Flipped Learning within Mathematics Teacher Education in KwaZulu-Natal, South Africa: Embracing Connectivism in Response to the COVID-19 Pandemic

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Abstract

The COVID-19 pandemic has disrupted life-encompassing societal and educational lockdowns globally. Higher Education Institutions are undertaking various approaches to complete the academic semester remotely while seeking to maintain academic integrity. Within the Fourth Industrial Revolution, digital tools are viewed as essential in facilitating remote learning. Globally, institutions are introducing virtual and remote learning within their curricula. In mathematics education contexts, coupled with embracing remote learning, are issues of what it means to incorporate flipped learning within the context of COVID-19. This chapter draws attention to a qualitative study that explored mathematics education students' perceptions of flipped learning within the context of the pandemic. The study was framed by connectivism, which is a network learning theory guided by the view that learning is a process whereby new information is continuously being acquired. Participants were invited to interactive virtual workshops focusing on flipped mathematics learning within the context of the COVID-19 outbreak. Subsequently, participants were interviewed online, based on their perceptions of flipped mathematics learning. The findings of this study indicate that there are challenges with using flipped learning and the advantages of collaboration inspired by flipped learning within the context of COVID-19. Globally, these findings have relevance when considering the perceptions and implications of flipped mathematics learning within the context of the COVID-19 pandemic.

Keywords: Connectivism, COVID-19, Digital Tools, Flipped Learning, Fourth Industrial Revolution (4IR), Mathematics

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1 Introduction

We have entered the era of the Fourth Industrial Revolution, and globally the use of digital tools is widespread (Pyper 2017). Digital tools are progressively displacing traditional pedagogy at educational institutions, and the use of the Internet and Information and Communication Technology (ICT) has revealed the capability to transform educational milieus (Du Plessis 2013). Currently, we are dealing with an unprecedented global health pandemic. At the time of completing this chapter (June 2020), globally, over 7.4 million people are infected, and more than 419 000 people have lost their lives due to COVID-19 (Elflein 2020). Within South Africa, over 55 400 people are infected, and more than 1200 people have lost their lives due to COVID-19 (Mkhize 2020).

The communicable coronavirus (COVID-19) disease, which originated in Wuhan, China, has dispersed swiftly, forcing people globally into lockdown conditions (Sahu 2020). Under lockdown conditions, people are not permitted to leave their homes except to obtain medical care, visit a pharmacy for medicine, purchase food and essential items, or to collect social grants.

Within these unique lockdown environments, Higher Education institutions are attempting to complete the academic semester remotely while seeking to maintain academic integrity. Since online pedagogy is considered as a way of confining the spread of the contagious COVID-19 disease (Murgatrotd 2020), large-scale, national initiatives to engage with digital tools to support online pedagogy during the pandemic are developing and progressing quickly. However, within the context of the pandemic, we need to establish if students and lecturers within South Africa are adequately prepared for remote and online pedagogy. This chapter reports on a study which sought to respond to the question: What are students' perceptions of using the flipped learning approach in a mathematics higher education milieu within the context of the COVID-19 pandemic?

2 Fourth Industrial Revolution

The Fourth Industrial Revolution involves innovative methods in which technology is embedded within societies and human bodies (Schwab 2016). Within the Fourth Industrial Revolution (4IR) era, technology, digital tools, robotics and artificial intelligence are transforming the way we exist. The rapid pace of this transformation is unsettling society, since the 4IR has transformed

the way nations subsist. The 4IR is epitomised by merging the physical and virtual world (Schwab 2016), shaping a universally connected and advanced society. Within the context of COVID-19, as professionals in the education sector, we ought to embrace this transformation to engage and interact successfully with our students.

