprets and judges teaching and learning outcomes and interprets their merit, worth, significance, and probity (Zhang et al., 2011). Through the analysis and conceptualisation of the lessons using the CIPP model the main strategies in the facilitation were categorised into broader strategies that led to the development of a conceptual framework for ERT.

Permission and ethical considerations

Permission was sought from the lecturer who received enough information to make an informed decision regarding his participation in the study and the head of department (HOD) was informed of the research that was to be conducted. Appropriate steps were taken to ensure the participant was fully aware of his participation and role. The participant's privacy and confidentiality were protected during and after the research process.

Ethical considerations

Study was approved by the lecturer participant at his home environment as it was during the COVID-19 lockdown.

Results

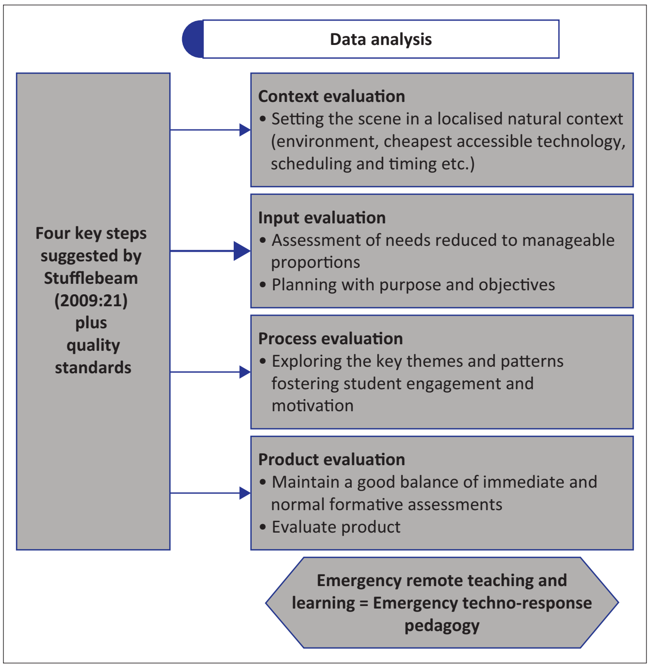
An interview was carried out with a recognised mathematics lecturer at a graduate school in South Africa. In a qualitative case study, the researcher asked the lecturer to narrate his experience with teaching during the hard COVID-19 lockdown.

Interview 1

> When COVID-19 knocked on my door, I was challenged mentally and psychologically on how I was going to deliver the subject effectively as compared to how I did it in my face-to-face classroom. Until I discovered Microsoft OneNote I went through so many challenges so much that I decided to also find out the status of my colleagues. It seemed that we were all frustrated about what next step to take. Several mathematics software (e.g. Wolfram Mathematica, MATLAB, Infinite Algebra 1) were recommended for the job but my colleagues and me found them very difficult. I personally didn't have time to go through them. In addition, I wanted a support technology that did not work different from my face-to-face classroom.
>
> The HOD discovered the ability of Microsoft OneNote in the teaching of mathematics as he had observed from one colleague from another school in cluster meeting. During the strict COVID-19 conditions in Level 5 where it was total lockdown with very minimum human movement, schools were totally closed. The HOD called for a meeting and advised the use of Microsoft OneNote. Each lecturer had to do a trial and error to come up with the most effective way to deliver a lesson using Microsoft OneNote.
>
> Since we were advised by the HOD to use Microsoft OneNote and each of the lecturers doing a trial and error, we all successfully managed to effectively deliver our lessons in our own different ways. I then sought to find out how to establish a model for the successful use of Microsoft OneNote as a teaching application. The success of Microsoft OneNote led to accept your request for an interview to observe my teaching and learning model. During an online staff meeting there was overwhelming positive feedback from the students as compared to the other different previous trials in the emergency remote teaching in the total lockdown.

Using the CIPP model to build the conceptual framework

The CIPP evaluation model was useful in analysing the planning and implementation done by the lecturer in this case study for the teaching of complex numbers during the COVID-19 pandemic. Using the CIPP model as a guide, analysis of the emergency remote mathematics teaching was made to ascertain the nature of the strategies used during the emergency period, as summarised in Figure 2.



