Future Education and Learning Spaces

Jako Olivier
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Perspectives on Teacher Education in the Digital Age

Springer

Future Education and Learning Spaces

ICT & Education in Uncertain Times

This series focuses on the possible education responses that can be implemented in uncertain times. Uncertainty could happen in times of crises or also in normal situations, where some information or actions are not known, resulting in uncertain educational scenarios. Besides, it also shows how emerging technologies, including Artificial Intelligence, Blockchain, Educational Games and Virtual Reality/Augmented Reality, will reshape the future of education to provide efficient learning/teaching experiences and assessments. Furthermore, the series discusses innovative pedagogical and learning approaches (e.g., the use of open educational practices and peer-to-peer learning) that can be applied in this rapid moving technological era to maintain education, including in uncertain times. Particularly, new instructional methods, such as game-based learning, should be designed based on the integrated technologies to provide effective learning experience, resulting in better learning outcomes. Future education should not solely focus on technology, but also on the applied instructional methods, as well as the human touch to maintain authentic and effective learning experience. The series also discusses how learning spaces can be designed to meet the growing tendency of Open and Distance Education, where thousands of learners can be taken the same course from different cultures, backgrounds and learning needs.

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Preface

Teacher Education, teaching and learning in general are facing unprecedented challenges in the wake of the Covid-19 pandemic. Digital technologies have impacted all walks of life, including education. Indeed, digital artefacts and applications have reshaped teacher-learner interactions within and beyond the four walls of the classroom. Moreover, digital technologies have increasingly become the means to ensure the continuity of education during the Covid-19 pandemic. As such, teacher education institutions have to embrace digital technologies. This book relates to the experiences and initiatives of teacher education institutions in the Southern Africa region to empower teacher educators and teachers to cope with teaching and learning in the digital age. The book covers the impacts of digital technologies on the teaching and learning process. Online and blended learning, digital pedagogies, the design of curricula and learning experiences to address the learning needs, and profiles of learners were considered in this book.

The aim of this book is to explore the experiences of lecturers, student teachers and teachers within the wider context of teacher education in the digital age. Uniquely, the chapters in this book come from diverse institutions within the Southern African region and as such present a view of the nature of teacher education specifically also in terms of the context of the Covid-19 pandemic. The different book chapters also present how the Southern Africans have harnessed digital technologies for education. This book is divided into four sections relating to (1) Introduction, Challenges and Needs, (2) Experience Sharing, (3) Different Approaches, and (4) STEM and Language Learning.

Based on an abstract prepared by the editors, a call for book chapters was launched to interested contributors in the Southern African region in February 2021 after which chapters were selected through a blind peer-review process.

The target audience of this book would specifically be academics and researchers. Furthermore, the chapters in this book contain original research content which have not been published before, and no part of the book has been plagiarised. The book

has been subjected to an independent and rigorous peer-review process. This book is the outcome of many months of online collaboration among the editors.

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Reduit, Mauritius — Avinash Oojorah
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Working on the book during the Covid-19 times was quite challenging. In this respect, the editors and chapter authors are recognised for their very significant roles in making this publication possible. We also want to acknowledge the unflinching support of our families in encouraging us to complete this book.

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Contents

Part I
Introduction, Challenges and Needs

Chapter 1
Exploring Perspectives on Teacher Education in the Digital Age: An Introduction

Jako Olivier, Avinash Oojorah, and Waaiza Udhin

Abstract This introductory chapter outlines the rest of the publication with regard to different perspectives on teacher education in the digital age. Apart from a brief contextualisation, this chapter then unpacks the nature and relationships between the chapters that follow.

Keywords Teacher education · Digital age · Educational technology · e-learning · Blended learning

1.1 Introduction

This book explores the nature of teacher education in the digital age. This phenomenon should be considered in a time where both key concepts are very complex as teacher education should—due to the needs of a changing society and technological context—be regarded as a lifelong, dynamic and iterative process and an age which is digital in the sense of ever-expanding technological advances occurring in a digitally divided world where access to technology is still not given in all contexts. In a world where there has been a lot of inequality in terms of teacher education (Verma 2021), there is a need to consider how this aspect functions in terms of a digital age. Indeed, Teacher Education could be seen as a lifelong process rather than one that can be completed after a few years of "training". Teachers should be comfortable with working with risks and change, digital technologies being one of the major sources of risk and change in the profession (Christie 2018). Moreover, there is also the issue of teachers and students having different levels of experience and expertise in terms of technology (Prensky 2001). It was significant that from the chapters the impact of the COVID-19 pandemic, although not the focus of the book,

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was evident as this accelerated the need for greater integration and use of technology in the teacher training sphere. This book hence links up with the wider discourse on teacher education within the context of the COVID-19 pandemic (cf. Allan et al. 2020; Ellis et al. 2020; Ferdig et al. 2020; Flores and Swennen 2020; Moorhouse 2020).

This book brings together original research conducted by a team of leading regional education experts on teacher education specifically in terms of the digital context from research done in Botswana, Eswatini, Mauritius, Namibia, South Africa, Zambia and Zimbabwe. The chapters show how teacher educators and teachers have creatively embraced digital technologies in the region. In the next section, an overview of the chapters that make up this publication is provided.

1.2 Chapter Overview

Like various countries around the globe, the SADC region encounters numerous challenges regarding the education and skills development sector. The main difficulties are mainly about "ensuring access, equity, efficiency, relevance and democracy in the educational and training policies" (SADC 2012). This publication brings together a number of exceptional conceptual and empirical studies related to teacher education within the Southern African region. As such, this book presents a unique view of teacher education in terms of the digital age in four thematically grouped sections.

Apart from this chapter, the next three chapters form part of a section that provides an overview of the introduction and some challenges and needs within the teacher education context. In the second chapter, Mmabaledi K. Seeletso from Botswana sets out an important theoretical framework for this book as this conceptual chapter considers the affordances of improved digital skills and competencies of teachers in the digital age. This chapter also clearly situates this book within a Southern African context which results in not only certain challenges but also many opportunities. Importantly, this chapter concludes that teacher training systems should provide sufficient training. Moreover, there is a need to adapt social practices with regard to technologies in order to allow for effective implementation adoption and transformative teaching in most African institutions. Teacher training should be cognisant of the fact that the student populations at the school level are changing and are increasingly exposed to technology. Hence, teacher training should adapt to this dynamic and technologically integrated milieu. Finally, this context has the potential to facilitate greater participation and opportunities for knowledge creation by students as they may be more informed about technology than their teachers.

Chapter three focused on special needs education teachers enrolled for open distance learning (ODL). This chapter, by Thomas M. Kaputa, Gistered Muleya and Francis Simui, explored the resultant reactions of ODL institutions in response to the disruptions of COVID-19 in Zambia and Zimbabwe in terms of the students' perspectives. This qualitative study with special needs education teachers at two selected ODL institutions involved participants sharing their experiences during their

practical work as well as the use of e-portfolios. The participants in this study showed varied experiences and this led to some practical recommendations. In this regard, thorough training in e-portfolio management and highlighted implementation were recommended as being very important. The participants also felt a need that explicit instructions should be provided and there seems to be a need for upgrading technical elements.

The focus of chapter four, by Tshepo Batane and Chandapiwa Butale, is the assessment processes in a technology course for an in-service teacher education programme at a selected university in Botswana. Importantly, it is evident that assessment plays a critical role in contributing to the development of teachers' competencies in using technology for teaching. This research advocates that the process of preparing teachers to use technology should be a comprehensive one that involves the development of appropriate skills needed for effective technology-based delivery. Despite some experienced teachers in this research showing skills in what could be considered traditional teaching aspects, they lacked technology-related skills. The chapter reported differences in skills mastery in different contexts. Finally, the chapter also emphasises the need for the provision of digital resources in schools. It was also recommended that some form of assessment be continued on the teachers beyond the training to ensure that they sustain technology use in their work.

The next section relates to experience sharing. The fifth chapter by Overson Shumba, Leonard Nkhata, Alex Simpande and Chewe Fwalo explores experiences of adopting emergency remote teaching and the transition to virtual learning in the context of a teacher education programme at the Copperbelt University, Zambia. This research found that lecturers and students demonstrated that the transition from remote teaching to online learning posed certain problems that had to be addressed at both institutional and personal levels. There is evidently a need to improve connectivity and to allow capacity building as well as provide psychosocial support for self-direction in blended learning environments specifically in the context of the COVID-19 pandemic and other similar emergencies. The need for development in terms of self-directed learning and information processing was clear. The chapter concludes by emphasising the need to re-envision the focus of their teacher education programme in terms of the emerging capacity building needs.

Chapter six, written by Moffat C. Tarusikirwa, aimed to understand the experiences of academics at the Zimbabwe Open University regarding teacher development at diploma, undergraduate and postgraduate levels in the age of ICT-based teaching and learning technologies. Furthermore, this chapter specifically highlighted the delivery of effective teacher development programmes in an Open and Distance e-Learning (ODeL) Institution in Zimbabwe. From the research, a number of issues affecting teacher development were identified, and it is stated that teacher development should evolve in line with technological changes. Evidently, the COVID-19 pandemic also prompted changes as face-to-face interactions were not possible. It is also noted that there is a need to build on the existing teacher development models to infuse ICT-based supervision tools that benefit students and fulfil teacher development standards. Apart from needs around infrastructure, skills of both students and

teachers need to be developed to be responsive to the requirements of increased ICT integration.

The next section handles different approaches. In chapter seven, Vicky Avinash Oojorah and Waaiza Udhin explore the transformation of traditional teaching and learning environments in the primary sector through the introduction of tablets and projectors in classrooms in Mauritius. This study specifically focused on the effectiveness of the empowerment sessions for educators of the Early Digital Learning Programme instituted by the Mauritian Ministry of Education. In this process, they assessed teachers' understanding of the functionalities of a Classroom Management System; measured teachers' abilities to create, edit and push e-assessment activities; and also explored the use of tablet technology by teachers at the classroom level. This research showed that educators not only would be able to implement the technology at the classroom level but also create a context conducive to transformation in the wider teaching and learning practices. The authors emphasise the importance of certain in-school factors such as the teaching and learning spaces as well as support from management; out-school factors such as the policy framework, development opportunities and support; and educators being able to plan their lessons in a skilful manner. Finally, the WAVI radar diagram is proposed, and this diagram illustrates the capabilities of educators to integrate technology in a given educational context. This instrument specifically identifies the following as being important factors in this context: Teacher Attitude, Teacher Knowledge, Teacher Skills, Support from School Management, Teaching and Learning Space, Support, Continuous Professional Development and the Policy framework.

Chapter eight, written by Waaiza Udhin and Avinash Oojorah, continues the focus on teacher education in the COVID-19 context in Mauritius. This chapter explored the affordances of webinars as a means of delivering content on an e-learning platform. This research specifically provides insights into how a webinar was organised, implemented as well as the assessment of learners' experiences. In this regard, the chapter relied specifically on autoethnographic data from notes, e-mails and other documents that charted the preparation and implementation of the webinar. The emphasis of this research was also to foreground the conceptualisation of the webinar and its meaningfulness as a learning activity without downplaying the technological configurations relevant to the intervention. This chapter concludes by stating how the webinar could have been enriched through greater attendee participation and input. Furthermore, the chapter illustrates the functional, social and educational affordances of webinars. Finally, it was also clear that the students attending the webinar felt confident that they would be able to replicate the process of setting up a webinar as well.

Chapter nine, written by Eveline O. Anyolo and Sirkka A. N. Tshiningayamwe, pertains to the contribution of online collaborative learning to Education for Sustainable Development in teacher education in the context of Namibia. This research showed that students were able to develop several sustainability competencies by doing sustainability tasks using online platforms. Some challenges were experienced in terms of creating space for effective collaboration online, and students in this study expressed a preference for face-to-face interaction for the sake of collaboration. However, the students acknowledged the importance of collaborative tasks.

This chapter emphasised the importance of students being collaborative, communicative, problem-solvers, good listeners, critical thinkers and able to take responsibility for their own learning. This chapter also recommended that students are capacitated towards improved communication in groups, developing collaboration skills, allowing for equal participation in collaborative work and being able to manage time as well as conflicts.

The final section relates to STEM and Language Learning. In the tenth chapter, Marietjie Havenga and Jako Olivier researched student teachers' active involvement in online robotics simulations, as part of a module on Information Technology at a South African university, with the aim of developing essential skills for the digital age. This chapter specifically focused on how student teachers can develop essential skills for the digital age through robotics simulations. Within this unique multimodal environment, it was found that student teachers were able to act in a self-directed manner towards developing several skills. Specifically, this involved problem-solving by relying on knowledge of the specific semiotic resources used within the robotics simulation environment. However, the importance of certain cognitive and self-directed learning skills, reflective practices as well as unique technical skills was evident. Furthermore, this chapter also relates to elements of innovation through active involvement in online robot simulations by the students. Finally, a need for differentiated and scaffolded support for student teacher learning in the context of robotics was noted.

In the eleventh chapter, Aletta Mweneni Hautemo and Michele F. van der Merwe explored the use of Wikipedia in presenting an educational design using a multimodal approach in structured environments in which interconnected text-based tasks are presented to stimulate dialogical interaction that could lead to a higher level of critical thinking in students specifically within the context of two Namibian languages. In this study, Wikipedia was used as a tool for language translation from English second language into Oshikwanyama and Oshindonga first languages, respectively, by pre-service language student teachers at a tertiary institution in Namibia. This study not only showed how using a Wikipedia translation task responds to the educational demands of the Fourth Industrial Revolution, but it also has the potential to aid the promotion and development of the languages of Namibia at the tertiary level. Furthermore, the Wikipedia translation task used for this research sets a good example of how student teachers and teachers can apply translation in a technology-enhanced setting for language learning. The skills learned through the process helped the participants to be able to translate in a bilingual setting and to be able to communicate effectively in both the relevant first and second languages. The task also influenced the way the whole learning community perceived translation in the classroom for teaching and learning languages. In conclusion, this chapter recommends the application of Wikipedia translation as a multimodal method that highlights the notion that bilingualism should be seen as an asset instead of a liability in language teaching and learning environments.

Educating French teachers within a digital era is the focus of chapter twelve which was authored by Karen Ferreira-Meyer, Albertus Barkhuizen and Karin Schmid. This chapter also approached this topic within the COVID-19 context and the challenges

posed in terms of French teacher training specifically in Eswatini and South Africa. This chapter considered the ways in which teachers of French in these two countries are trained at both pre- and in-service levels. A need for the digitisation of French teacher training in this context is evident, and this chapter engaged with the relevant variables and contextual factors pertaining to this process. Information was gathered from French lecturers and teachers in the selected countries. This research found that among the participants, there is a lack of understanding regarding pedagogical approaches and teaching methods specifically with regard to online teaching and learning. From this research, it is clear that further training is necessary in order to adapt to the digitisation of teaching and learning and to implement pedagogical approaches suited to the digital era. The chapter recommends developing relevant pedagogical approaches and skills for the purposes of this field in a digital context.

The final chapter, written by Jayaluxmi Naidoo and Asheena Singh-Pillay, involves research on digital pedagogy for mathematics and technology education at a South African teacher education institution. This qualitative study considered mathematics and technology education students' perceptions and experiences of digital pedagogy. For this study, postgraduate mathematics and technology education students, who are also practising school teachers, were invited to take part in interactive online workshops and interviews focusing on teaching and learning using selected digital tools. This chapter found that in this context it is clear that digital pedagogy has strengths for teaching and learning. Furthermore, it is evident that digital pedagogy can empower and motivate teachers and that digital pedagogy inspires virtual collaboration among the connected online community. Finally, the research also showed that digital pedagogy exposes specific unique challenges in a developing country such as South Africa.

1.3 Conclusion

The chapters in this book provide an interesting overview of the implications of the digital age for wider teacher education in seven Southern African countries. Two central themes emanate from the chapters: (1) The uniqueness of the region in terms of the need for development in terms of technology and especially skills among students and teachers in order to be effective in a digital context; as well as (2) the significant effect the COVID-19 pandemic has had on prioritising the need for learning to be negotiated digitally.

When it comes to skills, the needs are varied and often aligned with the availability of technologies within certain teacher training institutions. However, from the research presented in this book a number of highly successful interventions were discussed and the affordances of tools such as tablets, strategies such as collaborative learning and different platforms allowing for virtual learning, robotics simulations or e-portfolios were evident. It is also clear that for teacher education in the region, multimodal approaches are highly relevant and the issues around special needs and language were also prominent in these chapters.

In conclusion, apart from the informative overview of some experiences around teacher education in a digital age researched in this book, this publication also provides recommendations for similar contexts internationally.

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Chapter 2
Teacher Education in the Digital Age: Opportunities and Challenges

Mmabaledi K. Seeletso

Abstract This chapter considers some possibilities that may result from improved digital skills and competencies of teachers in the digital age. The chapter, conceptual in nature, also considers challenges that teachers face in the digital age. Available literature has been used to inform this conceptual chapter which looks through the lens of Gibson (1979) affordance theory. Bates (2016) argues that teachers must use ICTs for teaching to remain relevant. Digital technologies have proved that they can allow teaching and learning to continue during pandemics and crisis situations. This calls for stakeholders to engage and interact meaningfully through ICTs. Teachers, as key stakeholders in the education space, need to master technology use to enhance and improve their pedagogy and andragogy. However, research shows that digital technologies also present some challenges when used. Change in teacher education is key and needs to be prioritised. Teachers need to be nurtured into accepting and embracing technology, though some may resist (Fullan 2006). Citizens of Southern Africa continue to be frustrated by the digital gap in their countries. Therefore, it remains a challenge for their governments to support and give teacher education in the digital age the urgency it needs.