Students may be at different levels concerning preparedness for succeeding within the 4IR; students may be digital natives or digital immigrants. Digital natives are knowledgeable about the use of technology-based tools (for example the Internet, computers and other digital tools), and this term is generally used to typify individuals who have always been involved and associated with technology-based tools (Helsper & Enyon 2009). These individuals are more likely to succeed in using technology-based tools when learning. In contrast, digital immigrants are individuals who may learn and understand how to use technology-based tools, but rather than going online for information or working online first, they may print out information to peruse before visiting the Internet for assistance or information (Helsper & Enyon 2009). These individuals may need additional support with using technology-based tools. As is evident, lecturers need to know who their students are and what their abilities are concerning using technology-based tools when learning. This knowledge will assist when introducing the notions of the 4IR in the lecture room.

Also, our education structures need to be adapted to prepare students adequately to succeed within these conditions (Butler-Adam 2018). To develop the necessary capacity for the 4IR, education milieus ought to adapt quickly since the demand for remote and virtual pedagogy within this global health pandemic is increasing and progressing. Thus, the 4IR influences the function that Higher Education institutions play in preparing students for survival within our technologically progressive society. To take advantage of 4IR opportunities, we need to transform our pedagogy to include the effective use of digital tools.

3 Using Digital Tools within Mathematics Education Contexts

The digital world has entered education spheres, with technology progressively being used to deliver education in innovative ways (Grand-Clement, Devaux, Belanger & Manville 2017). Within the domains of this chapter, digital tools are software platforms and web-based resources that may be used with

computers or mobile gadgets that operate with text, pictures, audio, and video to support teaching and learning (Peachey 2017). For mathematics teaching and learning, Pope and Mayorga (2019) affirm that there are a plethora of online websites and an increasing number of educational applications that may influence students' learning and achievement. Within the 4IR and considering the novel COVID-19 pandemic conditions, Higher Education institutions are gravitating towards using digital tools for remote and online pedagogy.

Research (Cheung & Slavin 2011) has shown that using digital tools when teaching mathematics has enriched student performance. Digital tools in mathematics education milieus may assist students that are both struggling and are thriving (Bruce 2012). However, within the context of remote and online pedagogy, it is overwhelming for the lecturer to select the appropriate digital tool to navigate the plethora of available online tools. The idea is to select the most effective digital tool to achieve the full potential of online pedagogy to scaffold students' learning. Thus, it is the lecturer's responsibility to facilitate advancement in education (Montrieux, Vanderlinde, Schellens & De Marez 2015).

Since it is evident that digital tools are transforming the lecturer's role, we need to know how best to prepare and support lecturers during this transformation (Grand-Clement *et al*. 2017). Currently, the lecturer ought to use digital tools to enhance pedagogy within the 4IR while considering the reality and implications of the COVID-19 pandemic. Since pedagogy is transforming rapidly, one progressive approach to consider is the Flipped Learning Approach.

4 Flipped Learning Approach

The Flipped Learning Approach (FLA) is a combination of traditional teaching and teaching using digital tools (Ramakrishnan & Priya 2016). This approach requires a transformation or conventional pedagogy inversion and is established on the concept of switching in-class teaching time with out-of-class practice time (Hwang, Lai & Wang 2015). By using the FLA, students view subject matter using videos and PowerPoint presentations before the lesson. Hence, the use of digital tools is essential within the flipped learning environment. Within this environment, the lecturer is a guide or a facilitator.

Students and the lecturer collaborate actively within the lecture room based on prior planning. Rambe and Bere (2013) maintain that collaborative

learning motivates the construction of knowledge through interactions within the group. Collaborative learning also enhances the learning process and promotes the learning experiences for students (Tran 2014). This supports the view that learning is a collaborative effort rather than an involuntary endeavour (Lawson 2011). Thus, the FLA requires obligatory collaboration and participation from both students and lecturer. For this study, due to the contagious nature of the COVID-19 disease, remote teaching and learning were employed. Hence, the virtual lecture room was utilised. In this study, virtual teaching and learning refer to online teaching and learning that occurs remotely. Primarily, the virtual lecture room encompasses interactions between the lecturer and students who are located at different places at the same time.