CIPP, Context Input, Process, and Product.

FIGURE 2: The CIPP model guiding the conceptual framework.

Unpacking the conceptual framework for emergency remote teaching

The CIPP model was used to structure and analyse the five phases of the conceptual framework derived from the interviews and observations which were the context mapping, planning input evaluation, process building evaluation, the teaching and learning process evaluation and simple technology evaluation. Strategies that emerged from the analysis were used to facilitate a closer examination of the ERT approach to instructional delivery of complex numbers. The conceptual framework provides guidelines for teaching mathematics in an emergency response situation. The phases in the framework are analysed through lenses of the CIPP model as explained below.

Context mapping

This context evaluation phase enables the unpacking of two issues: analysing the context of the mathematics teaching space involved in ERT and reflection of the ETRP. During this phase, the following questions can be asked: Where is my student and where am I? What does my student have and what do I have? What can my student afford and what can I afford? Will my institution buy into my ideas? Will this idea work and if it doesn't what do I do? The answers that evolve here lead to the lesson planning document explained in the input evaluation. The analysis of the context requires the direct listing of the necessary resources required to carry out the reflected ideas. Table 1 gives an example of the list that was given by the lecturer involved in the case study.

Planning input evaluation

This stage in the conceptual framework speaks to the planning document that carries out the ERT in an ETRP. Through the interviews, lessons replay and observations a different type of planning that is not carried out in a normal face-to-face classroom was constructed (Table 2). In a face-to-face classroom, lesson planning is superficial and has many assumptions. The assumptions originate from the fact that the lecturer is present in the classroom with the students. The classroom has charts, has a board, has different types of materials that can be referenced during a mathematics lesson. A lecturer can jump, shout, touch, verbally explain and re-explain or bring physical objects in order to clarify a mathematical concept. However, this is very different when teaching is done remotely, at a distance and using a simple technology. Therefore, I observed the lecturer's planning document for the lessons with great interest. The planning document illustrated in Table 2 identifies the exact 'critical mini objectives' per each lesson. During a lesson there are main objectives. Now these main objectives need to be minutely unpacked to come up with the 'critical mini objectives' that deal with the real person and his mathematical being. These 'critical mini objectives' fall into questions that ask if the students need to see, touch, smell, lift, slide, taste, etc. The 'critical mini objectives' enable the choice of the support technology like Microsoft OneNote and the tools to use within this technology in order to achieve the 'critical mini objectives'.

Table 2 shows an example of a lesson plan in the teaching of complex numbers in college algebra. Mathematics components involve several subject matter strands, of which complex numbers were chosen for the demonstration. Learning complex numbers involves several types of thinking processes, namely seeing, listening, relating, applying, and reasoning, among others. To promote students' understanding of subject areas in mathematics, a process is followed as determined by what the student is supposed to grasp within that area of mathematics. This process guides the nature of the technology, the nature of the communication, and the interaction to be used during ERT. It is against this background that the article recognises lesson planning as an important part of ERT in an ETRP.

TABLE 1: Example of requirements needed to use Microsoft OneNote.

Requirements for the ETRP model to work	
1.	A laptop, preferably with at least 4 GB RAM.
2.	Internet connectivity (at least 5–10 mps) for each learner and the lecturer.
3.	Microsoft Teams or Zoom as broadcasting software.
4.	Laptop with Microsoft Office installed on it, where the Microsoft OneNote whiteboard is found.
5.	Wacom tablet or external mouse to write on the whiteboard.
6.	External microphone and headphones might be required depending on the type of laptop being used.
7.	Other: strictly depends on the simple technology or app chosen.

Process building evaluation

The process that the lecturer engaged here involved identifying learners' contact details (e.g. cell numbers) and sending invitation links through WhatsApp for learners to be part of the class, depending on the broadcasting software to be used. An example is given in Table 3.

TABLE 2: Lesson plan for an ERT in an ETRP.