Keywords Affordance theory · COVID-19 pandemic · Digital age · Resistance to change · Teacher education

2.1 Introduction

Teachers across the world are faced with an unprecedented change characterised by a number of factors, including diverse students as well as having to cope with ever-changing technology. To effectively face and overcome these challenges, teachers need solid grounding and training in technology-enhanced teaching for them to acquire the necessary skills and competencies. This will make them not only conversant with teaching in the digital era but also in dealing with the technological delivery

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that characterises the Fourth Industrial Revolution (4IR). The digital age is characterised by the use of technology. Even in the past, technology has always been used to support face-to-face teaching for improved delivery. Srinivasan (2017) observes that the digital revolution has and continues to change and impact peoples' lives, including how information is shared. Sharma (2017, p. 10) contends that "the digital revolution has transformed almost everything from our work at our organisations to our daily routines".

Teacher education needs to be geared towards promoting growth for knowledge creation. In most educational institutions in Africa, teachers lack basic training to match the world of rapidly changing technologies used for teaching and learning. This requires teacher training and development strategies that would expose them to new methodologies and strategies for technology-mediated or enhanced learning (Serafino 2019).

Over the years, institutions have made great investments to add technologies to support teaching (Elliot 2018; Glushkova et al. 2019), and it is now increasingly common for students to be encouraged to bring their gadgets, such as phones, to schools. In the past, in developing countries such as Botswana, gadgets were confiscated when students were caught with them. This does not happen anymore, as these once-forbidden gadgets are now used as teaching tools by teachers and as learning tools by students. Sharma (2017, p. 10) postulates that technology "is transforming the way children and young people play, access information, communicate with each other, learn, relearn and unlearn". Children are now playing active roles in their learning due to the classroom transformation brought about by technology. Teachers need to be trained on how to develop interactive, online content, and this increases teachers' knowledge, as they can collaborate on content design and development to produce high-quality content which will be a team product. As observed by Sharma (2017, p. 10), "teachers in this ever-changing digital era need a good balance of theoretical and practical knowledge to provide a solid foundation for their teaching". Leu et al. (2004) also appreciate the changing roles of teachers due to technology use. They note that teachers should be familiar with twenty-first-century students and understand their way of thinking for them to cope with the digital age (Leu et al., 2004).

This chapter is divided into four sections. In the first section, the introduction provides the background, and the definitions of the keywords used in the chapter are provided. The latter are affordance theory, COVID-19 pandemic, digital age, resistance to change, and teacher education. The second section foregrounds and argues the topic through the lens of Gibson, using his affordance theory. The third section discusses key issues that can be addressed by appropriate teacher education in the digital era. In the third section, the possibilities and challenges of teacher education in the digital era are also discussed. The section acknowledges that teacher education remains key to what the education system always turns out to be, including throughput in terms of students' academic performance. The section appreciates that most teachers may have been trained before technology was emphasised and adopted to facilitate teaching and learning and that to fit well in this digital era and in the 4IR, teachers need to be skilled in teaching through technology. The section further

emphasises that teachers should be exposed to accessible technology resources so that they can teach through the available technology methodologies by using the platforms for teaching at hand. In addition, the section appreciates the possibilities and challenges that come with digitising teacher education. The fourth and last section concludes the chapter, and salient recommendations are made to develop teachers who can effectively use technology to enhance teaching and content delivery.

Definitions of keywords

In this section, the keywords used in the context of the chapter are defined. Some of the definitions have been used as coined by the authorities. However, some of the definitions are provided by the author to suit the context in which they are used in the chapter.

Affordance theory has its origins linked to what the environment can afford or give its inhabitants. In this context, affordance theory refers to the available technology and how students and teachers can use these for their own benefit and advantage. This, in other words, refers to possibilities that one can derive from one's environment.

Zu et al. (2020, p. 15) define the ***COVID-19 pandemic*** as "pneumonia associated with a novel coronavirus, severe acute respiratory syndrome (SARS) coronavirus 2". This definition has been corroborated by Zheng et al. (2020). COVID-19 became a global pandemic at the beginning of 2020, disturbing most sectors from doing their usual businesses. The education sector was not spared, as students across all levels around the world had to stay home to observe the health protocols of social distancing.

The ***digital age*** refers to a time when machines dominate jobs that were in the past done by human beings. This is an era characterised by high technology use. We are currently living in the digital age, also known as the industrial revolution or the digital era. The use of machines to improve delivery and production has heightened during the digital age.

Resistance to change refers to an act where an individual opposes change or is not ready to accept new measures, especially those proposed by leadership. Whenever change is introduced in an institution or organisation, accepting it will differ among the stakeholders, especially employees where the change is being introduced. Some people will embrace and accept the envisaged change immediately, while others will take some time to accept it. Some people may also completely reject the envisaged change without even giving it a chance. The latter group comprises people who will resist change, making it their duty to oppose whatever change is proposed.

Teacher education involves teacher development and training strategies and methodologies. This is usually informed and guided by policies and procedures that must be implemented to ensure effective teacher education. Teacher education remains the main issue in the effective delivery of the curriculum in the entire learning process.

Technology and *digitisation* are used interchangeably to mean the same concept in this chapter.

Research Question

The following research question guides the discussion in this chapter.
What are the main opportunities and challenges teachers experience due to the digitisation of education?

2.2 Affordance Theory

Gibson (1979) explains affordance theory as an environment that offers several opportunities to the different animal species that live in the environment. In his view, these different animal species have different ways of life, and they use the environment in different ways. Gibson (1979, p. 129) contends as follows:

There are all kinds of nutrients in the world and all sorts of ways of getting food; all sorts of shelters or hiding places, such as holes, crevices, and caves; all sorts of materials for *making* shelters, nests, mounds, huts; all kinds of locomotion that the environment makes possible, such as swimming, crawling, walking, climbing, and flying. These offerings have been taken advantage of; the niches have been occupied. But for all we know, there may be many offerings of the environment that have *not* been taken advantage of, that is, niches not yet occupied.

2.2.1 The Affordances Theory Applied

Technology, by its very nature, involves several aspects. It must be appropriate for use by a group of people and should be easy to use for them to accept and embrace. Appropriate, user-friendly technology needs to have an Internet connection available, gadgets that are affordable and easy to use, and technical support readily available, among others. All these are needed to equip a twenty-first-century teacher who is faced with teaching millennials, also known as the "computer generation". Bates (2016) contends that technology should be about tools that may be used to solve real-world problems and not some assortment of tools that would create even more problems (of use) for users. Technology should also have relevance to the people's culture for them to be able to embrace it.

Technology for teaching should be useful, with affordances for different types of learning to increase participation (Kaplan and Haenlein 2016). Media used for a particular level, for instance, should be able to bring out desired learning outcomes, especially understanding of content by students. As such, the media used must package and present content in a way that allows users to access and use it with ease. The technology adopted for use should facilitate easy understanding of instruction and should accommodate all that is necessary to support text. Technology also needs to be able to fully engage students with a wide range of activities for them to be actively involved, even in the absence of their teacher.

Furthermore, the identified technology should have the ability to facilitate the different forms of interaction that characterise digital learning. This includes interaction between students; interaction between students and their teachers; and interaction between students and their content, among others. The cost of technology and the demographics of users must also be considered. It is also important to establish the reliability of technology before it can be adopted for use. The adopted technology must be easy for users or their institutions to maintain and upgrade, especially for teachers who are not technology specialists, as is common in most institutions. If the technology adopted for use requires advanced expertise, it is important for the institution to have the necessary support readily available for the technology to remain effective.

Change is never easy, and different people adopt and accept technology at different times. As such, some teachers may be slow adopters and thus take time to embrace the change that comes with technology. They may feel uncomfortable embracing something they feel is not from their "world". In developing countries, it is even worse, since teachers, just like most of their students, experience the digital gap, which makes teacher development difficult to achieve (Adnan and Anwar 2020; Serafino 2019).

2.3 Key Issues on Teacher Education in the Digital Age

The digital age can present numerous issues in the education sector. This section discusses opportunities and challenges that teachers can expect to face with the introduction of technology in learning institutions in the digital age.

2.3.1 Opportunities for Improved Teacher Education in the Digital Age

Srinivasan (2017) contends that digital learning promotes growth. Teachers need to receive effective training to be able to teach using technology. They need to be helped to acquire the necessary skills and competencies needed to teach in the digital age. Teacher education needs to use methods and strategies that can help develop and transfer the necessary skills for a knowledge-based society.

2.3.1.1 Knowledge Creation

Through digital teaching, teachers are able to help their institutions to promote, create, and use online resources to facilitate a more conducive teaching and learning environment (OECD 2017). Resources pulled together can further facilitate and

encourage active learning and collaboration. To fit into the envisaged knowledge-based economy, teachers, as knowledge creators, must be exposed to the necessary training to enable them to achieve this. Teachers need to move away from traditional teacher-centred instructional practices where they view themselves as more knowledgeable.

Technology-enhanced teaching promotes teamwork. Teamwork allows teachers to complement each other and thus deliver high-quality content which can be updated as and when necessary and used by other institutions. Digitisation also brings with it the ability to create, not just to be users of open educational resources (OERs), which is a form of open education (Bates 2016). OERs are "digital educational materials freely available over the Internet that can be downloaded … without charge, and if necessary adapted or amended" (Bates 2016, p. 34). OERs facilitate expanded access to knowledge through quality materials developed by teachers and educators in general. Digitisation does not only encourage the development and sharing of resources by teachers, it also facilitates active learning and sharing of resources by students. Bates (2016) notes that teachers can give students assessments on which they can work together to capitalise on the interaction they have to access the digital information at any time they so wish. Digital teaching helps both teachers and students work as a team. This helps them solve problems collaboratively, as a collective. The available social tools enhance teaching that always keeps students active. Digitisation can help computer-assisted teaching which facilitates computer-marked assessment. The computer-marked assessment can be programmed such that it guides students on the questions they get wrong and may even provide correct answers for students to appreciate where they have gone wrong. The feedback assessment in the computer-marked assessment can then help explain to students where they went wrong and help improve their performance.

2.3.1.2 Increased Interaction and Support

Following the interest in online teaching, traditional instructors continue to add more online components to their classroom teaching, including the use of PDFs with their notes. Most learning institutions are now going fully online for their delivery and support. In the words of Bates (2016, p. 33), "[f]ully online learning is now a key component of many schools and post-secondary education systems". The digital world facilitates interactive learning through webinars, video conferencing, and discussion forums, among the many possible means. Digitisation allows for the use of audio, which is important for language teaching, as it requires a lot of technical proficiency. It also allows for the use of videos. Digitisation allows teachers to use videos to capture experiments that cannot be done or explained by other media. Hence, Bates (2016:245) argues that "digitised teaching can create and present original teaching content in a rich and varied way". He further contends that digitisation allows for "[c]omputer-based animations and simulations" (Bates 2016, p. 246), which helps bring technology-mediated teaching as close to reality as possible.

Teachers are responsible for both their teaching and students' learning. Therefore, they need to support and motivate all students they teach—both the highflyers and the slow learners in the digital environment. Teachers are also expected to monitor how students manage their time. Flipped classrooms are gradually getting common with the advent of digitisation, especially in tertiary institutions. This allows for lecturers to pre-record the session, and students can then watch it later on their own. There are usually discussions and assessments based on the recorded content to check students' comprehension. All of these are vital to creating an inventive and interactive educational establishment (European Commission 2017; Khireddine 2020).

Institutions use a learning management system (LMS) to work in the learning environment. Both teachers and students should be knowledgeable about both the LMS and the different learning environments for them to participate meaningfully in the teaching and learning processes. Teachers must be a step or two ahead to be able to guide their students. Active learning takes place in an LMS when various groups interact with one another: students and teachers interact; students interact among themselves; and students interact with their course content. Such interaction can also be a response to other learning forums, such as discussions, chats, or responding to quizzes or other activities meant to check the students' comprehension levels. Online discussions can be asynchronous, where they are delayed, or they can be synchronous, where they are instant and done in real time. All these are possible in digitised teaching and learning. The main advantage is that students can always revisit sites if they missed something or if they wish to go through some content once more. More teachers and instructors have over time embraced online learning and now use online systems such as LMS to store content (Bates 2016). In the past, there has always been paper all over in some schools, with high possibilities of information either getting lost or confidential documents getting misplaced or ending up in the wrong hands due to poor record keeping. With digitisation came more reforms that brought with them improved filing systems which can be created in the LMS for electronic record filing. However, digitisation development is not without its downside. The machines and other gadgets need frequent maintenance to remain fully operational. These machines and gadgets may crash, leading to the loss of critical information if not backed up safely elsewhere.

2.3.1.3 Teacher Training and Development

From the literature on teacher training in the digital age, teacher training and development remain critical for the education sector to effectively address the changes brought about by technology. Students that remain physically apart are brought closer to each other and even closer to their teachers by technology. However, it is important to know that, for this to happen, teachers need to acquire the necessary skills to use technology tools. Developing and empowering teachers will help them become skilled and competent enough to deliver content in the digital era. This will help promote social presence, even when the teacher and their students are physically apart. Teachers need to get the necessary training to facilitate technology-mediated

delivery. This can help them become innovative in their teaching, compared to the traditional teaching and learning system where there were no resources that enabled a technology-enabled teaching environment. Primarily, teaching with technology will facilitate knowledge creation among teachers. Labbas and El Shaban (2018, p. 53) observed that "it is vital that educators are familiar with new educational changes, mainly those changes which are connected to technology". Digital teachers will, therefore, need to be great innovators to remain relevant in the digital era. They need skills to facilitate the design and development of highly interactive content. Technology further creates lifelong learners. This is because every day presents something new to learn and allows teachers to keep abreast of new developments and emerging trends as well as changing technologies related to teaching as they collaborate with both their peers and students. Digitisation allows for skills- and knowledge sharing. Teachers can connect anywhere through social media to exchange ideas and knowledge as necessary. They can search for knowledge, and they can also disseminate the acquired knowledge as they see fit.

Teacher education in the digital era should be done such that it allows for collaboration to be able to create a pool of content developers and knowledge creators. Teacher education should also be designed such that it imparts competencies for the twenty-first-century teacher for them to be change makers in the education sector. Rossikhina et al. (2019, p. 741) argue that "[t]he world is digital today. In order to have the necessary competencies of the 21st century, children should receive them at school". The same argument goes for teachers: they need to acquire the necessary training to impart the right content and competencies to children. Digital technology will help equip teachers and educators with the necessary skills to access various sources of information and allows for creativity and innovation. In essence, this makes it clear that teacher training remains crucial to prepare teachers to use the different technologies for teaching. The education sector cannot be doing things the way they did them a decade ago. They need to be relevant to the needs and demands of the twenty-first century. Digitised teaching facilitates personalise learner support. Teachers have the platform to provide unique solutions as demanded by diverse learners rather than applying "one size fits all" strategies to support learners. They can nurture their students and have discussions related to issues students may raise. As such, teacher training and development remains a priority in Southern Africa and other developing countries globally.

2.3.2 Challenges Teachers Face in the Digital Era

Digitised teaching has proven beyond a doubt that it can be both effective and efficient. This is because it has allowed teaching and learning to continue during the COVID-19 pandemic when the face-to-face delivery mode could not continue in all educational institutions due to health protocols of social distancing (OECD 2017). It

was necessary to adopt social distancing to curb the spread of the coronavirus globally. However, it has also become clear that, though digitisation facilitated the much-needed interaction and was no match for face-to-face delivery during the COVID-19 pandemic, digital exclusion was obvious in Africa. This exclusion did not only affect students but also teachers. As it were, students' technological skills exceeded those of their teachers (Warlick 2001). Therefore, some teachers fear the use of technology (Serafino 2019), as they see themselves as digital immigrants who cannot work with their students, whom they view as digital natives. Labbas and El Shaban (2018) and Prensky (2001) explain that digital natives are people born after 1980, while digital immigrants are those born before the digital revolution. So, teachers' lack of skills excluded them from being role players in technology-supported delivery which became the "in-thing" during the COVID-19 pandemic.

2.3.2.1 Lack of Resources and Skills

Research has brought to the attention of many unequal access to much-needed technology for digital teaching and learning to take place. This continues to impact negatively on effective teaching and content delivery. During the COVID-19 pandemic, digitisation made it possible for teaching and learning to continue with minimal disturbances. This is because schools that adopted online learning strategies to continue with their teaching progressed well. However, it became apparent that the schools that benefitted were private schools in most countries in Southern Africa, while government or public schools lagged behind due to a lack of resources. Most students and teachers in public schools also lagged behind, as they lacked the necessary expertise to facilitate online teaching and learning (O'Malley 2020; Serafino 2019). As such, the availability of learning gadgets to facilitate digitised learning remained the main challenge. Teachers who did not have the technology to facilitate teaching were the most affected, especially in developing countries of Southern Africa. It was evident during the COVID-19 pandemic that most institutions and, by extension, most teachers, were not ready for the digital revolution. It was clear that the calibre of teachers in most schools in Southern Africa still had a fear of and reservations about digital teaching and using technology for teaching. Many teachers, of course, had something to blame. As observed by Adnan and Anwar (2020), this included a lack of access to Internet facilities, lack of proper interaction, and ineffective technology. In Southern Africa, most of the teachers in government-owned or public schools lack the necessary technological skills and expertise to facilitate digitised education (Adnan and Anwar 2020). Other than the lacking skills among teachers and other workers in the education sector, Africa as a continent still experiences a serious shortage of resources, such as the Internet and gadgets necessary to facilitate digital learning. The cost of the Internet remains unaffordable for many citizens of developing countries, and the price of gadgets remains prohibitive, even among teachers. This corroborates Serafino's (2019:2) claim, who said that "[t]his is leading to a digital divide between those who have access to information

and communication technology and those who do not, giving rise to inequalities to access opportunities, knowledge, services and goods".

Most people from the working class in Africa own smartphones, with some using top-of-the-range models that they only use for calling and texting their friends and family members. Few teachers belong to this group. However, if, during their training, teachers are not exposed to digitised teaching, gadgets remain obsolete and under-utilised. Most teachers in Southern Africa have not appreciated that the same gadget they use for calling and texting their contacts could be a teaching device. This can only happen when teacher education, training, and development strategies and methodologies are revamped to embrace digitisation. In some African countries, bandwidth across households remains a serious challenge, even for those with gadgets and skills. Other parts of the continent struggle with fast, affordable, and reliable Internet connections due to a lack of the necessary infrastructure.