Within mathematics education settings, digital tools and websites, for example, Geogebra, Geometer's Sketchpad, Mathway and Mathwords provide support to students and lecturers (Rajkumar & Hema 2017). Within the flipped learning environment, the lecturer is tasked with transforming pedagogy within a large lecture room to an individual learning environment by using digital tools (Hamdan, McKnight, McKnight & Arfstrom 2013). In this learning environment, the student interacts with the content before the lecture. During the lecture, this content is explored further with classmates and the lecturer to clarify and promote understanding. Moreover, problem-solving activities are performed revolving around the material being studied.

Fundamentally, within the spheres of remote pedagogy, before attending the virtual lecture, students work with the content to participate in the lecture. During the virtual lecture, students deliberate collaboratively on their understanding , and via these deliberations they enhance their knowledge of the content under focus. The lecturer facilitates, probes and clarifies important concepts by means of videos and PowerPoint presentations before and during the lecture, and encourages students to contemplate dynamically and build on existing knowledge (Hwang, Lai & Wang 2015).

5   Theoretical Considerations: Embracing the Notions of Connectivism

The use of the Internet and ICT is necessary for facilitating teaching and learning within the 4IR. Worldwide, digital tools and online pedagogy are progressing rapidly within educational contexts (Foroughi 2015). New developments in online pedagogy have provided prompt access for teachers to

introduce various digital tools and interactive technology-based learning approaches within the 4IR education environment (Bailey 2019). The introduction of digital tools within the education environment, as well as the rapid developments in technology, has led to the promotion of the theory of connectivism (Goldie 2016).

Connectivism is not without critique, and researchers (Craig 2008; Verhagen 2006) argue that this theory is uncorroborated theorising and opinion of 21st-century proficiencies that do not sufficiently explain how individuals acquire knowledge. However, connectivism is significant for learning within the 4IR (Foroughi 2015), since connectivism is a network learning theory which is guided by the perception that learning is a process whereby new information is continuously being developed (Siemens 2005). Connectivism may also be understood as an extension of Vygotsky's theory of social constructivism (Kerr 2007). Siemens (2006) has maintained that a new learning theory is essential, due to the development and intricacy of information accessible on the Internet and for the ability to combine different data transmissions. Within the scope of connectivism, students engage with and interact within digital platforms, for example, social networking sites, blogs and online learning communities to deliberate on and advance existing knowledge (Goldie 2016).

The concept of networking is significant to connectivism since information is professed to be progressing from a network of people to a network of digital tools (Bell 2011). Hence, connectivism refers to networked social learning (Duke, Harper & Johnson 2013) and emphasises distributed learning, which is inspired by technology and the idea that knowledge may reside within digital tools (Goldie 2016). Connectivism allows for a community of students working with digital tools to rationalise what they are learning (Bell 2011).

6 Materials and Methods
6.1 General Background
This qualitative, interpretive study was situated within one mathematics Higher Education environment during the Level 5 National lockdown in South Africa. Gatekeeper access and ethical clearance were approved by the participating university's ethics committee. The study incorporated three interactive workshops and one semi-structured individual interview with postgraduate

mathematics education students. These students were also mathematics teachers at secondary schools. The participants were purposively selected for convenience, since the researcher taught or supervised these students.

6.2 Participants

The population for the study were 35 postgraduate students who were invited to participate in the study. Participants were provided with an informed consent form describing the process of the research. Twenty-seven students responded positively (17 male and 10 female). Five participants were randomly selected to participate in the pilot study.

6.3 Pilot Study

Conducting the interactive virtual workshops and semi-structured interviews during the pilot study improved the study's trustworthiness, transferability, confirmability, and dependability. During the pilot study, internet connections were slow and unstable during the workshops, since the pilot workshops were conducted at peak times when internet service providers were dealing with many customers. This led to slower network speed and unstable connections. Hence, the workshops took more time than was allocated. Additionally, some participants were unclear about what was required of them for specific questions during the online interviews. To eliminate issues of this nature, during the main study, the workshops were held with the consent of all participants during off-peak times to ensure the speed and stability of internet connections. Moreover, to ensure that each interview question was understandable, questions were rephrased to avoid ambiguity. The language used during the interactive virtual workshops and online interview process was focused and well-defined to improve the dependability and credibility of the research tools and procedure.