Topic	Sub-section	Main objectives	Critical mini objectives
College algebra	Introducing complex numbers	Evaluation of complex numbers and how parts of complex numbers are written, that is, real part and imaginary part. How complex numbers are evaluated, added, subtracted, multiplied, and divided. Argand diagram.	Seeing
		Listen to explanations on how problems with complex numbers are solved, that is, addition, subtraction, multiplication, and division. Application of Argand diagram in complex numbers.	Listening
		Relate the concept of complex numbers, what it means in mathematics; for example, situations where there is a need to find the square root of a complex number.	Relating
		Solutions to problems need to be showcased before possible simulations. Activities (self-assessment or straight assessment activities) to be carried out.	Applying
		After demonstrations are carried out by the lecturer, the students answer questions that apply to the taught techniques. The student goes through assessment activities while sharing their screen with the class, and the lecturer guides the students through the process.	Activity

ERT, emergency remote teaching; ETRP, emergency techno-response pedagogy.

TABLE 3: Example of the practical processes involved with the use of Microsoft OneNote.

Step	The practical steps carried out by the lecturer
1	Send invitation links to learners who will be part of the class. It also involves sharing the meeting ID and passcode of Zoom with the learners via WhatsApp groups. This allows the students to enter the class.
2	Open Microsoft OneNote, which is the whiteboard where illustrations will be presented.
3	Open broadcasting software Microsoft Teams or Zoom.
4	Share your screen on the broadcasting software, and upon sharing your screen, also confirm whether learners can see your screen and hear you.
5	You can now use Microsoft OneNote as your whiteboard and deliver the desired lesson.

Teaching and learning process evaluation

During the phase of process evaluation, the lecturer carries out the teaching with Microsoft OneNote. Figure 3 shows examples of the observed and replayed video lessons on complex numbers.

Product evaluation

The advantages of using Microsoft OneNote through Zoom are discussed based on another interview with the lecturer. The COVID-19 pandemic caused significant restrictions, including minimal human movement, social distancing, and limited gatherings, among others. In this learning situation, the Microsoft OneNote application embedded within the Microsoft Office package was selected for use. The Microsoft OneNote application made it possible for the lecturer to effectively deliver a mathematics lesson on complex numbers in a virtual context. The main advantages of Microsoft OneNote, which made the delivery of the mathematics lesson possible, included:

- It is cost-effective and comes with the Microsoft Office package.
- It is easy to use; no intensive training is required to use the software to deliver an online mathematics lesson.
- It is compatible with all laptops or desktops and can be used on most cell phones.
- There is no significant difference between a traditional classroom blackboard in a conventional classroom, and the Microsoft OneNote whiteboard offered within Microsoft Office.

The assessment results that were obtained based on the use of the Microsoft OneNote application proved to be even better than when teaching was presented in the face-to-face context. Absenteeism was eliminated to almost zero; students were self-isolating in their homes and had nothing better to do than to join their mathematics lessons. Since the use of Microsoft OneNote was a new experience for the students, they were excited and very happy about it. Their overall motivation to learn and ask questions also increased. This could be attributed to students feeling more confident to interact in their own spaces without the negative comments that can occur during contact classroom sessions. There was some feedback from students who attended classes using Microsoft OneNote through Zoom, stating that it was a successful alternative to strategies that might come in future. Through Zoom students could just click a button to raise their hand or share their written exercises. Students' classroom interactions and communication were easily managed. The other advantages of Microsoft OneNote are based on the personal observation and deductions of the lecturer.

Microsoft OneNote was cost-effective: There was suddenly no transport and extra food-related costs to attending in-person classes, and parents were therefore willing to go the extra mile to avail the students of Wi-Fi and laptops as the lessons were being delivered remotely. In some cases, not living on campus eliminated any further costs.

Microsoft OneNote offered a comparative face-to-face classroom environment: Microsoft OneNote offered several similarities compared to the traditional face-to-face classroom. It also had significant advantages over in-person classroom settings. Students did not face any challenges following up on concepts being demonstrated on the Microsoft OneNote whiteboard and could do their immediate assessment activities using Microsoft OneNote.

Some limitations in the use of Microsoft OneNote: Microsoft OneNote, as a stand-alone vehicle, is incapable of adequately handling all facets of instructional delivery and must be offered through other online interactive applications, like Zoom or Teams. A few negative comments were received from the students addressing connectivity challenges, isolation, and a lack of direct student-to-student interaction.