Lack of technological skills and expertise among educators, teachers in particular, hinders digitisation in most of the schools in Africa (Serafino 2019). Kaplan (2021) claims that digitisation comes at a cost, as it needs devices and Internet, as well as skills. As such, people need to be convinced to adopt technology. Teachers need to be able to access the Internet and search for whatever they wish to find to use to inform and improve their teaching. However, if they do not have these necessary skills, they may lose it all in the digital world, unless and until they are skilled through in-service training to remain effective in twenty-first-century teaching. Serafino (2019:2) contends that "[u]sers of the Internet can still be digitally excluded because they lack the skills to be able to confidently and safely navigate the digital world".

2.3.2.2 Technophobia and Resistance Among Teachers

There are teachers who fear technology because they have never used it before. They lack both the skill and knowledge to work through the platforms available for their use. Due to their lack of the necessary skills, expertise, and knowledge, most teachers tend to resist any new digital initiatives the leadership may wish to bring to their institutions. Technophobia, therefore, needs to be handled with caution for teachers to buy in and agree to the necessary training. Teachers, especially older ones, need to be engaged about what technology can do so that they can trust the envisaged change. If the change is not well communicated to the teachers, they may resist it, thinking that it is an initiative only introduced to replace them in their workspaces. Some teachers are still holding on to the traditional teaching strategies and methodologies due to their fear of change and fearing the unknown. Sudden digital transformation is not healthy and cannot be embraced if not well communicated to the teachers whom it is meant to benefit. As such, introducing new teacher training strategies and methodologies needs to be communicated with caution and handled with great care. It must be treated as a project that will involve all stakeholders for them to equally appreciate and embrace it.

Teachers also resist embracing change to digital teaching, as they think that there is no need. They would wonder why they should change something that has always worked so well for everyone. They fear that introducing technology and skills in developing countries might just destroy their teaching which has been going on well without technology.

2.4 Conclusion

Teacher training systems need to sufficiently train teachers. There is a need to change some social practices for technologies to be fully implemented and adopted to transform teaching in most African institutions. The African Union Agenda 2063 encourages countries and respective institutions to invest in teacher training to produce quality teachers that can compete globally. The absence of a robust teacher training and development plan for the digital age will render technology adoption in most schools in Southern Africa just a dream that can never be realised. A transformed teacher education system creates new learning environments, which are integral for twenty-first-century skills. Reforms in teacher training institutions need to be continuous to follow development trends lest teachers are left behind, yet they teach children who are advanced in the use of technology. Teachers need to be eager, like the children they teach, to try anything related to technology and its use.

Today, students grow up with technology all around them—from play stations and other gadgets at home, and this directly influences their learning in a positive way. Some children have access to extensive knowledge via the Internet. As such, they can be a challenge to their teachers if teachers remain inadequately trained. Teachers need to be adequately trained to match their students, who are more inquisitive, more interrogative, and always demanding answers their teachers at times struggle to answer. Research in most education establishments has confirmed that there are policies in support of integrating technology in teaching. What remains the challenge is the continued resistance by teachers in some circles who still want to be seen as the authority in the teaching field. In other cases, the challenge is expensive gadgets and Internet connection. Some teachers may be willing and ready for this development. However, the challenge will then be a lack of the needed skills to facilitate this.

Traditionally, teachers have always felt powerful and comfortable teaching content they know best and that they know is unknown to students. This makes them feel powerful, in authority, and in control. Digital teaching exposes them to the authorities that their students are, where students are now in control. In the digital era, teachers are facilitators as opposed to fountains of knowledge. This allows students to also contribute to knowledge creation and remain active in the learning process. However, this is one of the elements that leads to teachers' resistance to embracing technology-enhanced teaching in school.

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Chapter 3
Special Needs Education Teachers' Experiences of the Use of E-Portfolios in the "New Normal" in Open Distance E-Learning Institutions in Southern Africa

Thomas M. Kaputa, Gistered Muleya, and Francis Simui

Abstract This chapter focuses on Special Needs Education Teachers enrolled in Open Distance Learning (ODL) intuitions focusing on electronic teaching and learning. The advent of disruptive technologies and the COVID-19 pandemic have transformed the face of teacher development, as they have disrupted the usual way of doing practical subjects. The COVID-19 pandemic, in particular, has pushed educators into new frontiers of assessments in the form of e-portfolios. The usual approach—i.e., the submission of physical files which would be assessed by examiners—is being replaced by online assessment. This paper addresses the resultant reactions of ODL institutions in response to the disruptions from students' perspectives. The adjustments made to traditional practicums and teaching practice and the submission of hardcopy assessment files are interrogated. Using a qualitative approach, Special Needs Education Teachers at two ODL institutions in Zimbabwe and Zambia shared their experiences during their practical work and proffered how these e-Portfolios could be handled. They recommended thorough training in e-portfolio management and highlighted implementation as paramount.

Keywords ODL · e-portfolios · Special needs education teachers · Online assessment · ICT

3.1 Introduction

This chapter focuses on the experiences of Special Needs Education teachers enrolled in two Open Distance Learning (ODL) intuitions in Zimbabwe and Zambia, specifically the assessment of e-portfolios in electronic teaching and learning. Students

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enrolled in Special Needs Education undergraduate degree programmes at the two ODL institutions revealed their experiences of the disruptions from their perspectives. The dawn of disruptive technologies and the COVID-19 pandemic have transformed teacher development assessment, as they have disrupted the usual way of assessing practical subjects. Studies show that the COVID-19 contagion has transformed education to new methods of assessments (Khan 2021), as the transformation of hardcopy portfolios to e-portfolios has been adopted (Syafei et al. 2021). The traditional approach in student–teacher assessment—i.e., the submission of physical files and assessment by examinees—is being replaced by online assessment in the "new normal" characterised by global COVID-19 health restrictions. Syafei et al. (2021) claim that this transition to e-portfolios is marked by a dearth of research to inform practice. This development has seen a surge in the level of civic awareness among learning facilitators of the use of online platforms to deliver education activities. This resonates well with what civic education does to those that get exposed to its ethos (Mwanangombe et al. 2020). Additionally, another study conducted by Muleya et al. (2019) on exploring learning related to digital platforms does confirm the power of civic education in raising civic awareness among the citizens in many areas not limited to e-portfolios.

Traditionally, the physical portfolio was marked and graded, and the student got feedback. The physical execution of the practicum and the submission, which are the aspects under study, are critical to the whole process, as they enable the marking and grading of the student's work. We interrogated the adjustments made in the traditional practicums and teaching practice and the submission of hardcopy assessment files. Online assessment entails a number of components and procedures which culminate in the compilation of the student's best work in an e-portfolio or file. Through a qualitative approach, Special Needs Teachers in the programmes shared their experiences during their practical work regarding challenges met and proffered ways of improving online assessment of e-portfolios in the departments.

3.1.1 Context of the Study

The study was undertaken at the Zimbabwe Open University (ZOU) in the Department of Disability Studies and Special Needs Education (DS&SNE) and at the University of Zambia (UNZA) at the Institute of Distance Education (IDE). These are associate institutions jointly offering selected degree programmes online (Simui et al. 2018). ZOU is a fully Open and Distance electronic Learning (ODeL) institution in Zimbabwe. UNZA is a dual-mode institution that offers degrees both face-to-face and online at IDE (Hamweete 2012). Both have electronic learning management systems (e-LMS)—MyVista for ZOU, and Astria at UNZA—that house the various programmes on offer. Teaching and learning of students in the two Special Needs Education degrees presented on MyVista for ZOU and Astra for UNZA have tended to cover all aspects except the practical construction and submission of practical work

files for assessment. Students upload all their assignments for marking and grading and get feedback within two weeks of submission.

The Special Needs Education programmes at the two institutions traditionally have a practical work component to enable the student to practise the theory learnt in taught courses. This practical aspect is crucial, as it prepares the student–teacher for the world of work. Kaputa and Gwitimah (2013) outline the theory and processes that students should do in the practicum, culminating in the construction of a physical portfolio of selected artefacts, supervision reports and narrative reports as evidence of work done. The theoretical aspect of these courses is covered in the online modules on both MyVista and Astra in preparation for the practicum. At both institutions, programme regulations guide how the practical work or practicum ensues at the selected locations. At DS&SNE, the practical work comes in the form of a practicum. The regulations require students to be attached to a location, which may be a school, hospital, workplace, or any other relevant place, focusing on their areas of expertise. An introductory letter introduces the student to the receiving institution to give access to the student. The students would do their practicum for a specified period before the assessment. After the period, the student compiles a file that contains all aspects of the work they would have carried out under the supervision of both local and university supervisors. Students place their work, including a narrative report, supervision reports and artefacts, as evidence in a file(s) and physically submit these to the departments for assessment. The submitted files are examination items that are marked using standardised marking guides. Announcement of the practicum results to the students is done together with other examination results.

The disruptive advent of COVID-19 and the resultant health restrictions stopped the above process as these jeopardised students' lives. The two institutions came up with alternatives to the practicum in the form of online provision of all aspects of the assessment process. Unforeseen changes to the use of e-portfolios and online submission became prerequisites for the students who had registered for the courses. Physical processes like online submission, marking and feedback were required from both the students and the course tutors. The research was undertaken to understand the different experiences of students who were using e-portfolios in their practical work and were required to submit them online. This would enable course tutors to finetune their e-portfolio assessments to ensure that their quality is equivalent to that of hardcopy submission. The main research question that directed this research was as follows: "How have Special Needs Education students managed the transition to the use of e-portfolios?".

3.1.2 Research Questions

The following research questions guided the study:

- What are Special Needs teachers' experiences with the submission of e-portfolios during their practical work?

- How did they manage e-portfolio online assessment challenges during the period?
- How can departments improve the management of e-portfolio assessments?

3.2 Literature Review

3.2.1 Theoretical Framework

The research was based on two theories: Equivalency theory (Simonson et al. 1999) and an integrated Multimodal Model for Online Education (MMOE) (Picciano 2017). According to Simonson et al. (1999), provisions for students in distance education (DE) programmes should be equal to those in face-to-face programmes. The designing of equivalent learning experiences for students in both ODL and face-to-face settings is advocated. The designing of online practical work procedures in ODL should, therefore, be equivalent to the physical submission of portfolios.

The MMOE theory explains the online provision of the segments on the electronic learning management system (e-LMS). Figure 3.1 illustrates that the MMOE theory is applicable for online and blended institutions, as it accommodates all teaching and learning processes.

The MMOE comprises seven segments that take place around a learning community. In this study, Special Needs teachers, course tutors and stakeholders in the practicum locations made up the learning communities of each respective university. Therefore, we can explain the various segments of single-mode and dual-mode

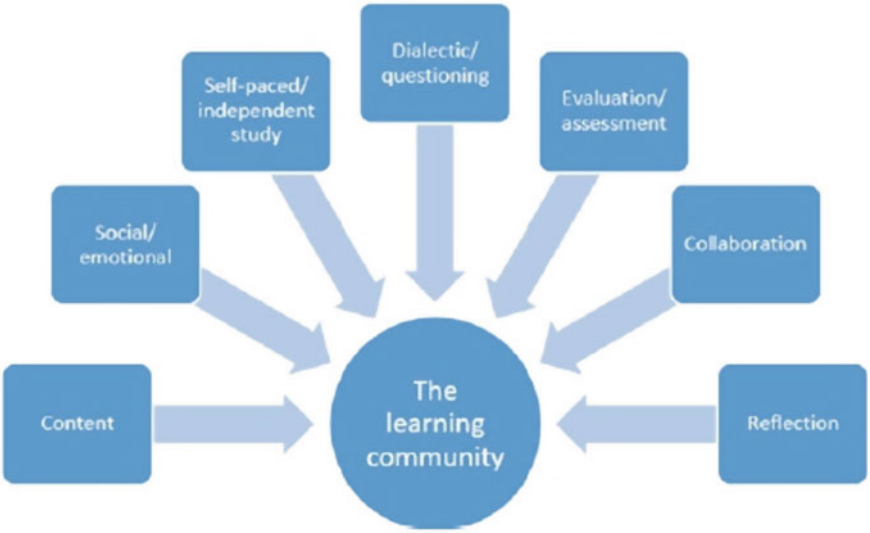

Fig. 3.1 Illustration of a multimodal model for online education (Picciano 2017)

universities. Single-mode universities' focus is on activities revolving around content on e-LMS and self-paced independent study using software for the practicum and assessment/evaluation of portfolios. Equally, according to Picciano (2017), dual-mode universities use a blended approach in their e-LMS content and focus on a self-paced independent study using software and assessment/evaluation of portfolios. Students in blended settings rely on the course tutor in comparison to those in ODL institutions. COVID-19 is a catalyst that propelled all universities to be fully online without the necessary technology. This dilemma was interrogated in this research. This study is focused on a self-paced independent study using software and evaluation/assessment of assignments, with a special emphasis on e-portfolios submission.

3.2.2 Special Needs Education Teachers' Experiences of the Submission of E-Portfolios

The use of portfolios as a component of practical work in education enables an all-round assessment of the student, as it dwells on all facets of learning. Students' ability to connect theory to practice enables educators to confirm that effective learning has taken place. According to Birgin and Baki (2007), portfolios are based on Piaget and Vygotsky's constructivism, which explains students' propensity to acquire and socially construct their knowledge and skills. By so doing, cognitive, affective and psychomotor skills are involved in the learning.

A portfolio has numerous definitions, as it finds use in a spectrum of areas, like commerce, fashion, and art. For education, we picked the definitions of Arter and Spandel (1992) and Paulson et al. (1991), who state that a learning portfolio is a collection of the student's best work which shows their effort in specified areas. Additionally, a learning portfolio is compiled over time to show the student's competencies (Barton and Collins 1997). The issue of authenticity is important, according to Collins (1992). Portfolios include a narrative (Kaputa and Gwitimah 2013) that displays the student's metacognitive abilities (Chick 2013) through reflection (Winsor and Ellefson 1995).

A portfolio can be physical or electronic. An e-portfolio comprises a collection of activities in an electronic format. Accordingly, it can be the electronic conversion of paper-based items placed in electronic files (Barrett 2007) or the carrying and uploading of activities online with constant reflection and feedback from self, peers and tutors (Scully et al. 2018). Assessment of e-portfolios is done online.

To address the focal point of this study, we needed to identify the components of an online assessment. Practical work is a component of online assessment, such as tests, exercises, assignments, interviews and presentations, among others. Passing practical work in the form of a practicum, internship and teaching practice is a major requirement at both universities. Thus, the amount of anxiety in students is immeasurable, especially during the COVID-19 pandemic. Kaputa (2021) states that one ODeL

university in Southern Africa has incorporated online assessment, using e-portfolios to replace hard copies. According to Robles and Braathen (2002), e-portfolios are created to assess students' learning. Online assessment entails checking the e-portfolios and measuring student learning. The course tutors should help students create e-portfolios by placing their best work in them. The grading is done online, and feedback is given to the student.

Emerging research on e-portfolios shows that the success thereof hinges on the nature of their implementation (Scully et al. 2018). However, success depends on the placement of appropriate antecedents. Several factors need to be in place for this to happen. Attitudes, infrastructure and collaboration are key for effective implementation. Attitudes towards the use of technology in education have been largely negative. Scully et al. (2018) cite a number of studies on students' experiences with e-portfolios. The summarised findings show that students were positive about learning e-portfolios when they knew the processes involved (Lewis 2015) or when they felt that they had presented their correct effort (Bollinger and Shepherd 2010) or had prior knowledge related to e-portfolios (Wakimoto and Lewis 2014). However, students were not satisfied with e-portfolios that focused on the narrative report only, as it benefitted those with writing competencies (Struyven et al. 2014).

Strategic focus in most developing universities has been on physical infrastructure. Peters (1983) indicated the role of technology in his definition of DE. However, technological development in education, especially in ODeL, is now responding to the disruptive nature of COVID-19 that blocks humans from meeting as a way of reducing contamination. The development of appropriate Information and Communication Technology (ICT) infrastructure to carry out the different activities, which support the use of e-portfolios, is now the focus of most universities. Infrastructure development needs funding, which, in most cases, is scarce. Thus, universities are at different stages in this area. Levels of infrastructure development differ between countries, with developing countries lagging behind in this regard, hence their focus on traditional methods of assessment. The migration to e-learning has had a negative impact on students, as most cannot access the needed gadgets to access e-LMS. Synergies with technologically-advanced universities would enable the pooling of expertise.

3.2.3 Managing E-Portfolio Online Assessment Challenges During the Period

Joyes et al. (2010) established that many processes take place during the implementation of e-portfolios. These include the gathering and selection of activities, writing the narratives, and navigating the online platforms to upload to or stream on the e-LMS. Departments need to prepare students and their lecturers for their expectations. The online activities must be operational on the e-LMS. Studies have shown that students

tend to be satisfied when informed of the course expectations (Lewis 2015). Challenges experienced with e-portfolios have mainly been technical (Modise 2021), training, time, supervision, and support when implementing the practicum (Mapuranga and Bukaliya 2014). Lack of appropriate gadgets, such as computers, affects the quality of electronic submissions. Most students in Africa can only afford basic cell phones that are not compatible with the software used in e-LMS.

Student orientation that culminates in training is essential if they are to access the materials, upload, and navigate online. Student and lecturer negative attitudes have significant effects on the uptake of technologically-based programmes. The propensity to rely on traditional forms of assessment significantly affects the training of both students and lecturers. Universities need to ensure that students are orientated and trained to use technology.

E-portfolios need time to complete. Unlike formal examinations, a student may be required to do the e-portfolio for periods ranging from up to a year (Mihail 2006). According to Mapuranga and Bukaliya (2014), students have requested more time to complete e-portfolios. Support for students during their e-portfolio reduces students' attrition rate. Students who receive technical support are likely to complete the course as compared to those who do not receive any support. Support via online tutorials, tutorial letters, and other platforms like WhatsApp and e-mails tend to motivate students to complete their e-portfolios. The provision of supervision of the e-portfolio is another form of support that helps to reassure the student that they are on course.