6.4 Main Study

Twenty-two participants participated in the main study. Data were generated via three interactive virtual workshops and semi-structured online interviews. Although 22 participants participated in the virtual workshops, due to personal, family, or other obligations, only 11 participants were available to be

interviewed. Six male and five female students were interviewed for the main study. To assure participants of their anonymity, pseudonyms were used as presented in Table 1.

Table 1 Participants who Participated in Online Interviews

Participant #	Pseudonym	Participant #	Pseudonym
1	Judy	7	Nozipho
2	Themba	8	Anele
3	Sizwe	9	Mandla
4	Zodwa	10	Rajesh
5	Lekha	11	Carl
6	Gloria		

6.5 Interactive Virtual Workshops

A sequence of virtual interactive workshops (N=3) focusing on the FLA for mathematics was conducted with participants. The virtual workshops were facilitated by the researcher (lecturer), and participants were provided with supplementary online notes, PowerPoint presentations of case studies, and examples of online assessments focusing on using digital tools and free online websites within a virtual flipped mathematics education environment. In this virtual flipped learning environment, the lecturer shared resources with students online.

The virtual workshops focused on academic writing, assessment, providing feedback, identifying and correcting students' misconceptions in mathematics. At the end of the third virtual workshop, the participants were invited to online interviews scheduled during the Level 5 National lockdown in South Africa. This meant that each participant would have the opportunity to reflect on what they had learned from the workshops with a view to advanceing their pedagogy and thereby promoting their personal and professional development. The interview was conceived to explore students' perceptions of using the FLA in a mathematics higher education milieu within the context of the COVID-19 pandemic.

6.6 Semi-structured Online Interviews

The purpose of the interview was to explore students' perceptions of using the

FLA in a mathematics higher education milieu within the context of the COVID-19 pandemic. Each interview was approximately 25 minutes. The interviews were conducted online using digital tools, for example, Zoom, Moodle, Skype and WhatsApp chats, at a time that was suitable for each participant. Each interview began with a few general questions to put the participant at ease. The interview then progressed to specific items, focusing on the participant's perceptions of flipped mathematics learning within the context of COVID-19. The interviews were semi-structured and concentrated on the following key questions:

- What are the participants' perceptions of the flipped learning approach for mathematics?
- Are online mathematics workshops beneficial to participants?
- What are the strengths of using the flipped learning approach for mathematics?
- What are the challenges of using the flipped learning approach for mathematics?

The online interviews were recorded and transcribed. Transcriptions were emailed to each of the eleven participants for scrutiny to ensure the correctness of each interview transcript.

6.7 Data Analysis

The data analysis process initiated the formation of codes for relating participant responses to each interview question. During data analysis, steps, as discussed by Tesch (as cited in Creswell 2014, 198) were followed to organise all unstructured data. The interview transcripts were carefully read, and notes were made. Each interview was then examined and analysed to explore what the information meant within the context of the study. Subsequently, a list of common topics was identified, and similar topics were clustered together. The topics were then shortened as codes. A descriptive word for each topic was defined and categorised. All interviews were later re-examined to establish a relationship between the categories. A final abbreviation for each category was used. The interviews were subsequently categorised/recoded using a definitive list of abbreviations (for example challenges or significance or advantages of flipped learning within the context

of COVID-19) which were finally captured as themes.

The classification of themes also incorporated ideas established on Connectivism (for example, the effects of using digital tools for learning mathematics and contributions of online discussion forums for learning mathematics within the context of COVID-19). Two main themes were identified from the qualitative data analysis of the interview transcripts, which were the themes of challenges of using flipped learning and the advantages of collaboration inspired by flipped learning within the context of COVID-19.