Connectivity: Not all students have access to high-speed internet connections. Some are using internet connections from service providers (including MTN, Cell C, Vodacom and Telkom, among others). Due to their geographical locations, some do not have strong internet signals, making it difficult for them to attend and participate in the online class.

Isolation: Most students are not used to being isolated from their lecturer and peers. They are used to the normal environment where they mingle with classmates on the campus. While this teaching method has proven to be helpful in these turbulent times, some students were complaining that it is affecting their social life.

Student-to-student interactions during lesson time: A few students raised concerns that it was no longer possible to chat with peers during and after class or have some short discussions on difficult mathematical concepts. This is no longer possible, yet the model works well in promoting student-teacher interactions.

Discussion

According to the first paragraph in the interview, face-to-face lecturers who had to move to fully online teaching faced the greatest challenge. They had no technical skills and there was need to quickly adapt to the new need and environment. The use of a simple technology that did not require them to learn advanced and complicated mathematical software became

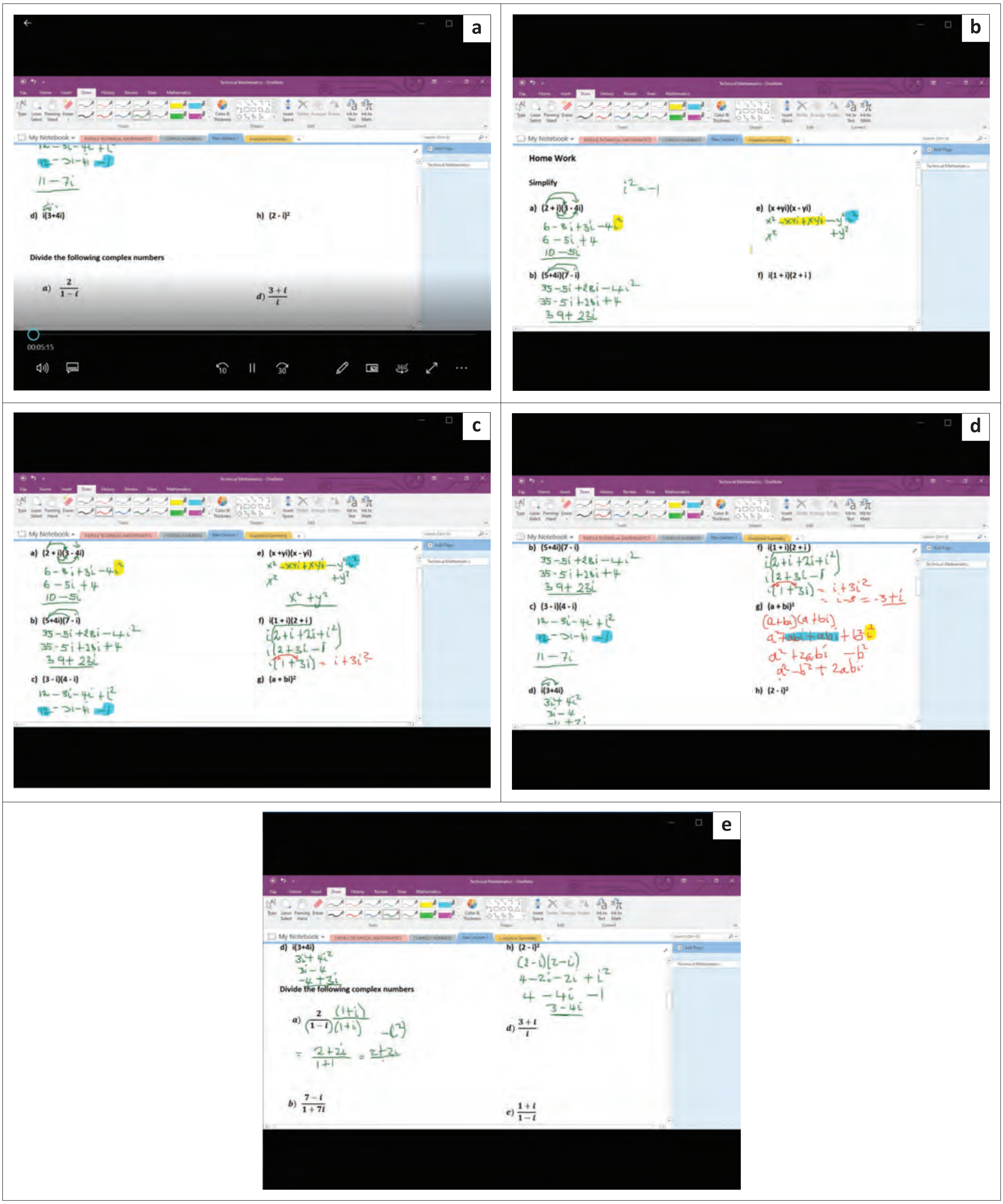


FIGURE 3: Example of observed lessons presented through Microsoft OneNote and Zoom, (a) Lesson 1, (b) Lesson 2, (c) Lesson 3, (d) Lesson 4, (e) Lesson 5.

key. The idea was to showcase the simple technologies among the mathematics teachers until more advanced mathematical software could be learnt. Simple technologies like Microsoft OneNote resembled a face-to-face classroom which they were used to.

The purpose of this article was to develop through a simple technology a conceptual framework for ERT in an ETRP. Many students were unable to access a proper learner management system during the pandemic because universities and colleges were not ready for this eventuality.

Therefore, delivering content through Microsoft OneNote was a major innovative advantage. The teaching delivery method described in this article mimics the face-to-face lecture style of the 'live' classroom which is the students' preferred teaching mode, as discussed during the interviews (Kuhn & Johnson, 2019). The ETRP enabled the development of a conceptual framework that could guide the successful ERT of mathematics using Microsoft OneNote. During the interviews, the concept of 'emergency innovation' was visible in the lecturer's narratives; he chose a tool or combination of tools (support technologies) consistent with the intellectual challenges at hand.