3.2.4 Suggestions for Improving the Management of E-Portfolio Assessments

E-portfolio use is a new phenomenon with a paucity of research (Scully et al. 2018), and the need for the assessment of the whole person makes it an ideal instrument in the current environment. Departments must fully capacitate course tutors on all the processes of e-portfolios. Thus, knowledgeable course tutors who know their requirements are in informed positions to support and supervise their students, especially those confronted with problems. In the same vein, students should understand the aims and objectives of e-portfolios. Modules must present to students all the processes involved in the implementation, construction, submission and assessment of their e-portfolios (Kaputa and Gwitimah 2013; Scully et al. 2018). Objectives and outcomes of the e-portfolio must be explicit so that students can link them to workstations. Communication of all aspects of the course motivates students, inculcating positive attitudes in them towards e-portfolios. Modise (2021) recommends that universities provide technical support to students so that they focus on doing their e-portfolio. However, course tutors need to use technology as a helper of e-portfolios rather than the focus (Scully et al. 2018).

Birgin and Baki (2007) propose giving feedback to students as part of the assessment. Such feedback enables the student to correct aspects in their e-portfolio. Providing feedback to the student reassures them that their e-portfolio is relevant and improves their teaching in their workplace.

3.3 Methodology

The research focused on ZOU and UNZA. Both institutions offer degrees in Special Needs Education through ODL. By means of a qualitative approach, Special Needs Education teachers at these universities shared their experiences during their practical work and proffered how these e-portfolios could be submitted online for assessment. A qualitative case study design was used to generate data from DS&SNE (ZOU) and IDE (UNZA). The sample consisted of 20 Special Needs Education teachers from DS&SNE. These teachers were in their final year, and they and their e-portfolios were submitted online. The latter provided their perspectives on the students' experiences. This helped the authentication of the students' data by their course tutors. The research design enabled the collection of as much information as possible from the two units (Cohen and Manion 1989). Data were collected by means of an open-ended questionnaire using Google Forms and focus group discussions (FGD) on WhatsApp platforms created by the course tutors. We sent the Google Forms link to the open-ended questionnaires by e-mail to all the participants and the course tutors and ordinary e-mails to those who had failed to access the link and submit the forms. FGDs enabled participants to clarify issues raised in the open-ended questionnaire.

The data were analysed using thematic content analysis as suggested by Miles and Huberman (as cited in Hammond and Wellington 2013). This involved reading the statements and WhatsApp transcripts, looking for patterns, which enabled us to perceive categories and themes and subthemes in line with the research questions. We adhered to Cloutier and Ravasi's (2020) recommendation that one uses tables and figures in the presentation to ensure trustworthiness in line with qualitative research.

3.4 Findings

The generated data provided demographic data and the themes. Emergent themes are illustrated in Fig. 3.2.

Both institutions assessed their students, with IDE students doing the theory of the practicum during the COVID-19 lockdown. IDE students used the Astria Learning Management System to submit their assignments. DS&SNE students could submit their e-portfolios on MyVista.

The participants were both male and female Special Needs Education teachers in their final year at both institutions. These teachers had done their practicums in their areas of expertise in the various regions, in line with the requirements of the

Fig. 3.2 Emergent themes

course regulations. The full-time course tutors from the regional campus and the national centre authenticated the generated data from individual students and FGD. The generated themes were communication on the requirements; preparation for e-portfolio submission; challenges encountered; and suggestions for improvement of the online assessment. The first and second themes fell under research question 1; the third theme fell under research question 2; and the fourth fell under research question 3. We analysed and interpreted these themes and presented and discussed them in the sections below.

3.4.1 Special Needs Education Teachers' Experiences of the Submission of E-Portfolios

Theme 1: Communication on the requirements

Communication was the most important aspect of the participants' experiences. Communication embraced every aspect they raised. However, three subthemes were prominent, namely requirements for the e-portfolio; alternatives for submission; and availability of support services.

Communication on the requirements of the course, specifically the requirements for doing and submitting the e-portfolio online, was raised by the teachers. MyVista was the main communication modality used by the course tutors. However, due to a number of challenges, most of the teachers could not access it. They resorted to other means, as stated by one teacher:

> These have been communicated through 'WhatsApp' social media; through direct phone calls with the Mash. West Coordinator; through Text Messages (SMS) and through e-Mails.

Some students physically visited the coordinators to get the requirements. Course tutors confirmed that the e-LMS platforms at ZOU were used to convey requirements in the course module and through online tutorials.

> Students have a guiding module on their eLearning platform. I also give them supplement notes and tutorials.

The second sub-theme was on the alternatives for the submission of the portfolio if they failed to upload it to the e-LMS. Some students claimed that there was no alternative, as they were required to submit online only. Most students said that they were told that they could submit the hard copy if they exhausted all methods of submitting online. Their course tutors confirmed the first claim by students:

> Students can only submit online and we have not been accepting any other way for the last two years.

Another tutor said:

> There is an alternative to using our old method of submitting hard copies. However, we encourage them to submit online at all costs. If they fail to submit online, they can arrange with IT people at the campus to assist them.

The third theme was on the availability of support services. Three support services were in place for the students: ICT laboratories and WiFi at the regional campuses; course tutors to guide them; and notes.

One course tutor confirmed:

> We as a university have put in place computer laboratories with laboratory assistance who are there to assist students who face submission challenges.

Theme 2: Preparation for e-portfolio submission

Preparation for e-portfolio submission was a major issue for the participating teachers, as it enabled them to submit their e-portfolios. Three subthemes were identified: training; needs; and focus of the practicum.

Although no training was provided specifically for e-portfolio submissions, most participants felt that the assignment training they got on MyVista was adequate to enable them to submit online. In this regard, participants said the following:

> I did not receive any training apart from following recommended guidelines from the University Practicum module

> Intended to use the same route as that of assignments. Through MyVista.

> At such a time like this. It's a bitter pill to get all the necessary information since some documents need the school head and learners; but on the side of the tutors, no problems encountered as it's our tradition to use online lectures.

Despite having no specific training for this exercise, they claimed that they had no option but to comply with the course requirements. One course tutor in the FGD narrated the following experience of students:

> Because they [students] lacked preparation for this, they at first panicked and questioned how such documents could be uploaded on MyVista. So, we had to cool their tempers and assure [them] that it was possible. At the end as those who had successfully uploaded shared their successes, the phobia vanished from the majority while a minority remained hesitant and not ready but were forced by the deadline dates to try their luck.

Course tutors at the various regional campuses used other methods to persuade the students to convert their files to e-portfolios and submit them. Some of these were:

> Encouraged them to embrace technology, since the world has gone digital

> We helped them through WhatsApp platforms

> Asked them to visit the IT lab for help

In the FGD, one participant said the following:

> Preparedness was partly disturbed by lockdowns, which made it difficult for me to meet the school staff as well as learners to work with. As a result, submission was done hurriedly in order to meet the deadline.

The students indicated what they needed to be able to complete all the e-portfolio processes. They needed:

> A working e-LMS platform and Data connectivity. Even the course tutors also needed adequate internet connectivity and a more efficient PC and laptop; data bundles, especially this time when they were working from home.

The third sub-theme was on their practicum focus areas, as shown in Table 3.1. Lecturers, by virtue of their having students' records, provided their focus areas. All DS&SNE students uploaded their e-portfolios to MyVista. Students focused on all taught aspects in order to combine theory and practice.

For example, one teacher did their practicum at the following two sites:

> Teaching the visually impaired primary school learners at Jairos Jiri Special School and Rehabilitation Work at Kadoma General Hospital – Rehabilitation Department.

Table 3.1 Practicum focus areas

Students	Course tutors
• Teaching the visually impaired • Rehabilitation • Disability centre • Resource unit	• Policy • Application of theory • Management skills • Teaching • Rehabilitation • Special needs education • Disability studies • Rehabilitation • Therapies • Disability counselling • All-inclusive development areas

The programme regulations required them to do their practicum at two sites in a year.

At IDE, the focus was different due to the COVID-19 restrictions. One course tutor summarised the students' experience as follows:

> We ended up with theory without practicing even in practical areas such as braille and sign language.

The last theme involved accrued benefits of using e-portfolios. One teacher participant mentioned the following:

> It gave me self-evaluation as l was looking at each item and seeing the strengths, weaknesses and suggestions. It requires hard work and patience, e.g. child study IEP to mention a few.

One course tutor summarised the benefits to them as course tutors:

> It's safer
>
> As the academic field embracing IT, it means moving with the trend
>
> makes marking flexible and convenient as one can access and mark the files anywhere with office space a challenge in most regions, it will reduce [sic] cramp.

3.4.2 Managing E-Portfolio Online Assessment: Challenges During the Period

Theme 3: Challenges

Students from both institutions faced incapacitating challenges. IDE used alternative ways of assessment. IDE students could not do their practicals, as pointed out by the course tutor:

> Practicals are physically done and validated. We had challenges during COVID-19. Students couldn't do their practicals owing to quarantining state of affairs.

IDE offers its Special Needs Education degree in the manner explained by the course tutor:

> [Its] blended online and face-to-face Assignments are given via the learning management system.

This may have affected their provision, as students failed to use the traditional practical work procedures.

DS&SNE students experienced challenges as they tried to do their practicums and submit them online. However, their challenges were more on the processes involved in the construction of the e-portfolio, its submission, and feedback. Table 3.2 summarises the challenges.

One Special Needs Education teacher from the capital city of Harare summarised it all as follows:

Table 3.2 Challenges faced by students and course tutors

Students	Course tutors
• No data provision—financial • No laptops • No training • Training manual is needed • No feedback • Poor network • Power cuts • Could rarely get required instructions • Submitting my practicum online • Attachment of hard copies • Difficult to sieve information required	• Network challenges and lack of data • Technophobia (students & tutors) • e-LMS efficiency • District centres not IT connected • Students had no e-mails addresses

> For me submitting my practicum online was a bit challenging in the sense that l did not know exactly how to go about it except that l had to follow the pamphlets on my vista because the practicum had to be submitted. Attachment of hard copies, l did not know if l had to take pictures of the hard copies and had no one to ask about it. However, l did what l had to and submitted the practicum.

> The only feedback l got was my final mark on my result slip. So l do not really know how l performed as in the strengths and weaknesses on my completed practicum.

The course tutor confirmed this

> Students lack compatible devices; they experience data challenges and, most significantly, network challenges. In addition, students experience high costs when they are scanning some practicum documents and evidence as attachments to the narrative report.

Students showed partial satisfaction with the whole process, as they said they were prepared to submit their e-portfolios online for assessment despite the challenges they had experienced.

3.4.3 Suggestions for Improving the Management of E-Portfolio Assessments

Theme 4: Suggestions for improvement of online assessment

Both institutions recommend online submission and assessment of e-portfolios as the best method. One course tutor (IDE) stated:

> E-Portfolio is the way to go

A DS&SNE course tutor affirmed this statement:

Table 3.3 Suggestions for improvement

Students	Course tutors
• Training • Laptops • Need online tutorials • Improve communication • Post some literature online • Opening the portal • By creating room for hand delivery • Have e-mails	• Communicate calendars early • Students need training • Inaccessibility of MyVista • Continuous student support • Teaching students e-portfolios online • Visit the IT lab for help • Encourage them to embrace technology • System should be self-correcting • Revise and align the computer module

> It's time to align ourselves to this 4th computer compliance industrial revolution. The 5.0 heritage-based education demands that, especially in this COVID-19 period where social distance is demanded. I pointed out that the demands of the university to submit practicum online are a plus on your part as they are equipping you and our students with skills to remain relevant or to keep your heads above water in this new normal

The suggestions in Table 3.3 summarise the recommendations from both institutions.

Course tutors must seriously embrace students' submissions, as pointed out by one student:

> I think there is a need for proper communication between the faculty and students. That is why we provided our phone numbers and email addresses because l only discovered that there was a deadline but as a student l did not know what needed to be done and therefore there is a need for adequate training on how to layout and submit a practicum online.

Students highlighted the need for training and online tutorials:

> I suggest the importance of training be conducted by Universities highlighting the exact practicum materials to be sent online

> More training is needed on how these practicums should be carried out. Yes, the module does help but there is a need for tutorials.

> Prepare them, give them supporting notes that they use for trials, and always have user-friendly fast internet. The system [MyVista] should be self-correcting whenever one faces challenges and interactive too.

3.5 Discussion

The purpose of the research was to find out how Special Needs Education degree students were managing the transition to the use of e-portfolios brought about by the "new normal". COVID-19 disrupted the provision of physical teaching and learning

activities, including assessment. Practical subjects, like the Special Needs Education practicum, were not spared. Therefore, the study aimed to find solutions through the examination of student experiences. Responses depicting student experiences and lecturers' authentication provided answers to all the posed questions. E-portfolios were not equivalent to hardcopy portfolios, as required by the Equivalency theory of Simonson et al. (1999) due to the COVID-19 pandemic. Both institutions aligned with the MMOE theory by Picciano (2017). The discussion focuses on their responses in the areas in which they participated.

Communication on the requirements of the e-portfolio dominated the students' responses. Communication permeated all the students' experiences, as it is the vehicle used to prepare them. Scully et al.'s (2018) findings from the analysis of wide-ranging studies resonate with our findings. The similarity is in the aspects which needed to be communicated to students. The finding as regards the preparation of the e-portfolio is in agreement with that of Wakimoto and Lewis (2014). Students could do activities that were similar to what they had experienced before. For example, experiences of uploading assignments to the e-LMS equipped students with the necessary skills to upload their e-portfolios. Students knew their focus areas and proceeded to construct their e-portfolios. Alternative methods of informing them enabled the completion of their e-portfolios.

There were significant technical challenges in the implementation of the e-portfolio. Our findings show a focus on the technical aspects of e-portfolios, unlike Birgin and Baki (2007) and Scully et al. (2018) who found that the focus was on the content and implementation of e-portfolios. This affirms Modise's (2021) recommendation that universities must improve the technical aspects of e-portfolios. Students should not expose themselves to COVID-19 by visiting their course coordinators and regional campuses in contradiction to government health restrictions that safeguard them from mortality.

Students made numerous suggestions for improvement: student preparation through training; module revision to include e-portfolios; making MyVista user-friendly; and improving internet connectivity so as to ensure that the e-portfolio is compiled and submitted seamlessly. Both institutions highlighted the need for training and enabling facilities. The partnership between the two institutions should enable them to share experiences regarding how they improve e-portfolio implementation, compilation and submission. In a study conducted by Kaputa (2021) of three institutions in the Southern African Development Community (SADC), he mentions an ODeL institution that is using e-portfolio assessment as an alternative to traditional paper-and-pencil examinations. Institutions need to collaborate to address the technical impediments so that students submit quality e-portfolios.

3.6 Conclusion and Recommendations

3.6.1 Conclusion

The students answered the main research question by expressing their experiences with e-portfolios. They shared varied experiences from both institutions. Both institutions assessed their students' practicum in response to the conditions that were prevailing in their countries. DS&SNE students participated in their practicum, created e-portfolios and submitted these to MyVista. However, they were partially satisfied with the preparations. IDE students were unable to submit e-portfolios due to COVID-19 quarantine in their countries; therefore, they were examined on the theory of the course submitted via the Astria LMS platform. ZOU students benefited from their experiences with the MyVista platform. They had no choice but take use e-portfolios despite the numerous challenges they had experienced. E-portfolio management involved the use of alternative electronic modes.

3.6.2 Recommendations

- The students recommended thorough training in e-portfolio management and highlighted implementation as paramount.
- The departments need to be explicit as to what should be done in the whole e-portfolio process.
- There is a need to upgrade the technical aspects for both students and lecturers.
- Further research must focus on the actual implementation of e-portfolios in the "new normal".

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Chapter 4
Assessment in Preparing In-Service Teachers to Teach in the Digital Age

Tshepo Batane and Chandapiwa Butale

Abstract Current global technological transformations in education compel teachers to have technology skills that enable them to effectively function in digital classrooms. Thus, it is important for technology teacher training programs to equip teachers with the requisite skills. Assessment plays a crucial role in assisting one to cultivate these skills during training. In this study, we investigated assessment processes in a technology course in the in-service teacher education program at the University of Botswana to find out how they were contributing to technology skills development among the teachers. The Technological Pedagogical Content Knowledge (TPACK) model was used as the theoretical framework for the study. The findings indicated that the assessment pieces used for the course addressed the requisite skills that teachers need to use technology effectively. Evaluation of students' performance in the various assessment pieces identified gaps in skill attainment that needed to be addressed. These included designing evaluation activities in lesson plans, identifying specific objectives for the use of tools, pedagogy, and application of design principles in developing digital resources. The results imply that assessment practices in in-service teacher training programs should focus more on requiring teachers to demonstrate technology skills in authentic situations to cement skill acquisition and improve their confidence. There is also an urgent need to provide requisite resources in the schools to promote skills application.

Keywords Assessment · In-service teacher education · Technology competencies

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4.1 Introduction

Assessment is an important component in preparing teachers to effectively utilize technology in lesson delivery. The main goal of technology teacher training programs is to equip teachers with the requisite skills needed to utilize technology effectively in their work. Assessment plays a crucial role in assisting to develop these competencies through requiring learners to demonstrate acquisition of specified skills at various stages of the program. This helps to identify learning gaps and the support that students may be needing to master the skills. Traditionally, assessment practices focused on measuring knowledge acquisition, and a letter grade or numerical mark was deemed as an indicator of skill and/or knowledge proficiency or gap (Taras 2005). As such, assessment tasks mainly required learners to regurgitate information provided during teaching (Simonson et al. 2000). The advent of technology in learning introduced a new set of skills that teachers need for effective technology integration. It is crucial to establish how current assessment practices in teacher education are responding to these new requirements.