7 Findings and Discussion

The findings and discussions are captured in the section that follows.

7.1 *Challenges of Using Flipped Learning within the Context of COVID-19*

7.1.1 *Time Taken and Expenses Incurred for Downloading Free Online Resources*

The participants downloaded and viewed the videos and PowerPoint presentations before attending the virtual workshops. The participants did not experience challenges with videos and presentations taken directly from the participating university's website or portal. However, some of the participants had difficulties due to the lack of infrastructure or resources outside of the lecture room. These ideas are supported by excerpts from the interview transcripts that follow:

> **Carl:** … it was tricky … some resources that were free expected me to download apps … took … long … used … data … could not get more data easily … in lockdown …
> **Gloria:** … the free websites … took longer … it was free but … needed to download … apps … was a challenge … took long … lots of data … expensive … better to have the information sent to us …
> **Lekha:** … problems with … free resources … not … enough time to download … information … could access the videos that were sent … it is better if the resources were … university website …
> **Mandla:** … free resources … not free … used … my airtime and … data to get information …

Sizwe: … the free resources expected me to work on my computer … problem … my computer is also used by my children … not always available to me …

Themba: … get used to using different websites at the same time … not used to it … complicated … many instructions on … free websites … much time … was difficult …

Zodwa: … finding the free resources you[1] [the lecturer] … to look at before the workshop … took long … data … expensive … slow … asked my children to help … they are used to working online…

The preceding transcript excerpts indicate that students are willing to embrace the 4IR and have a desire to welcome the FLA. However, the lack of material resources affects their ability and confidence in online learning (Klopfer, Osterweil, Groff & Haas 2006).

Within this study, students indicated that the free resources were challenging, expensive and complicated to access. In contrast, some students had problems with accessing the necessary information to add on to their existing knowledge. They found the recommended free online resources complicated and expensive to use. While each student is distinctive in the manner in which he/she embraces online learning, within the ambits of connectivism, material and resources must be easily accessible to all students since accessibility has consequences for student interaction, performance and success (Gilbert 2015).

7.1.2 *Fulfilling Family Responsibilities During the COVID-19 Pandemic*

The participants believed that during the pandemic and the lockdown conditions, they needed to ensure that they could manage their time for learning strategically but felt that they needed to fulfil their family responsibilities first. These views are exhibited in the interview transcripts that follow:

Judy: … had other responsibilities … time wasn't only focused on learning during the lockdown … I am a single parent … young family to take care of …

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[1] Words in square brackets have been added by the author to clarify the interview transcripts for the benefit of the reader.

> **Mandla:** … though at home … my children are worried … disease … too busy to talk … busy learning …
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> **Nozipho:** … many things were happening at home … whole family is with me … to ensure that all my work and cooking is done before the workshop … need to have space and time to think … workshop … many distractions during … lockdown … helped having my video off … feeling embarrassed about … small … crowded home … need … to plan myself … not very good with working … computer … need to try things … first before … workshop … used … resources for more information...
>
> **Themba**: … was difficult especially … with … coronavirus … my family is scared … I am busy with workshops …
>
> **Zodwa:** … was difficult … my son was also sick during the lockdown …

While the participants were attempting to embrace online learning within the domain of connectivism, they did experience challenges. They also had to fulfil their family responsibilities while trying to meet their academic obligations. Thus, lecturers ought to collaborate first with students to ensure that students are adequately equipped to embrace the FLA especially within the context of the COVID-19 pandemic where students also need to deal with social, family and emotional issues related to the lockdown conditions.