This article was initiated by the fact that universities allowed lecturers to do whatever they could in the absence of a long-term organised strategy. The conceptual framework for ERT in an ETRP allows higher education lecturers to act as agents for change in the teaching of mathematics or any other subject. ETRP knowledge is vital as it describes the knowledge that lecturers must develop in an emergency. It also presents approaches to teaching, assessment and evaluation that can capture the complexity of a crisis in, for example, a pandemic, and its strength is its attention to the use of a simple technology instead of a complex approach to ERT and learning. Using the CIPP evaluation model to analyse a mathematics lesson on complex numbers enabled the development of a conceptual framework for ERT in an ETRP. The comprehensive framework explored the complex dynamics behind the use of Microsoft OneNote in emergency teaching and learning. The effort of a lecturer during an emergency and outside an institutional context was analysed.

It was also observed that the lecturer was forced to take some non-academic roles during the ERT. These included finding out what time was most suitable for the lessons, preparing some entertainment to motivate the students, giving compassionate support to students who experienced gender-based violence, lost members of the family or had personal losses, and having empathy during the interactions. Among other findings through observations, it was clear that students felt more connected with the lecturer when the lecturer gave them more non-academic support. However, these roles taken by the lecturer overloaded the lecturer with more work that went unrecognised by their respective academic institutions.

The key contribution of this study is its explicit invocation of an ETRP, an emergency response approach to higher education instruction that can be used during pandemics. This study draws clear connections between the responsive pedagogy and bridging the digital divide to play a more prominent role in the practice of ERT.

Recommendations

Throughout the interviews, the lecturer stressed the importance of a community of lecturers to handle remote mathematics teaching during emergencies. It is therefore recommended that institutions move away from a 'siloed' model in which a small group of staff work exclusively to support fully online students, toward an 'integrated' model in which knowledge and skills regarding online teaching support are spread across the entire institution (Wang, 2020, p. 7). This finding was also reflected in a research study that supported the importance of collaborating and building relationships between staff and other departments to ensure students' full academic support could be better achieved during emergency periods (Ryan & Deci, 2020). Discussions about the role that each lecturer was playing during COVID-19 was crucial. These deliberations can provide an opportunity to build new relationships among staff members that can be shared when there is a crisis. 'Academic resilience during emergencies comes from an ethos of collectivism that is borne of mutual recognition of one another's personhood through Ubuntu (I am because you are)' (Enslin, & Horstemke, 2004, p. 10).