In Southern Africa, in-service teacher education programs are faced with the challenge of re-training teachers such that they can transform their teaching practices to use technology and equip learners with twenty-first century skills. Lack of preparedness has been reported as one of the leading causes of inadequate adoption of technology by teachers (Hero 2020; Johnson et al. 2016). For in-service teachers, the situation is dire, as for the most part, they are set in their ways and often find it difficult to adopt technology use. In Botswana, there has been little evidence to suggest that technology training for in-service teachers that has been done so far has produced significant results, as most teachers continue to not use technology in their teaching (Kgalemang et al. 2015). Therefore, it is important to study the various aspects of technology teacher training programs to find out how they prepare teachers for technology integration. Such studies may highlight areas where said programs may be lacking and may guide us in developing more effective training programs. In this study, the assessment processes of a technology course in the in-service teacher education program at the University of Botswana were investigated. The overarching research question was how the assessment processes in the course were contributing to the development of technology skills among teachers.

4.1.1 Context of the Study

The focus of this study was on a course entitled *Information and Communication Technology Applications in Schools*. The choice of the course for the study was based on its purpose to equip teachers with skills to use technology in teaching–learning processes. The study focused on the way the course assessed students to investigate the role that the assessment was playing in the endeavor to develop these digital skills among the teachers. Traditionally, students taking this course have very low

technology competencies, as they received their pre-service training many years ago before technology became part of learning. All the teaching and assessment processes of the course were conducted using digital platforms, mainly Microsoft Teams and Moodle. The course ran for a total of 16 weeks and had previously been delivered using a blended learning approach, but due to the COVID-19 pandemic, the course was offered completely online during this study.

4.1.2 Significance of the Study

The results of this study are aimed at improving the assessment processes of technology-training courses to better develop teachers' skills for effective technology use in lesson delivery. Botswana is venturing into uncharted territories of digital learning, and it is important for teacher training programs to adequately prepare teachers for this new learning landscape.

4.1.3 Objectives

The objectives of this study were to:

- establish the students' technological experiences before they started the course;
- analyze the assessment activities used in the course;
- analyze students' performance in the assessment activities;
- evaluate the assessment program of the course from the students' perspective.

4.2 Theoretical Framework and Literature

4.2.1 Technological Pedagogical Content Knowledge

The Technological Pedagogical Content Knowledge (TPACK) model by Mishra and Koehler (2006) was adopted in this study to assist in guiding the investigation of the role assessment played in the effort to cultivate appropriate technology skills among teachers. The TPACK Model outlines critical skills that teachers need so that they would be able to use technology effectively. According to this framework, teachers need three sets of knowledge, namely:

Technological Content Knowledge (TCK): This refers to the ability of the teacher to competently use various technology tools in their teaching. The most common resources used for instructional purposes are productivity tools, such as Word processors, spreadsheets, databases, and presentation tools. Online productivity tools have

also become an important part of education. According to Johari et al. (2018), developing these skills would help increase teachers' confidence and comfort with technology. Studies indicate that there is a high correlation between teachers' technology competencies and their use of technology in delivering their lessons (Anderson and Putman 2020; Dogan et al., 2021). An analysis of literature by Spiteri and Rundgren (2020) to explore factors that influence primary school teachers' use of technology identified teachers' skills as one of the critical precursors of technology use. The international disposition of this study suggests that this is a cross-cutting issue that plays a significant role in technology uptake.

Pedagogical Content Knowledge (PCK): PCK entails the knowledge that teachers need to have about their subject matter and how to deliver such content. According to this concept, the different subjects in the curriculum are best delivered using certain specific teaching strategies; as such, teachers need to be skilled in different methodologies and be able to apply them appropriately to achieve their lesson goals. The Rubric for Effective Teacher Technology Use developed by Johnson (2013) recommends that, to better guide the assessment of technology used by teachers, it is important to start with analyzing effective teaching before looking at technology use. This implies that teachers need to have a good pedagogy before they can be good technology users. One constant message that has been preached throughout the years is that pedagogy should drive technology, not the other way around (Attard 2015; Johnson 2013). Technology teacher education programs have a responsibility to ensure that students develop sound teaching practices to help them better integrate technology in their teaching.

Technological Pedagogical Knowledge (TPK): According to this concept, when teachers are knowledgeable and skilled in the various pedagogical approaches that would best deliver their content, they should be able to identify the most appropriate ICT resources that would support such approaches. Over the years, the most common criticism against teachers' use of technology has been the attempt to impose technology use over traditional forms of teaching which do not support learner engagement and innovativeness (Johnson et al. 2016; Trimble 2003). Promethean (2016) developed an infographic that traces how teaching methodologies have evolved over the years as the technology becomes part of learning. This includes the changes in the dynamics of teacher–student interactions, increased innovation, and increased access to resources, among others. These changes call for innovative and adaptive strategies that leverage the capabilities of available technology resources.

In this study, the TPACK model became a useful guide because, with the requisite skills identified, the framework gave direction on the kind of assessments that should be used in the effort to prepare teachers to use technology. The model was also used as an analytic framework in evaluating students' performance in the various assessment pieces, thus assisting to identify gaps in the participating teachers' competencies that needed to be addressed further.

4.2.2 Assessment in Developing Technology Skills

Integration of technology in learning requires a synergy of different forms of skills and knowledge as elucidated by the TPACK model, and assessment activities can help identify the areas where teachers may be lacking and direct them to appropriate help (Campbell and Godin 2014; O'Reilly 2016). According to Johari et al. (2018), assessment, if done properly, can assist in developing and honing the needed skills and helps increase teachers' confidence in using technology.

Performance-based assessment approaches have been identified as one of the best ways to appraise and help improve ICT skills among learners (ITU 2018; Tuparova and Tuparov 2010). This type of assessment requires students to demonstrate their knowledge and skills appropriately through performing a particular activity, either as individuals or in a group. The assessments can take various forms, such as creating a product to use in real life. This kind of activity would require students to outline the procedures they followed in developing the artifact, and educators say it is this journey that is important because it offers a deeper insight into the cognitive and non-cognitive proficiencies of the students (Johnson 2013; Pillai et al. 2020).

Regarding the development of technology skills, performance-based assessment frameworks have been used to measure digital skills, mainly in simulated environments. In these approaches, it is important to first identify the digital competencies to be measured in the assessment (Engelhardt et al. 2021; Tuparova and Tuparov 2010). The assessments are designed to require students to demonstrate a wide range of skills from low level to, most importantly, higher-order ICT skills which require incorporation of other key competencies such as evaluation and critical thinking (Engelhardt et al. 2021). Performance-based assessment designs often adopt a problem-based approach which requires a demonstration of a combination of skills, including technology use, analysis of information, communication, and collaboration (Duch et al. 2001).

In other performance-based frameworks, the assessed ICT skills are separated into operational skills and conceptual skills, whereby learners must be competent in the former before the latter, with the additional benefit of interactivity (Tuparova and Tuparov 2010). This procedure serves a diagnostic purpose because it helps identify areas where the learners need help before moving to the next level and ensures that students master basic skills to ease the acquisition of higher-level ones. Performance-based assessments for measuring technology skills are conducted using ICT resources such as computers and specialized software, and this enables multidimensional testing where various skills can be measured concurrently (Leaser 2020). According to Leaser, this also helps institutions monitor skill development in various areas.

Another important feature of performance-based assessment in technology skills is the provision for self-assessment, which allows learners to reflect on their own capabilities. Studies show a positive relationship between self-assessed technology skills and initiatives to improve on areas of lack, based on feedback (Johari

et al. 2018; Sailer et al. 2021). Biggs (2003) claims that the process of learning should equip students with the capability to self-assess their work because, as other authors also indicate, this leads to skilled learners who are able to self-monitor their progress toward achieving their goals (Nicol and McFarlane-Dick 2006; Sadler 1989).

In pursuit of effective ways of assessing learners, performance-based assessment seems to be a better substitute for traditional testing approaches (Quansah 2018; Top Hat 2020; Sumardi 2017). Technology teacher training programs are faced with an enormous task of developing the various competencies that teachers need to efficiently function in digital classrooms. In Botswana, the government is committed to providing teachers with the requisite skills for today's classrooms, particularly digital skills. Teacher education programs in the country (both in-service and pre-service) are required to provide quality training to help the country realize its aspiration of the Fourth Industrial Revolution (Iloany 2014), and technology training is an important component of these programs. Various studies have investigated these technology-training programs, and one common conclusion has been their ineffectiveness in fully preparing teachers to use technology (Boitshwarelo 2009; Kgalemang et al. 2015). In a study by Major and Tiro (2012), pre-service teachers reported that their training program focused too much attention on theory than on providing them with practical skills. This sentiment has been shared by various other stakeholders in the country, who decry inadequate preparedness of new teachers as they get to the field (Sebobi 2014; Makwinja 2017; Mukhopadhyay et al. 2009).

In reviewing teacher education programs in Botswana, research has mainly focused on the content offered and the teaching methodologies used to prepare teachers (Hunter and Molapo 2014; Iloany 2014; Mangope and Mukhopadhyay 2015; Mannathoko 2013). No study has investigated the way teachers are assessed during their training to understand how it impacts their skills development. Investigating this phenomenon has become even more important in the COVID-19 era in which tremendous changes have been forced upon education. With technology taking center stage in learning, it is imperative to investigate how developing countries like Botswana are adjusting to the prevailing circumstances and are preparing their teachers.

4.3 Methodology

This research was a case study, and the unit of analysis was the Information and Communication Technology Applications in Schools course at the University of Botswana. The class consisted of 33 students. A mixed-methods approach was used to collect data. Quantitative strategies were used to obtain information on the participants' background and level of technology skills at the beginning of the course and their evaluation of the assessment processes at the end. Statistical analyses were also performed to examine students' performance in different assessment pieces to gain an understanding of their skill development during the training. Qualitative approaches,

Table 4.1 Data collection and analysis strategies

Data collection strategy	Data analysis procedures
Needs analysis survey	Statistical models were used to analyze the quantitative data, and content analysis was used for the qualitative data
Review of assessment pieces and activities used for the course	Content analysis: the process involved the identification of the competencies in each assessment piece that were being evaluated in relation to the course content
Analysis of students' performance on the various assessment pieces of the course	Statistical analysis: this involved analysis of students' performance on each identified competency as in above. The grades obtained for each item were categorized according to quartiles to give a picture of how students performed in each. The feedback provided in the students' work was also processed through content analysis
Students' evaluation of the assessment processes of the course	Content analysis and statistical models were used to analyze the data

on the other hand, were employed mainly to obtain information on the kind of technology skills that the assessment pieces were designed to evaluate. Open-ended questions were also included in the study surveys to obtain in-depth information about the participants' needs state and their evaluation of how the course assessments impacted their skills development. Table 4.1 below shows the data collection strategies and the analysis procedures employed in this study.

4.4 Results

4.4.1 Students' Needs Analysis

Table 4.2 shows the age range and gender of the students who participated in the needs analysis exercise.

Table 4.3 indicates the number of years that the participants had been teaching before they enrolled in the course, juxtaposed with their experience with using

Table 4.2 Age range and gender of participants

Count of gender	Age bracket			
Gender	**41–50**	**51–56**	**51–60**	**Grand total**
Female	7	1	12	20
Male	5	0	5	10
Grand total	**12**	**1**	**17**	**30**

Table 4.3 Participants' teaching length and experience

Teaching length (years)	Computer teaching experience		
	No	Yes	Grand total
16–20	4	1	5
21–25	5	0	5
26–30	5	2	7
31–35	11	0	11
35–40	2	0	2
Grand total	27	3	30

computers for teaching. All the participants indicated that they were also holding managerial positions in their schools, such as principals and deputy principals.

The results above show that students enrolled in this course were older people, with all of them over the age of 40. Most of the participants had a teaching experience ranging from 31 to 35 years. 90% of the participants reported that they had no experience in using computers for teaching. The analysis also indicated that, before the course, participants had very low technology competencies, with about 80% indicating that the only things they were able to do with a computer were basic typing and internet surfing. This reported low level of technology skills among these older teachers is a common phenomenon in education, mainly because the technology was neither the part of their teacher training nor the part of learning (Fernández-Cruz and Fernández-Día 2016; Vásqueza and Noriegab 2013).

In terms of access, the study showed that there were no sufficient computers in the schools where the participants worked before taking the course. The data showed that the ratio of the schools' population to the number of computers available in the schools was very high. The average ratio was 1:32. This implies that there is a need to speed up the pace of provision of computer resources in schools so that the teachers can immediately put into practice what they have learned when they get back to the field. This is crucial because, as studies show, access to resources is one of the major prohibiting factors to technology use in education (Hébert et al. 2021; Johnson et al. 2016).

4.4.2 Analysis of Assessment Pieces

Table 4.4 identifies the skills that were evaluated by the various course assessment pieces.

The above table indicates that the three sets of knowledge identified by the TPACK model for successful technology use are addressed in the assessment activities of the course. TCK skills are assessed by requiring students to demonstrate the use of various applications that are used in classroom settings and developing digital artifacts to use as instructional resources. TPK is assessed by requiring students to

Table 4.4 Assessment pieces and evaluated skills

Assessment activities/pieces	Competencies evaluated
Lesson plans based on instructional design models	Systematic development of an instructional unit/lesson plan that addresses the following: proper coining of objectives that address various domains and levels of learning; identification of appropriate resources; appropriate teaching strategies; systematic utilization of resources; student engagement; effective lesson evaluation activities
Development of digital teaching resources Presentations	Skills in developing digital teaching resources adhering to design principles Utilization of digital resources in identified contexts. The presentation should address the following: identification of the specific objectives pursued using the resource; appropriate assessment techniques used to measure students' learning from the resource; presentation techniques; pedagogical approaches
Final projects	Demonstration of skills through using various computer applications for simulated real-life situations Development of products such as databases and graphics

identify appropriate resources to use in pursuing particular objectives under specific contexts. PCK is assessed through the development of lesson plans and content to demonstrate mastery of the subject matter and identification of the best strategies to deliver specific content. In this study, since the teachers were not able to apply their lesson plans in real-life classrooms, simulated environments, using their classmates as the learners, were used. The peers were also required to give feedback.

4.4.3 Students' Performance on Assessment Pieces

4.4.3.1 Assignment 1: Development of a Lesson Plan Based on an Instructional Design Model

Analysis of students' performance on this assignment revealed that, generally, students performed well in the various components of the lesson plan, with most of the students scoring in the 51–75% and 76–100% quartiles, as shown in Fig. 4.1.

The area where students seemed to have challenges was the evaluation section; the results show that more than 50% of the students scored in the 0–50% half.

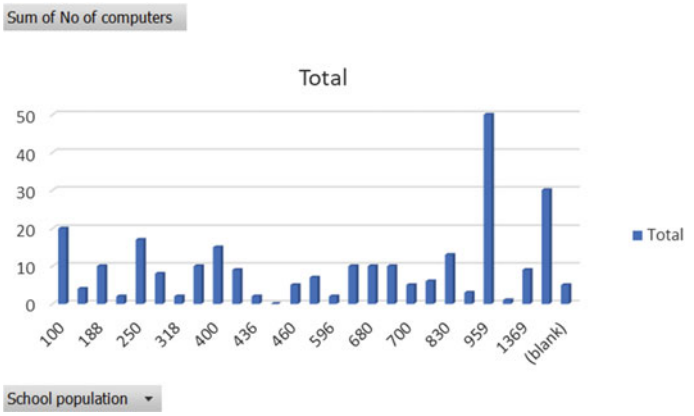

Fig. 4.1 Students' performance in assignment 1

Analysis of the students' work indicated that most students struggled to design innovative evaluation activities that they would use to assess whether the lesson objectives were met. The unsatisfactory performance in designing evaluation activities to assess attainment of lesson objectives illuminated a shortcoming in the teachers' PCK element as per the TPACK model. Lesson evaluation is an important component of lesson development. Demonstration of mastery of content should be accompanied by robust ways of finding out whether the lesson objectives have been met. Failure to sufficiently address this component means the lesson plan is incomplete (Milkova 2016; Stronge and Xu 2019). Therefore, the study identified this as an area of need in which teachers needed more training.

Analysis of feedback given to students indicated that students were given specific information on what they failed to do in designing appropriate evaluation activities and what they needed to do to achieve this. This is illustrated by the following example:

> You need to describe specific activities that you would use to find out whether the lesson objectives have been met; refer back to each objective and identify an activity that can help you find out whether it has been met.

4.4.3.2 Assessment 2: Part A: Development of Digital Resources

This assignment required students to create a digital resource that they would use as instructional material to teach a particular topic in their subject. The analysis of the students' performance indicated that most students were able to use applications such as Microsoft Paint and Microsoft Word to develop innovative, appropriate digital instructional resources such as posters and diagrams to be used for their teaching (see Table 4.5).

The analysis showed that students performed very well in terms of demonstrating mastery of applying design principles in developing the digital tools to be used

Table 4.5 Students' performance in the creation of digital resources

Components	0–25%	26–50%	51–75%	76–100%
Innovative material	5	3	7	18
Adherence to design principles	4	0	8	21
Specific objectives	10	18	0	5
Appropriate assessment	4	3	12	14

as instructional resources, which improves the effectiveness of the resource (Bandli 2020; Smaldino et al. 2012). The development of skills in producing digital resources is crucial to technology training for teachers. Research indicates that, when teachers are competent in using technology tools, they can identify the best resource to use for their lessons (Dlamini and Mbatha 2018; Drossel and Eickelmann 2017), as TPK also contends. In the African context, it is important that teachers are skilled in developing various digital artifacts so that they can be able to develop material that is contextually relevant to their learners.

Nevertheless, analysis of this assignment also indicated that most students did not do well in terms of identifying the specific objectives they were trying to pursue in their lessons by the material they had developed. The TPACK model says that teachers should have skills in identifying appropriate tools to pursue specific objectives, which means that objectives should be well-defined before the identification and development of resources. In the assignment in this study, students were required to develop the tools first, then identify the objectives that the tools were assisting to achieve. This study shows that this sequencing of skills demonstration is not the most appropriate as objectives must be identified first. Educators advise that is important to first define the goals that are being pursued in education, then identify appropriate technologies and teaching strategies that would facilitate the achievement of such (Kurt 2015; Smaldino et al. 2012).