7.1.3 Limitations Experienced by Students Who are Not Digital Natives

It was evident that the participants of this study were not all digital natives and were not accustomed to using technology-based tools. The participants, therefore, needed to learn new skills (for example, how to use Dropbox) to participate effectively in the virtual workshop. This view is supported by Roper (2007), who indicates that to access and be successful with learning online, students are expected to have a specific set of skills for this type of learning. Some of the skills required for successful online learning include necessary computer skills, searching for information, communicating online, time management and collaboration skills (Morrison 2014). Participants also indicated that they needed to practise before the virtual workshop in order to transform their learning and embrace the FLA. These views are exemplified in the transcript excerpts that follow:

Judy: … I think about maths by working on paper … difficult … to go … the Internet … the virtual workshops took some time to get used to …the interactive bit … I was sometimes left behind because of my slow computer …

Mandla: … it took time to get used to … I could work before the workshop to look for the information for the workshop … take my time … not rushed … during the workshop … time was limited … had to work in pace with each other…

Rajesh: …virtual workshop … good idea … things happening around us … may not get a chance to ask … questions … need to … plan before … workshop … need to think about … questions … important … ask … questions during … workshops … not good with technology … taught myself how to use Dropbox[2]… an achievement for me …

Themba: … I had to look up information during the workshop … working with two things at the same time on the screen was difficult … I am not that good with using the computer … have to practice and learn now …

The challenges faced by the participants could be because the participants are digital immigrants. Acquiring new skills (for example, learning how to use Dropbox) and updating knowledge using technology and online networks are aligned to the theory of connectivism (Goldie 2016). Hence, for some participants, flipped mathematics learning was challenging since they were digital immigrants and not digital natives.

7.2 Advantages of Collaboration Inspired by Flipped Learning within the Context Of COVID-19

7.2.1 Forming Partnerships within the Virtual Lecture Room

Lecturers who promote philosophies of empowerment within their lecture rooms are prepared to distribute control of the learning process to their

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[2] Dropbox is a personal cloud storage service/online backup service that is frequently used for file sharing. Dropbox is available for Windows, Macintosh and Linux desktop operating systems. A basic Dropbox account is free and includes 2 GB of space.

students. In the transcripts that follow, this idea is supported by Anele and Rajesh. Moreover, the participants suggested that participating in virtual workshops created a sense of partnership, collaboration, and enthusiasm. These views are reflected in the transcript excerpts that follow:

> **Anele:** … felt part of a team … could work together … felt a little better…bit calmer working online with my colleagues … wanted to participate, … my lecturer, became a part of the online class …
>
> **Rajesh:** … was a better option than the traditional workshop … wanted to be a part of the virtual workshop … I felt excited to be a part of these sessions … we could all work together with the lecturer to solve … problems … given time to process and discuss our ideas … we were heard ... I could also improve on information … obtaining more information from … websites … share this information on the class Dropbox …

As was evident, within this transformed education environment, the lecturer became a collaborator with the students. The participants believed that the use of FLA inspired collaborative learning. The virtual lecture room within this study was viewed as a collaborative and encouraging space within which to work. Collaboration is supported within the notions of connectivism, whereby student learning is enhanced by participation (Duke, Harper & Johnson 2013).

7.2.2 Support Provided within the Virtual Lecture Room

The participants were also comforted by the awareness that their peers and lecturer were available to support and guide them while they were learning within the context of COVID-19. During the lockdown, people are not allowed to meet colleagues or friends due to physical and social distancing. The workshops created a space to meet colleagues and friends virtually to discuss mathematics learning as well as issues of a personal nature. This contact reassured the participants. These sentiments are reflected in the excerpts that follow:

> **Gloria:** … using the flipped learning … not … uncomfortable … had a few problems … could ask for help … it consoled me … was a bit depressed during … lockdown … coronavirus was disturbing …we talk

to each other about the maths concepts and also … how we are dealing with home life … I don't feel alone … the workshops also supported me emotionally … help with understanding concepts … it's more interesting … it is not only working on your …work together … we are also supported with the websites … we can always download information to update knowledge … I can do much more with the help I am receiving …

Zodwa: … it was very hard for me during this time … my son was ill … I could ask my friends for help during the workshops and even after the workshops … spoke on WhatsApp[3]…

Gloria and Zodwa believed that they could rely on the participants of the virtual workshop for support and reassurance, and they felt consoled and calmed by the support they were receiving during these unique times. Within the scope of connectivism, learning is considered to be developing, whereby new information is continuously embraced (Siemens 2005), this view is supported by Gloria's comments.