During pandemics, lecturers need to change from a pre-prepared teaching perspective to a possibility-focused perspective characterised by a self-empowered lecturer role. This goes hand in hand with Kuhn and Johnson's (2019) notion of the need for a practical approach for predictive models that cater for predictive pedagogies in the future. The article provided theoretical and practical recommendations that higher education institutions and lecturers can incorporate into their e-teaching strategies during emergencies.

Conclusion

Greater attention should be paid to finding and formulating teaching strategies that use simple technologies to communicate and interact effectively with students during emergencies. This article presented a conceptual framework for ERT of mathematics in terms of better preparing for future pandemics. This approach is dependent on the innovative push from lecturers and the context of the students. Overall, the findings suggest the need for higher education institutions to be conscious of unforeseen situations that can suddenly appear across the globe, forcing them to quickly identify sudden gaps in student support.

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Competing interests

The authors have declared that no competing interests exist.

Authors' contributions

Both authors contributed to the conceptualisation, methodology, formal analysis, investigation and writing of the original draft.

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Data availability

The teaching audio and vision lessons were made available by participant consent to the researchers.

Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy of any affiliated agency of the authors.

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Appendix 1: Detailed analysis

STEP 1: Identify the exact details of the learners (e.g. cell numbers). Send invitation links through WhatsApp to learners who are going to be part of the class depending on the broadcasting software to be used. On Zoom you can share the meeting ID and passcode to the class via a WhatsApp groups. This allows them to enter your class.

STEP 2: Open Microsoft OneNote which is going to be the whiteboard where illustrations are going to be presented. Microsoft OneNote is a free software that comes with Microsoft Office, so to open Microsoft OneNote you need to go to Microsoft Office folder. This varies from machine to machine since in some cases it appears on the main menu. Once you are on Microsoft OneNote open the Drawing tab, which is where you find tools to use for the lesson. On the drawing tab you find board pens, board eraser and a tag for simple shapes that may be used during the session.

STEP 3: Open broadcasting software Microsoft Teams or Zoom. Both programs have a chat section where students can interact, comment or give suggestions as the lesson progresses. Students have an option to click a raise hand button on both software should the need arise. This would notify the lecturer on which student might be in need of attention. Students can also write their names in the chat section as a way of taking register. This allows the lecturer to monitor who is attending the class or not.

STEP 4: Share your screen on the broadcasting software and upon sharing your screen also confirm with the learners whether they can see your screen and hear you. This is when students have accessed your class or are still accessing your class using the link or meeting ID and passcode that would have been supplied earlier.

STEP 5: You can now use Microsoft OneNote as your whiteboard and deliver the desired lesson. Students would be seeing your demonstrations on the whiteboard on their screens as well as hearing your voice. Both software Zoom and Microsoft Teams have video option where the lecturer can opt for a video where students would see the lecturer or not to be seen by students. This is normally determined by the signal strength during the lesson.

Appendix 2

Table 1-A2: The CIPP model.

CIPP	CIPP framework	Standards for quality practice in the ETRP mathematics lesson
Context evaluation	• Define the characteristics of the environment • Determine general goals and specific objectives • Determine the context of the resources needed to deliver the project • Diagnose the problems or barriers which might inhibit achievement of goals and objectives	• Identify participants' needs. • Follow an emergency techno-response pedagogy • List of the needed resources • Electricity and Wi-Fi are needed: non-negotiable
Input evaluation	• Identify learning goals • Design an intervention to meet the objectives • Determine the resources needed to deliver the programme	• Plan table for emergency techno-response pedagogy • Set up Microsoft OneNote and download Zoom
Process evaluation	• Design project as an effective instructional strategy to meet learning goals • Design project that is engaging and targets participants' needs.	• Step-by-step explanation of mathematical processes • Teaching actively engages participants in meaningful and personally relevant mathematics activities
Product evaluation	• Advantages of using Microsoft OneNote through Zoom	• Decide to accept one not within the ETRT • Allow for a case study research approach