4.4.3.3 Part B: Presentations

Here, students were required to do online presentations, demonstrating how they would use the digital materials they had developed in a classroom setting. The presentations were done in groups, and students were also required to assess their peers as they presented. The results indicated that students performed well in the presentations, particularly in demonstrating high levels of confidence, showing that this is a skill they had honed as teachers over a long period (see Table 4.6).

A shortcoming was noted in the method of delivery where participants demonstrated how they would use the tools in their classrooms. The pedagogical approaches were predominantly teacher-centered, indicating that the teachers needed a lot of training and practice in using learner-centered strategies. According to the TPACK model, for technology to be effective, teachers need to employ appropriate teaching approaches that promote innovativeness and learner engagement to achieve their

Table 4.6 Students' performance on presentations

Components	0–25%	26–50%	51–75%	76–100%
Clear and logical	0	0	0	33
Voice projection	0	0	0	33
Confidence	0	0	0	33
Learner engagement	7	11	9	6

lesson goals. Rogers (2018) claims that, if a teacher succeeds in delivering their content in an interactive manner using digital resources through their learning management systems, they demonstrate high competence in TCK. Maor (2013) introduces the concept of digital pedagogies, which are described as pedagogical approaches whereby new technologies change the way teaching is done to foster learning. According to Maor, for technology to have a meaningful impact on education, there is a need to shift to this paradigm.

Further analysis of the presentations in this study indicated that students greatly participated in giving feedback to their colleagues on their work and engaged each other. This, according to numerous research, is a vital element of students' learning because students benefit a lot from peer learning (Duncan 2005; Tulis and Goldstone 2020). Also, involving students in assessment assists them to examine their learning and take ownership thereof (National Research Council 2000).

Another element of note in this assignment was that students did well in designing evaluation activities for their lessons. This component was also in Assignment 1, and students did not do well then. The improved performance in this aspect indicated that students utilized the feedback they were given to better their work. According to Sachdeva (1996), "[e]ffective feedback plays a critical role in helping adult learners achieve their educational goals and reach their maximum potential" (p 1).

Studies based on TPACK indicate that feedback is an important component of skills development in the use of technology. In their 2019 study, Baran et al. found that, in an effort to improve teachers' skills, there was a positive relationship between increased levels of TPACK and variables such as collaboration, real-world experiences, and feedback. Aktaş and Özmen (2020) conducted a study to investigate the impact of a TPACK development course on pre-service science teachers' performances. As part of the study, students were required to make a series of presentations based on lesson plans, demonstrating TPACK skills. The results of the study showed that the feedback obtained from prior presentations helped improve performance, including a shift from teacher-centered approaches to student-centered ones. Similar results were obtained by other studies which reported positive gains in TPACK development as students were assessed in various skills and given corrective feedback on their performance (Anderson and Putman 2020; Durdu and Dağ 2017; Tondeur et al. 2019).

4.4.3.4 Assessment 3: Analysis of the Final Project

This comprehensive assessment required students to demonstrate skills they had acquired throughout the course and apply them appropriately in simulated real-life situations. This mainly involved using different Microsoft Office applications for various purposes in teaching and administration. The analysis indicated that students generally performed well in the various components of the assessment (see Table 4.7).

The element that seemed to be problematic to the students in this assessment was the development of digital resources. The poor performance in the development of digital resources—particularly concerning the application of design principles in developing the resources—was a surprise, since students had previously done well in this element. This skill was previously assessed in Assignment 2, and students performed well in it. Further analysis of the two assessments revealed that, while in Assignment 2, the assessment question was deliberate in requiring the learners to apply the design principles in developing the tools and specific marks were apportioned to the component, the question in the Final Project did not spell that out, hence they ignored the requirements. This brings to the fore the concept of grading and its effect on students' learning. Opponents of grading argue that grades are detrimental to students learning because they become an end goal, and students pay more attention to elements that will make them pass without truly internalizing and appreciating what they are doing (McGuire 2015; Miller 2015). This failure of students to apply design principles in this task is a sign that students did not grasp why they needed to do so; they were more interested in the grades. This is concerning, as it may be a sign of what to expect when they get to the field. Unfortunately, this may contribute to the failure to effectively use technology in learning.

It remains a challenge to ensure that students will apply skills learned in the classroom beyond school where no marks are given. Educators and researchers recommend various strategies that could promote students' understanding and appreciation of learning material for application beyond the classroom. The National Research Council (2000) emphasizes that the skills learned in the classroom must make sense in real-life contexts and teacher trainees must be given opportunities to practice applications of such over an extended period. The TPACK model asserts that, to truly measure the development and attainment of skills, students should be required to address real-life challenges and apply the skills through authentic tasks and document their progress as they show the skills (Mishra and Koehler 2006). In their study on

Table 4.7 Students' performance on the final project

Component	0–25%	26–50%	51–75%	76–100%
MS word	0	0	0	33
MS access	0	0	5	28
MS excel	0	0	5	28
MS powerpoint	0	0	8	25
Digital teaching material	2	22	9	0

TPACK competencies of Education alumni in their work, Agustini et al. (2019) found that the alumni had higher levels of content and pedagogical knowledge and lower scores in technology application. This gap between technology skills and knowledge gained in learning during teacher training and the application of the skills in real-life classrooms has been extensively noted in the literature (Aktaş and Özmen 2020; Ottenbreit-Leftwich et al. 2010) and needs to be addressed with vigor. Frederick et al. (2006) point out that the classroom is an environment with its own complex mix of factors such as management of learner behavior and other competing responsibilities which may cumulatively tempt a teacher to abandon newly acquired technology skills for the tried and tested traditional teaching. As such, assessment for technology skills also requires training the teachers' mindset to be able to apply technology in their classrooms, even when the circumstances are not favorable.

4.4.4 Students' Evaluation of the Assessments

4.4.4.1 Perceptions of the assessments

The students reported that the assessment they liked the most was the development of a lesson plan because they found it easier to do. This was corroborated by their good performance on this assignment. On the other hand, they found the development of digital tools to use as instructional resources difficult, because it was their first time doing this. However, regarding usefulness, they considered the Final Project as the most effective, as it allowed them to apply the various skills obtained during the course and helped them to identify their weaknesses, as demonstrated by the following quotes:

> …Final Project. It included almost all topics I was taught. The assessment gave me the opportunity to develop and test my ICT Skills I learned in the course.

> …Final project. I had to incorporate different concepts which were interesting to do.

According to Aldonio and Andrijani (2008), students' perceptions of the various elements of their learning are very important, because negative perceptions about certain components lead to failure to perform well in those areas. In the case of assessments, establishing students' perceptions about the various assessment pieces provided essential feedback in the design of future assessments to capitalize on approaches that resonate well with students of this caliber and generally identify areas that need to be improved.

4.4.4.2 Technology Use in conducting assessment

Participants indicated that they initially feared the idea of having to use technology to prepare and submit assessments, since their technology skills were low.

However, with practice, they ended up being comfortable with this mode and even like it because it helped improve their digital skills further, as shown by the following quote: "Using technology for assignments was excellent, appropriate and quick." However, some students had misgivings about digital assessments, as they believed that some of their colleagues were using the platforms to cheat: "I feel some colleagues might have taken advantage of virtual testing by copying or not using their own knowledge as some struggled with basic computer skills."

The students' feedback indicated that the participants embraced the use of technology in learning and assessments by the end of the course. Consistent with other research, this study showed that older teachers generally fear technology (Raman and Yamat 2014; Winter et al. 2021), but when forced into situations where they have no choice but to use it, they get used to it and find that it is not as difficult as they have imagined. The general attitude toward technology by the end of the course was very positive, which gives hope for extensive use beyond training.

4.5 Conclusions and Implications

This study showed that assessment plays a critical role in helping develop teachers' competencies in using technology for teaching. Preparing teachers to use technology should be a comprehensive process that involves the development of an appropriate set of skills needed for effective technology-based delivery. The analysis of students' performances in the assessment pieces through the TPACK framework assisted in identifying gaps in the development of skills during and at the end of the course, thus assisting to direct appropriate re-mediation and issues to consider for professional development.

The assessments demonstrated that participants in this study, being long-serving teachers, were skilled in traditional aspects of teaching, such as teacher-centered lesson delivery, but needed more help with technology-related skills. This study also showed that certain skills were assessed more than once throughout the course to check how much students had attained them. This process proved to be useful because it revealed the inconsistencies in skill attainment by the participants, particularly when students demonstrated mastery of skill in one element, then later showed a struggle with the same component in a different assignment. This indicated fragility in possession of such skills. Therefore, more effort needs to be put into cementing such competencies among students.

Moreover, the application of acquired skills in the real world remains uncertain. The reported inadequacy of resources in the schools where the teachers work is a cause for concern, because for the teachers to apply said skills more and improve their confidence, they need to practice in their classrooms. Hence, there is an urgent need to provide digital resources in schools. It is recommended that some form of assessment be continued on the teachers beyond the training to check whether they sustain technology use in their work.

Compliance with Ethical Standards The first author of this article was the instructor of the course used for the study.

Permission was sought from the University of Botswana Office of Research and Ethics, since the data used for the study were the property of the university and the participants were students in the university. Also, informed consent was obtained from the students to participate in the study.

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Part II
Experience Sharing

Chapter 5
Transitioning from Emergency Remote Teaching to Virtual Learning: Experiences with Digital and Innovative Pedagogies and Competencies in Teacher Education in a University Setting

Overson Shumba, Leonard Nkhata, Alex Simpande, and Chewe Fwalo

Abstract The outbreak of the novel coronavirus disease (COVID-19) created a new landscape in teacher education. Initially, emergency remote teaching was adopted, and within the course of a year, there was a transition to virtual learning. This chapter discusses the experiences of adopting emergency remote teaching and the transition to virtual learning in the context of a teacher education programme at the Copperbelt University, Zambia. Anecdotal evidence and results from a mini survey of narratives of lecturers and students are provided which profile the views on competencies needed for virtual learning. The chapter further reflects upon the existing curriculum and how it may be innovatively adapted to meet the new learning environments. Major shifts needed to capacitate teacher educators, teachers and learners with digital competencies and self-directed learning are proposed. The chapter adds to the discourse on digital and innovative pedagogies and efforts to prepare mathematics and science teachers for teaching and learning in the digital age in Southern Africa.

Keywords Competencies · Emergency remote teaching · Pedagogy · Teacher education · Virtual learning

5.1 Introduction

In his book *Future Shock*, futurist Alvin Toffler (1970) describes "the shattering stress and disorientation that we induce in individuals by subjecting them to too much change in too short a time". The COVID-19 pandemic has led to the abrupt closure of schools, colleges and universities and the sudden adoption of emergency remote teaching (ERT). The adoption of ERT has created bewilderment on the part of some students and lecturers. This was the case in Zambia starting in mid-March

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2020 when the first COVID-19 infected person was reported, leading to the closure of schools, colleges and universities and the cancellation of face-to-face classes.

Various ERT approaches were adopted, but due to several factors, these may not have been as effective as when online learning is well planned and implemented. In addition to inadequacy of infrastructure, students and staff needed time to get to terms with the disruption caused by the pandemic and to adapt to the realities of learning at a distance, mostly alone, and in self-directed ways. Many students and staff had inadequate ability in the use of video-conferencing tools, and the course materials were not designed for online learning. There was simply no time for careful planning and design needed for high-quality online learning. ERT is thus a fair description of the status. Hodges et al. (2020) explain it as follows:

> ... emergency remote teaching (ERT) is a temporary shift of instructional delivery to an alternate delivery mode due to crisis circumstances. It involves the use of fully remote teaching solutions for instruction or education that would otherwise be delivered face-to-face or as blended or hybrid courses and that will return to that format once the crisis or emergency has abated. The primary objective in these circumstances is not to re-create a robust educational ecosystem but rather to provide temporary access to instruction and instructional supports in a manner that is quick to set up and is reliably available during an emergency or crisis (https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning).

In this chapter, the authors evaluate the impact of the pandemic on staff and students and on teaching and the attainment of knowledge and teaching competencies via ERT and virtual learning and assessment modes. It is conjectured that the COVID-19 pandemic and ERT have helped education and training systems to leapfrog towards education of the future. The Ministry of Higher Education in Zambia envisions this future as follows:

> The future of learning away from the distant walls of a classroom, the future of giving equal access to training opportunities to everyone regardless of their financial status or where they live in Zambia, and the future of equipping trainers with requisite resources—the Internet, learning management systems, computers, and power backup systems—for a cost-effective and efficient delivery of e-learning. (Phiri 2020)

Considering this, the authors reflect upon the existing curriculum and how it may be innovatively adapted to meet the new learning environments and learner profiles. Proposals are made as regards some major shifts needed to capacitate teacher educators, teachers and learners with digital competencies and self-directed learning, information processing, creating and packing content, and online assessment, feedback and feedforward.

5.2 Methodology

This chapter is based largely on an analysis of and reflections on the authors' experiences and observations in the course of working in a teacher education university department at the Copperbelt University, Zambia. Informal meetings, interviews and

a mini survey of lecturers and student teachers were conducted to gauge experiences and perceptions. These sources serve to provide some anecdotal evidence upon which this chapter reflects. This chapter complements this with a desk review in which the authors find some complementing experiences associated with the COVID-19 pandemic and the impact it is having on education systems. For example, some university teachers have been reported to be thriving, while others have been "surviving" in the context of ERT for which they were not prepared (Moorhouse and Kohnke 2021). By sharing the experiences in a Zambian context, the chapter adds to the understanding of both the impact and opportunities created by the pandemic. The issues surrounding ERT are a subject of many recent publications (Anthony Jnr and Noel 2021; Valsaraj et al. 2021; Whittle et al. 2020).

5.3 Experiences with ERT and Virtual Learning in Teacher Education

Fitzpatrick (2012) defines e-learning as "anything delivered, enabled, or mediated by electronic technology for explicit purpose of learning". Haythornwaite (2002) identifies three important factors for "building and sustaining e-learning communities", namely: content-related communication; planning of tasks; and social support. Guri-Rosenblit (2018) argues that, in implementing digital technologies in higher education, a lot of emphasis must be on student learning and not on professors' teaching. Effective distance and e-learning require that experiences be properly planned and structured. Glazier and Harris (2021) caution us concerning the loss of personal relationships and the lack of instructor presence resulting from the transactional distance created in virtual learning settings. Fiock et al. (2021) stress the importance of teaching presence that they identify with three elements: facilitation of discourse; direct instruction; and instructional design and organization. These issues take on a higher magnitude of importance in the context of ERT, where learning environments are rapidly developed to provide temporary instructional support (Whittle et al. 2020). The chapter thus tries to share some of the experiences of how ERT was undertaken and the digital and psychosocial experiences of both student teachers and lecturers.

5.3.1 COVID-19 Closure and Readiness for ERT

During the period March 2020 to April 2021, the Copperbelt University undertook many initiatives that saw Senate formally adopt the dual mode of learning and assessment as standard practice. A couple of weeks after the closure in March 2020, the Centre for Academic Development, the Directorate of Information and Communication Technology (DICT) and the School of Information and Communication Technology (SICT) collaborated to introduce Zoom video-conferencing to staff. This was

demonstrated virtually, and lecturers were encouraged to use this platform and other media such as WhatsApp. Students essentially learnt on their own how to access and use this platform. Later, a link of the learning management system (LMS) was provided to students on their portals. Thereafter, DICT adapted the Moodle platform accessibility on the LMS.

In this emergency situation the pandemic created, there was no time to ascertain full competencies for use of these platforms by staff and students or to effectively plan and design materials for online delivery. Everyone was to learn on the go. This is particularly an issue for teacher education institutions where students must learn remotely while simultaneously be prepared to teach learners in the school system, also remotely. This is a challenge the teacher education programme faces. Therefore, this necessitated to share some of the experiences and introspect on the future in which remote learning is part of the new normal.

5.3.2 COVID-19, the Teacher Education Context and the Learning Crisis

The teacher education programme at the Copperbelt University is relatively small. It is run by the Department of Mathematics and Science Education that sits in the School of Mathematics and Natural Sciences. It has a total of 263 students in its four undergraduate programmes and comprises 65 females and 198 males. The four programmes are Bachelor of Science to prepare teachers who will teach natural science subjects in secondary schools, i.e., biology, chemistry, mathematics, and physics. In spite of its size, it is a programme of considerable national and regional importance. It prepares graduate teachers for mathematics and natural science subjects in secondary schools and provides opportunities for them to undertake graduate studies. Given its importance for STEM education, a mini survey of education students and lecturers was conducted to get a sense of their experiences.

First, it was clear that the pandemic was a serious emergency, and it had created a learning crisis. The experiences of the four authors in their interactions with other staff and students were pooled for reflection. A snap survey and informal interviews also helped to understand the situation. In this anecdotal evidence collected, the majority of students and lecturers expressed negative sentiments, and 25 of these responses are captured in Table 5.1. In the table, only six statements (roughly 25%) had positive experiences. Noteworthy among positive statements are those associated with popularized benefits of e-learning: “It has helped me to know to work independent”, and “[i]t is exciting as I can teach and learn from the comfort of my home or office at any time”.

The bulk of the stated experiences were sufficient to cause for concern. Inadequate ICT infrastructure, poor internet connectivity, and lack of access devices and data bundles were the major issues raised. These are the main reasons for the negative assessment of experiences with online learning and not the online learning itself.