7.2.3   Group Learning within the Virtual Lecture Room

Within this study, the students suggested that collaborative learning using virtual workshops supported their mathematics learning since they could actively interact with one another and their lecturer and learn from these interactions. For some participants, collaborative learning supported by the FLA transformed their preference for individual learning to group learning. The interview excerpts that follow support these ideas.

Nozipho: … to have my video off … only audio on … felt more at ease … workshops … did not feel judged or shy … made learning maths easier for me … could also ask the group … clarification … prefer this … learning …

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[3] WhatsApp is a free to download messenger app for smart devices. WhatsApp uses the internet to send messages, images, audio or video files. This app allows users the freedom to text, share audio files, photos and videos with individuals or groups.

> **Sizwe**: … workshops opened my eyes … always work on … own … working in … group was better … group helped me learn … lecturer … available … to assist on the spot …

The participants valued the group learning and maintained that they preferred this type of learning. Group learning also promotes the learning experiences for students (Tran 2014). Moreover, through digital tools, students learn through participating in the process of contributing and receiving academic assistance, knowledge sharing and problem-solving (Webb & Mastergeorge 2003). Similarly, according to connectivism, knowledge is adapted and constructed by students who interact collaboratively within activities related to that knowledge (Mallon 2013). Within this study, it was evident that by incorporating flipped mathematics learning to include virtual workshops, the students successfully collaborated and discussed solutions and content in groups while the lecturer facilitated.

8   Conclusions

This study aimed to explore mathematics students' perceptions of using the Flipped Learning Approach (FLA) within the context of the COVID-19 pandemic. If the philosophies of connectivism are embraced within 4IR virtual environments, the FLA may amplify the benefits of meaningful student learning. The nature of 21st-century collaboration has changed, and technology-enriched environments are influenced by the ideas of connectivism. Characteristics of connectivism endorse collaborative strategies that are generally effective in easing mathematics anxiety and accomplishing successful learning outcomes. This was evident in this study, since the lecturer within this study transformed traditional pedagogy to create a collaborative and engaging technology-enriched virtual lecture room. This transformation supported students' learning. Participants in this study encompassed the ideas of connectivism, acquired new skills (how to use Dropbox) and updated their knowledge using technology and online networks. The participants also interacted collaboratively within digital platforms to discuss, adapt and reconstruct their experiences.

This chapter concludes with some suggestions for lecturers who wish to embrace online pedagogy. Firstly, the challenges of flipped learning within the context of COVID-19 is essential for lecturers to acknowledge. To alleviate

this issue, lecturers ought to test out free online resources first to better inform their students of the critical requirements regarding the amount of data, cost of data and time required to download information. This may inform the students accordingly concerning whether they will be able to access information from these resources. The lecturer also ought to ensure that the resources are user-friendly, cost-effective, data-efficient and easily accessible. Moreover, when preparing for online teaching, lecturers ought to acknowledge that students also have family obligations.

Secondly, the advantages of the collaboration inspired by flipped learning within the context of COVID-19 is essential. Lecturers ought to acknowledge that students are sociable individuals and require feedback and communication from peers and the lecturer. Apart from conversations about the content being discussed, during lockdown conditions within the COVID-19 pandemic, students may not have other individuals who may relate to what they are experiencing within their homes. Students need to engage, collaborate and interact with other individuals during this unprecedented era for emotional, social and health benefits.

Finally, based on the findings of this study, it was evident that for the successful integration of the FLA within the virtual lecture room, there is a need for lecturers to be involved in professional development workshops focusing on how to enhance student learning while integrating the FLA within their virtual milieus. These professional development workshops would be of benefit to lecturers globally as we embrace the 4IR more so, within the context of the COVID-19 pandemic.

Acknowledgements

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