Table 5.1 Extract from 25 responses on experiences with adoption of online learning

1. What are your experiences [as lecturer/student] with the adoption of online learning starting from the period in March 2020 when COVID-19 was declared a pandemic? (25 verbatim responses)
As a student with the adoption of online learning as became difficult and challenging us students in terms of money for bundles and poor network
The learning process isn't entirely satisfactory, there are some courses that need face to face Interaction with lectures and having to learn these courses online has been a bit of a challenge
The experience has been pathetic due to the fact that online learning is a failed way of conducting lessons
Really bad, as schools or students are not yet fully adapted to the process
Very sustainable
As student it's not as effective because actual online lessons are not carried out
It's quiet challenging
It's a little bit challenging due to poor network
It has been difficult with network connection, sound failure, sometimes missing classes due to lack of bundles
It's been a fair experience. As long as the internet was stable I've had no challenges
It has okay though the zeal to study and understand hasn't been there because of 2 weeks online and 2 weeks physical so this has been disturbing us …more especially myself
My experience has not been so good overall ever since online learning was adopted. I believe it can be improved (i.e. made more effective)
It has been difficult to cope with the learning
Bad experience. I have had to learn new things
Very few students attend an online lecture
Learning became a challenge
It is exciting as I can teach and learn from the comfort of my home or office at any time
I have seen the side effects to online learning. I attend lessons wherever I'm through online, no specific place I can be
The online e learning it cause poor performance due of unstableness network or bad network system we are using
It's difficult learning online
It has helped me learn how to work independent
It is helpful but not as comparing with physical learning. Because online learning requires money
It is very slow especially when too many people are using it
Virtual learning is helpful but not as comparing with physical learning. Because it requires money
1. Internet connection problems. 2. Lack of enough bundles for students
It's as being very bad with me due to poor network.

Two lecturers submitted that "intermittent internet connectivity has been a challenge" and "not all students are able to logon due to lack of bundles or poor network". In the initial stages of the implementation of online learning, one lecturer lamented that, "I faced challenges because it was not anticipated before the pandemic…I did not receive pedagogical training in virtual learning". When asked about their competence in teaching and assessing online, three said they were competent, while one indicated that it depended on assessment. The last said, "I am not that competent to even teach online". The use of the CBU Opus or Moodle platform showed that four of the lecturers used Opus but not Moodle, while one indicated that they used neither Opus nor Moodle.

5.3.3 Pedagogical Adaptation and Self-Directed Learning

As part of the mini survey, lecturers and students were asked to assess their own technical capabilities to teach and learn online. Five lecturers indicated that online learning had created anxiety and they were not feeling pedagogically capable to continue with online learning. A significant number of students indicated that they needed the lecturer for them to learn; were not competent to continue with online learning; and even found it disruptive to their learning. Responses from the students in the mini survey are indicative of this when asked to rate the statements. Table 5.2 shows responses on the two extremes (*1 = not like me at all and 5 = very much like me).*

Digital competencies, information processing and self-directed learning are key for effective online learning, and among the students sampled, these were problematic areas. As seen above, only four (17.4%) found a statement like "I learn a lot on the course material on my own" as a fitting description to themselves. It is assumed that due to the proliferation of diverse sources of information, students get lost in the sea of data. This makes information processing a needed competency. During interactions with the students, many of them expressed a lack of confidence to access and use the e-resources platform of the university library.

The advent of online learning has placed immense demands on learners' ability to manage themselves in the learning process. Self-direction and self-management are critical in the situation of ERT and in online learning (Lasfeto 2020). The evidence considered above indicates the need to prepare student teachers for self-directed learning because little learning takes place when they do work alone.

At the start of and during ERT, lecturers in the teacher education programme used WhatsApp to keep in touch with their students and to share course materials and notes. Students in the teacher education programme used WhatsApp in

Table 5.2 Self-rating of students on items describing their competencies ($n = 26$)

	Not like me at all	Very much like me
1. I need my lecturer to be available for me to learn	2 (8.7%)	13 (56.5%) (−)
2. I plan and balance use of my time	4 (17.4%)	10 (43.5%) (+)
3. I teach myself ICT skills by exploring on my own	2 (8.7%)	8 (34.8%) (+)
4. I plan my own learning schedule	5 (21.7%)	8 (34.8%) (+)
5. I am competent enough to continue with online learning	10 (43.5%)	1 (4.3%) (−)
6. I plan and follow my own timetable	2 (8.7%)	7 (30.4%) (+)
7. I rely on the timetable of my class to learn	3 (13.0%)	6 (26.1%) (−)
8. I search and find learning material beyond the course reading list	5 (21.7%)	7 (30.4%) (+)
9. I learn a lot on the course material on my own	5 (21.7%)	4 (17.4%) (+)
10. I find online learning disruptive to my learning	5 (21.7%)	10 (43.5%) (−)

Table 5.3 Responses to the survey

What is working		What is not working	
Audio notes and text notes	80	Discussions	30
Discussion and interaction	4	Too many messages	33
No response	5	Feedback from lecturer not good	24
		Too much pressure	4
		Connection problem	4
		Information overload	3
		Bundles	5
		Moving too fast with teaching	5
		Nothing to say	2
		Taking down notes from audio	
		Scared of lecturer	2
		Suggestion to use zoom	2
		Website (needs update)	3

different ways (Shumba and Simpande 2021). WhatsApp can be an important part of e-learning, with a significant positive impact on learning achievement (Amry 2014; Sayan 2016). One of the authors (Simpande) explored the efficacy of this platform in learning the communication skills course, which is required by all first-year students at the university, regardless of major. At the end of the teaching and learning period, he administered a two-item survey to students ($n = 92$) to indicate what worked and what did not work when using WhatsApp. Results are presented in Table 5.3. During the period, the structure of a face-to-face class was adopted. This included (1) introduction and development delivered via recorded voice notes; (2) a "live" discussion through texting; (3) an exercise to follow up on pre-recorded material and discussion; (4) and finally, taking attendance register. The WhatsApp sessions followed the 2-hour time allocated on the university official calendar for the course.

Most students identified audio and text notes as the form of delivery that worked for them. What is evident is that what was not working for them was not the platform itself, but rather the way it was used pedagogically. For example, they identified discussions and feedback by the lecturer, too much pressure and too many messages as the problem areas.

This case highlights difficulties in the transition from ERT to virtual learning. Based on this case alone, three critical areas emerged in the teacher training programme at the Copperbelt University that need more attention. The three issues first-year students are: self-directed learning; information processing; and virtual teaching and learning competencies.

5.3.4 Psychosocial Support and Preparedness

Psychosocial factors impact on e-learning (Penman and Ellis 2012). Therefore, academic and psychosocial unpreparedness for virtual learning experiences is a concern that was found for both lecturers and students in the teacher education programme. In our context, most were not psychologically prepared for the new pedagogical ways. One student (Table 5.1) reflected on the change as follows: "Bad experience. I have had to learn new things". Another stated that, "[t]he experience has been pathetic due to the fact that online learning is a failed way of conducting lessons". These experiences tend to be associated with the problems of access and inability to pay for data services. Part of the problem is linked to inadequate adaptation of materials and pedagogy for online delivery by lecturers (exemplified in Table 5.2). In addition, it is evident that ineffective communication was also a common problem. For example, some lecturers sent handouts without directly meeting students in online classrooms. In other countries, it was found that many lecturers were oblivious to the fact that students were experiencing complicated emotions like frustration, anger, resentment and anxiety in the process of adjusting to virtual learning, were isolated from their friends and faced financial cost implications (Sundarasen et al. 2020).

The academic and psychosocial support was inadequate for both students and lecturers to adapt for virtual learning. A few weeks after the COVID-19-induced closure, lecturers were introduced to video-conferencing platforms to prepare them for remote teaching and learning. This was done virtually, but the orientation did not achieve 100% reach, especially as some were not confident with the use of technologies such as Zoom. No structured training was provided to students who had already vacated campus. Given the nature of the pandemic, some staff and students would have needed psychosocial support, and the challenge was to provide this support virtually. In the COVID-19 emergency, "virtual students" needed this support, and virtual psychosocial counselling (Dimri 2021) was feasible. Three informal interviews with lecturers in the department revealed anxieties concerning their well-being because of the possibility of them being infected. The introduction of ERT made them feel overwhelmed and unprepared pedagogically. Their ICT skills were initially poor, resulting in them experiencing fear, anxiety and frustration. The mere fact that they were isolated from others meant that they could not easily consult with their colleagues. How they coped can be illustrated by three lecturers—X (non-adopter), Y (frustrated adopter) and Z (successful adopter)—interviewed by one of the authors (Nkhata) at the Copperbelt University.

Participant X opted to continue meeting the students physically, stating, "[w]hen the university was closed, I resorted to sending them notes", and "I have not had any virtual lectures with students because I have limited ICT skills competencies". Participant Y complied with the university directive not to meet students physically but met students once or twice virtually. He later stopped due to "the fewer numbers of students attending these zoom lessons. For example, only 20 out of 100 students attended the virtual classrooms". Participant Y also stated that "home was not a

conducive environment for teaching due to disturbances from family members especially children". In addition, the banning of social gatherings meant that as lecturers operated from home, they used their personal resources to pay for internet services to conduct virtual lessons, which proved expensive. Participant Z indicated he initially sent notes to the students through WhatsApp during ERT. The participant quickly and successfully transitioned to virtual learning. The participant used the Google Meet and Moodle platforms for teaching and assessing students. The participant had no psychological and social challenges in utilizing ICT platforms. According to this participant, "I use Google Meet, and more than 50% (80 of 150) students attended my lectures".

5.3.5 Developing Knowledge and Competencies for Teaching

In our context, the requirement for lecturers to have a teaching methodology qualification is somewhat new. Most expected that face-to-face ways of the teaching and learning process could be simply replicated in online environments without fundamental changes. Whilst some orientation workshops for virtual learning were conducted for lecturers, the lack of teaching methodology for some of them introduced an impediment in their transit to ERT and virtual learning. The lack of training in teaching methodology could have impacted their attitude and adaptation to virtual pedagogies. Bozkurt and Sharma (2020) emphasize the need to become conversant and upskilled in virtual pedagogies. Face-to-face pedagogies cannot simplistically be replicated into digital forms where students can learn unsupported by their lecturers and/or independently. More structured support and pedagogical training workshops are needed to ensure proper adoption of online learning.

5.3.6 Frustration with Teaching Practice and Research Projects

Teacher education institutions traditionally incorporate teaching practice (school-based practicum) in their training programmes (Sasaki et al. 2020), and this aspect has faced challenges in the era of COVID-19 (Kadir and Azizi 2021; Moyo 2020). This is the case with the teacher education programme at the Copperbelt University. One intake did not report to assigned schools because they had closed. The other intake had its practicum terminated 5 weeks into the term of 14 weeks due to closure. This has been an area of frustration for staff and students who were due for this mandatory aspect of their education and training when COVID-19 led to the closure of schools and the university. According to Sasaki et al. (2020), COVID-19 has led to teacher education institutions failing to meet teaching practice requirements. Transitioning to a virtual practicum had never been thought of, and its acceptability with the

Teaching Council of Zambia remains unexplored. Consideration is being given to a pilot initiative in which students would teach online and be observed virtually. It proposes to adopt one of the secondary schools as a demonstration centre in which virtual classes with students can be conducted. In their school-based projects, students have largely focussed on experimenting with various face-to-face approaches to teaching and learning, indicating that action research is well embraced. However, innovative action research projects are needed that would exploit the many ICTs and their integration for virtual learning and learning management. What may be a challenge presently is that virtual platforms like Google Forms, WhatsApp, Moodle and Opus LMS have not been fully mainstreamed. Anecdotal evidence suggests that most of our students and lecturers do not have sufficient confidence and competencies to fully utilize these tools.

5.4 Discussion: Teacher Education in the Digital Age

The above sections have highlighted many experiences of the adoption of ERT, the transition to online learning, and the preparedness for and perceptions of the psychosocial impacts. Those experiences have also shown that lack of self-direction and digital skills and competencies impacted on perceptions that lecturers and student teachers expressed regarding ERT and e-learning. In our context, this could affect the transition to becoming a dual-mode University, blending face-to-face and online learning. The teacher education training programme at the University is progressively moving forward to keep pace with this transition. As this happens, observations from the experiences indicate the need for:

(i) enhanced ICT infrastructure, connectivity and remote access;
(ii) capacity building in pedagogy generally and in online and blended learning;
(iii) building capacity for ongoing attainment of digital competencies; and
(iv) capacity building for self-directed learning.

It is important for the teacher education programme to re-envision its strategies and curriculum. The main drivers it must take advantage of include the following:

(a) the national policy context of teacher professional standards (Ministry of General Education (MoGE) 2019) and the education curriculum framework (MoGE 2013);
(b) the availability of an ICT competency framework for teachers (UNESCO 2018);
(c) the emergency of digital learning taxonomies (Churches 2009); and
(d) the reflexive appreciation of models of teachers' technological pedagogical and content knowledge (Mishra and Koehler 2006).

The professional standards for teachers in Zambia make reference to the use of ICT. For example, the standards stipulate the development and use of "relevant, sustainable and innovative teaching and learning materials including ICT". One of

the indicators specifies "use a wide variety of pedagogical strategies (e.g., ICT, social media, and local materials, innovative and creative approaches)" (MoGE 2019). This makes acquaintance with technical and pedagogical aspects of ICTs relevant aspects for teacher development. As noted in other educational contexts, the pervasiveness of ICTs in everyday life leads to a situation where learners may be coming to school more literate than some of their teachers (Labbas and Shaban 2013).

In the context provided in this chapter, some colleagues referred to themselves as "BBCs", meaning *born before computers*, thus lacking confidence in their use of ICTs. In such a situation, it would be unrealistic to expect that the teacher role of becoming innovative facilitators of learning enabled by ICTs would be achieved easily in the COVID-19 period. It is thus necessary to reconsider pedagogy and content of teacher education programmes. This is necessary because, in primary and secondary schools, information and communication skills represent an important category of "key competencies" in the revised education curriculum framework in Zambia (MoGE 2013). Labbas and Shaban (2013) emphasize that the way students think and the way they communicate, share, exchange, create and game in a digitalized world is now different. For example, students use e-mail, texting, or chats to communicate, with less need for face-to-face interaction. They create and share information on blogs, wikis, webcams and camera phones, and engage more frequently in peer-to-peer exchanges (Labbas and Shaban 2013).

These changes in the way students think and do things reflect new opportunities that teacher education ought to embrace. McGarr and McDonagh (2019) highlight two challenges for the teaching profession: (i) the need for teachers to be proficient in using ICTs for professional tasks; and (ii) fostering productive and relevant use of ICTs among their pupils. They need both technical and pedagogical skills for which teacher education must now prepare them.

Above, it was noted that the professional standards for teachers in Zambia include the use of ICTs and social media for teaching and learning (MoGE 2019) and that ICT skills reflect a major category of learner competencies in the revised school curriculum framework (MoGE 2013). As the education system settles into the adoption of dual-delivery modes, teacher education institutions need to interrogate the complex subject of "professional digital competence" to define or select appropriate models for their attainment. McGarr and McDonagh (2019) provide a useful review of some of the models of digital competencies in teacher education.

The UNESCO ICT competency framework for teachers, Version 3 (UNESCO 2018), is particularly valuable in our context. It assumes that teachers must have competencies in the use ICT to be able to deliver quality education. They need this to be able to guide their students to learn how to learn in digital environments. The framework organizes the 18 competencies it proposes into a 6×3 matrix of aspects of teachers' professional practice and three levels of teachers' development in making pedagogical use of ICT. The six aspects of a teacher's professional practice are understanding ICT in education policy; curriculum and assessment; pedagogy; application of digital skills; organization and administration; and teacher professional learning. The three levels of teachers' development in pedagogical use of ICT entail basic ICT competencies; knowledge deepening; and knowledge creation. They must

have competency in learning environments where students can work collaboratively using ICTs. Teachers ought to have competencies to design and set up learning environments in which their students can create new knowledge. Eighteen digital competencies are associated with each aspect of professional practice and the corresponding level of teacher development in the UNESCO (2018) model. For example, at the level of knowledge acquisition, teachers can articulate how their classroom practices reflect what is guided by policies at institutional and/or national levels. At the level of knowledge deepening, they acquire competences to design classroom environments that, for example, integrate ICT in teaching, learning and assessment activities. At the level of knowledge creation, they can support self-directed learning among students.

Overall, the UNESCO ICT CFT Version 3 envisions the need for engaging teachers and their students in activities that yield higher-order learning outcomes. For this focus on higher-order learning, it is instructive to adopt taxonomies of learning that would guide and facilitate learning with digital tools. An example is Churches' (2009 model. It adapts the revised Bloom's taxonomy of Anderson et al. (2001) (Krathwohl 2002) to create the "Bloom's digital taxonomy". In Churches' model of the digital taxonomy, "the learning process can be initiated at any point" or level in the taxonomy, and collaboration enabled by digital tools can have considerable impact on learning at each level. In the taxonomy, a range of learning outcomes that are not used by educators and their students to engage are clearly visible. For example, there is a need to make the possibility of collaborating, negotiating, debating and other higher levels of communication real as students engage with learning materials online. This might alleviate the transactional distance (Glazier and Harris 2021) and isolation associated with online learning.

The authors expect that the UNESCO ICT CFT (2018) and Bloom's digital taxonomy (Churches 2009) draw attention to the theory of pedagogical content knowledge (PCK) (Shulman 1987). Shulman stated that PCK entails "an understanding of how particular topics, problems, or issues are organized, presented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (1987, p 8) and the "most useful forms of representation of these ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations-in a word, the ways of representing and formulating the subject that make it comprehensible to others" (p 9). Mishra and Koehler (2006) extend Shulman's PCK to the situation of teachers integrating technology into their pedagogy. They proposed the Technological Pedagogical and Content Knowledge (TPACK) model which may be helpful for teachers to effectively integrate ICTs in teaching. The integration is influenced by the interactions among the three components of teachers' knowledge, i.e., content, pedagogy, and technology (Mishra and Koehler 2006). The development of TPACK by teachers is critical to effective teaching with technology. As they explain:

> TPACK is different from knowledge of all three concepts individually. Instead, TPACK is the basis of effective teaching with technology, requiring an understanding of the representation of concepts using technologies, pedagogical techniques that use technologies in constructive ways to teach content, knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face, knowledge of students'

prior knowledge and theories of epistemology, and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones (Koehler et al. 2013; p. 16).

5.5 Conclusion

This chapter is based on anecdotal experiences. Lecturers and students demonstrate that the transition from remote teaching to online learning poses problems that need to be tackled at institutional and personal levels. Particularly needed are the aspects of connectivity and capacity building and psychosocial support for self-direction in blended learning environments threatened by COVID-19 and other emergencies. Despite the positive responses to ICT skills and personal competencies, it is evident that there are gaps in the curriculum and the competencies and learning outcomes pursued. Self-directed learning and information processing are some of the areas that need heightened attention. Some of the developments and frameworks highlighted in this chapter must be interrogated in the process of re-visioning the department's teacher education programme. Future research needs to explore how educators and students in teacher education programmes have settled in blending e-learning and in-person methods as part of the new normal. Such research must explore competencies, self-direction and psychosocial statuses.

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Chapter 6
Teacher Development in the Digital Era: Experiences from a Zimbabwean Odel Institution

Moffat C. Tarusikirwa

Abstract Advancement in communication technology has brought about many changes in the field of teacher development, such as the need to infuse the many technology-related skills required by today's teachers in teacher training content. Ertmer and Ottenbreit-Leftwich (2010) identify several such skills and knowledge required. In their view, teachers should be enabled to handle technological tools for use in their teaching. They need to practise microteaching using ICT-based teaching methods. New teachers should be digital natives as opposed to digital migrants in order to cope with the new approach to teaching and learning. At the Zimbabwe Open University (ZOU), there has been a transition from face-to-face tutorials to online tutorials, with the University shifting from Open and Distance Learning (ODL) to Open and Distance e-Learning (ODeL) so as to keep with the trends in instruction delivery from a regional and international perspective as well as in pursuit of finding cheaper and innovative ways to deliver student instruction. With this shift came a number of successes and challenges that were worsened by the emergence of the COVID-19 pandemic. This study sought to understand the experiences of academics at ZOU regarding teacher development at diploma, undergraduate and postgraduate level in the age of ICT-based teaching and learning technologies. A qualitative research methodology, triangulated with aspects of quantitative research methodology, was used. A case study research design was employed. Purposive sampling and interpretive content analysis were used to generate and analyse the data. The study revealed several challenges, namely, issues of an ICT skills gap among both staff and students, access to ICT gadgets, internet infrastructure, and data bundles that needed to be solved. It is recommended that a number of ICT-based teacher development models be developed that could be used in the digital era.

Keywords Teacher development · Digital era · Open distance learning · ODel Institution · Zimbabwe

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6.1 Introduction

This chapter focuses on the delivery of effective teacher development programmes in an Open and Distance e-Learning (ODeL) Institution in Southern Africa. The issues of successes and challenges to learning and tutoring, the impact of ICT (Information Communication Technology) on delivery and, recently, the effect of the COVID-19 pandemic on teacher development, are covered in this chapter. Moreover, this chapter recommends a way forward with respect to the use of digital technologies for teacher development.

6.2 Background to the Study

6.2.1 Higher Education in Colonial Zimbabwe

In colonial Rhodesia, the school system was divided into primary and secondary levels. The primary (and what came to be termed the public) school sector was established for settler children, while education to the local population was provided by missionaries (Gaidzanwa 2007; Martin and Johnson 1981; Maunde 2003; Tarusikirwa 2016). The secondary sector mostly comprised of schools for settler children. Missionary schools provided the only "A"-level education for locals in the country. Due to high competition for the few available places, very few locals managed to enter those schools. As regards gender, girls were heavily affected. In short, inadequate provision, traditional sexist attitudes, customary law and poverty combined to place enormous constraints on black girls' access to education (Gordon 1994). In terms of Open and Distance Learning (ODL), UNISA and a few local correspondence colleges offered the service.

Well into the twentieth century, the higher education system comprised of two elements, namely, technical and teacher training college sectors in Zimbabwe. Teacher training took place in one college, Gweru Teachers' College, established in 1947. This was a full-time teacher training college. It is noted that, during this period, there was no university presence. For those students seeking university education, South Africa and the United Kingdom of Great Britain were destination points (Gaidzanwa 2007; Maunde 2003; Tarusikirwa 2016).

6.2.2 Higher Education: Newly Established University Sector

Between 1950 and 1980, there was a slight expansion of the public higher education system that now includes universities. During this period, the first university college in Zimbabwe—The University College of Rhodesia and Nyasaland—was established, whose foundation had been laid in 1945 (see Maunde 2003).

The University of Rhodesia was established in 1952 by a Royal Charter of the British government, first as a college, and then assuming university status three years later. The overall purpose of the university at that point was to train African elites as well as to contribute to the development of the country (see Gaidzanwa 2007). At the end of this period, the higher education system was made up of three colleges and one university. The size of the higher education sector was small, as it comprised only four institutions. There was no ODL presence in the country for teacher development.

6.2.3 *Higher Education: Expansion of the University System, and the Birth of ODL*

As outlined earlier, the higher education system in the previous period was marked by a slow expansion, as one university was added to the three colleges (two polytechnics and a teacher training college). By contrast, in the post-independence period, more rapid growth of the system included the establishment of six new public and five private universities, bringing the total number of institutions after independence to 15. Among the new public universities that were established during this period were the National University of Science and Technology in 1991, Great Zimbabwe University in 1994, Chinhoyi University College of Science and Technology in 1994, Zimbabwe Open University in 1996 (an ODL institution), Bindura University of Science Education in 1996, and Midlands State University in 2000. The private sector universities established during this period included Solusi University in 1984, Africa University in 1992, Arrupe College in 1997, Catholic University in 1999, and the Women's University in Africa in 2002 (Maunde 2003).

As part of this overall expansion, the University College of Rhodesia and Nyasaland had further grown both physically as well as in terms of overall enrolments. For example, at the end of the previous period, the enrolment figure of 188 escalated to approximately 10000 in just under a quarter century (Zvobgo 1985). This was the reason for the birthing of new university campuses, including ZOU, an ODL institution. The demand for ODL education had started to be felt and demanded by the working public.

6.2.4 *The Zimbabwe Open University*

Another public sector university—the subject of this study—is ZOU. A Distance and Open Learning Institution in Zimbabwe spread across the country's 10 provinces was established in the same time frame. It is important to mention that ZOU has shifted from being a Distance and Open Learning Institution to an Open and Distance e-Learning Institution (ODeL). This process is currently ongoing. ZOU had its roots in the University of Zimbabwe, having started in 1993, as the Centre for Distance

Education. In 1996, the Centre for Distance Education became a University College of Distance Education, which became the Zimbabwe Open University through the Act of Parliament of 1999. ZOU's overall aims were to empower people through affordable lifelong learning while they were involved in developmental endeavours. As a public sector university, ZOU had a similar governance structure to that of the University of Zimbabwe with the President of Zimbabwe as Chancellor. It started with three faculties but has since grown to seven faculties, namely: Agriculture; Arts and Humanities; Education; Commerce; Law; ICT; and Science.

During this period, the number of students grew rapidly in enrolment terms, from 14 313 in 1999 to 23 161 in 2001, and by 2005, ZOU was the largest university in Zimbabwe, with a student population of over 20 000, putting pressure on the government to provide more universities. ZOU enrolled adult part-time learners who were all non-residents.

ZOU followed the American semester-based education system, with courses that were designed to be covered in modules per semester. The curriculum consisted of educational management courses, such as Bachelor of Education (BEd) Management, and Master of Education (MEd) Management degrees; commercial degrees, such as Bachelor of Commerce (B.Com), Master of Business Administration (MBA); and science degrees, such as BSc Mathematics (Maunde 2003). At its inception, the award of degrees was done by the University of Zimbabwe; however, ZOU became a fully-fledged university awarding its own degrees in 1999.

The ODL model used by the Zimbabwe of University worked well but started to be affected by ever-rising costs due to the hyper inflationary economic system that befell the country from the late 1990s to the present times. The hardcopy print module became expensive to produce in the face of large student numbers and rising production costs of materials and printing. Part-time lecturer and tutorial venue hires became expensive. The institution needed to find cheaper and alternative ways of offering the educational service. One such way was to shift from ODL to ODeL. With ODeL, it was possible to offer lessons in a cheaper and affordable way, hence, the institution commenced a transition from ODL to ODeL, starting with the introduction of an online learning platform MyVista. ZOU is now well on its way to the ODeL mode of lesson delivery, including for teacher development.

This study set out to explore the experiences of academic staff at ZOU with respect to the following issues: successes achieved to date; challenges to learning and tutoring with regard to access to technological equipment and internet facilities; skills, if any, which are required to be developed in both academics and students; challenges of access to teaching and learning materials; the impact of ICT on tutorial/lesson delivery at ZOU; the impact of COVID-19 on lesson delivery and student learning at ZOU; the effect of the COVID-19 pandemic on teacher development with respect to lesson delivery, assignment writing and feedback, examination writing, teaching practice supervision, research project supervision, among others; and recommended teacher development models that can be developed for use by the Department of Teacher Development to supervise students on teaching practice (TP).

6.3 Research Methodology

This study involved a qualitative research methodology, triangulated with aspects of quantitative research in terms of percentages and figures. The qualitative research methodology was used to explore the situation existing in a Zimbabwean higher education institution (HEI) pertaining to the development of teachers through ODeL in order to interpret successes and challenges, the effect of the COVID-19 pandemic on teacher development and the way forward for teacher development through ODeL. A case study research design was used in this study. A case involving a single ODeL institution was the subject of the study. The study involved 10 regional campuses of the University across Zimbabwe's 10 provinces. The population of the study consisted of all academics in the Department of Teacher Development across the institution's 10 regional campuses. It included both males and females in the Department. As for the data collection instrument, an interview schedule with semi-structured questions was used. The schedule gathered data on gender, title, programmes and level taught, among other aspects. Purposive sampling was used to select the informants from among the academics. A face-to-face semi-structured interview technique through the MS Teams app was used to generate data on the experiences of informants as regards issues of lesson delivery, assignment uploading, assessment and feedback, examination-writing by students, availability of learning resources, TP supervision, research project supervision, the impact of digital technology on learning, accessibility of learning equipment, availability of internet facilities, and the effect of the COVID-19 pandemic on tutorials. Interpretive content analysis was used to analyse the data.

6.4 Findings and Discussion

The table above shows the profile of informants who were academics spread across the institution's 10 regional campuses. As shown in Table 6.1, the informants were a

Table 6.1 Profile of informants by academic programmes and levels taught

Gender	Academic (Professor)	Academic (Senior Lecturer)	Academic programmes and level taught in teacher development	Frequency	Percentage (%)
Male	1	14	PGDE, BED, DIPED	15	75
Female	1	4	PGDE, BED, DIPED	5	25
Total	2	18		20	100

majority of senior lecturers and two professors. More men than women were interviewed due to the staff complement in the university which had a male majority at the time of the study.

6.4.1 Successes Achieved with the Shift from ODL to ODeL

In response to the question on their experiences of successes at the institution, most academics mentioned a number of successes achieved because of the introduction of ODeL in the institution. One of the themes that emerged from the successes achieved due to the digitalization of teaching and learning at ZOU was that of assignment submission online. Most interviewees felt that they had been successful in getting students to submit their assignments online on the institution's online platform MyVista. According to Byrnes et al. (1995), assignments submitted electronically have the advantage of flexibility in submission as well as immediate feedback to the student by the tutor. The move from ODL to ODeL had been driven by a number of factors. One such factor was the time it took for students to submit handwritten assignments at regional campuses which was, at times, very time-consuming for some students. With ODeL came online assignment submission. This was a quicker way to do it. In addition, the marking of assignments was made quicker and easier. Once students submitted them online, the tutors were able to quickly access them online and mark them. That way, students got quick feedback on their assignments. In the views of informants, research projects that, like assignments, were also submitted as hard copies could also be submitted online and marked quickly online. So, both assignments and research project deadlines could be met without problems. Here are some statements from the informants:

- Submitting and marking assignments online was a success.
- Submitting and marking research projects online was a success.
- There was also the increased use of the online platform MyVista.
- The rate of timely assignment submission increased with uploading of assignments online.
- More students were able to meet assignment deadlines with the advent of online submissions as opposed to the hardcopy handing-in system.

A further success involved the use of online tools for workshops, group discussions, meetings and tutorials. The MS Teams App, Zoom, and Google Meet were additionally used for teaching as well as learning purposes. Informants said the following on the developments that digitalization ushered in with respect to the holding of tutorials, meetings, workshops and conferences:

- Successful group discussions and chats were carried out through the formation of WhatsApp groups and MS Teams App with students in various courses and levels of study and between lecturers.

- There was an increased learner and lecturer awareness on the use of Technology in tutoring and being tutored.

Submitting and marking assignments online were a success. Previously at ZOU, before the advent of ODeL, student assignments were submitted at regional campuses as hard copies. This process delayed the marking and feedback processes, as students had to travel to the centre, sometimes for long distances, to hand in assignments for marking. Sometimes, assignment hand-in and marking deadlines were not achieved due to a number of issues—for example, there was a long time lag between hand in of assignments and marking. Now, with online submissions, the marker can immediately mark the submitted assignment, and the student gets feedback. The same goes for research projects, with the exception that these are regarded as examinations; hence, while the marking is immediate, the mark is only released later when examinations results come out. Additionally, it is noted that, as students and academics began to accept and appreciate the ODeL mode of teaching, which was mainly done online, there was an increased use of the ZOU online teaching platform MyVista.

Moreover, informants mentioned that more students started to meet assignment deadlines as opposed to the past. Academics and students were also able to carry out successful group discussions through the various online platforms, for example, MS Teams. Such discussions included students across the various programmes and levels in the Department of Teacher Development. Furthermore, informants revealed that both lecturers and students had begun to become aware of the use of ICT in teaching and learning.

The shift from ODL to ODeL at ZOU did not come easily—some challenges were experienced by both academics and students.

6.4.2 Challenges Experienced with the Shift from ODL to ODeL

Informants mentioned that both academics and students experienced challenges of access to technological equipment. Due to poor salaries and poverty, some academics could not afford to buy computer laptops and/or smartphones for use during tutorials as well as the marking of assignments and research projects. The same issue affected students in the country's peripheries or remote regions. The challenge of the lack of access to ICT equipment was exacerbated by the unavailability of internet facilities in certain remote rural corners of the country. Students in such places could not access internet facilities to attend online lessons and continue with the other aspects of their learning. Internet infrastructure was non-existent. This resonates well with international literature (Bates and Pool 2003; see Brown and Brown 1994). Other challenges that came to the fore involved unavailability of data bundles for both tutors and students. Among the tutors, part-time tutors were the most affected. Another issue that was highlighted by the informants was the effect of the intermitted electricity, load shedding and lack of electricity infrastructure in some parts of the country.

Such a scenario did not augur well for the ODeL mode of teaching and learning, as it adversely affected a section of students and academics. The institution could not afford data bundles for both tutors and students. Moreover, informants mentioned that a number of students and lecturers lacked ICT skills for online teaching and learning (see Bates and Pool 2003). For example, some were not familiar with ICT tools, hence, could not maximize the use of the available e-resources. Another factor that emerged was that of resistance to change by some students and academics. This was shown by their insistence on students to continue to submit hardcopy assignments and research projects for marking.

The arrival of the COVID-19 pandemic was another factor that impacted on the institution's move from ODL to ODeL. The COVID-19 pandemic had a negative impact in so far as it led to the closure of the institution, among others. The shift from ODL to ODeL became the real deal for teaching and learning. The institution had to speed up its plans for digitalization overnight.

The following were some of the challenges mentioned by informants.

Informants raised the challenges to learning and tutoring with regard to access to Technological equipment and internet facilities.

- No data available for most students and all tutors. Part-time tutors are greatly affected by this issue.
- Electronic gadgets not working efficiently.
- In some cases, no gadgets available to facilitate marking and tutoring.
- Students do not have data to connect to Internet from the Institution.
- Internet connectivity is poor in remote rural areas and some students cannot access internet for tutorials. This challenge is exacerbated by lack of electricity in some areas of the country and load shedding by the power utility.
- A number of students are not familiar with technology hence cannot maximize the e-resources available.
- Hardware in the form of [laptops], [desktops] and smartphones is not adequate for our students in the districts centres in the peripheries of the country.
- Have no internet facilities at home for online tutorials via MyVista or Microsoft [T]eams. This challenge was made worse during the COVID-19 lockdown period when people could not go to the office for work.
- No data bundles from the institution to work from home.
- Both Students and lecturers have limited access to connectivity.
- Unavailability or no access to smartphones by students and some lecturers.
- Resistance to change by some academics and students.

The above resonates well with international literature on the effects of COVID-19 on higher education (see UNESCO Report 2020). Due to the current economic situation prevailing in Zimbabwe, most students, and even some lecturers, are poor and cannot afford ICT gadgets. Additionally, internet facilities are hard to come by, particularly in remote rural areas of the country. In Zimbabwe, therefore, academic staff and students are still grappling with the old issues of accessibility to gadgets and ICT communication channels. Consequently, tutoring and marking of assignments and feedback become difficult. Moreover, as alluded to above, informants brought

to the fore the aspect of lack of provision of internet data bundles to students from the institution. As a result, students' access to the online tutorials, among others, was limited to what they could afford with their meagre resources. It is important to mention here that teachers and the students in this Department were poorly paid.

Furthermore, it has been mentioned above by informants that internet connectivity is poor in remote rural areas and some students cannot access internet for tutorials (see Brown and Brown 1994). This challenge is exacerbated by lack of electricity in some areas of the country and load shedding by the power utility. As such, ODeL learners are affected negatively. In addition, informants raised the issue that some learners were not familiar with technology, hence, were not able to access or maximize the use of e-resources placed on the online teaching platform due to an ICT skills deficit among them. Additionally, informants mentioned the aspect of the shortage of hardware such as desktop computers, laptops and smartphones at district centres in the peripheries of the country. Such a scenario meant that students were not able to access the tools with which to execute learning at ZOU district centres. However, it is important to mention that the institution expects students in general to provide their own ICT gadgets for learning purposes.

In addition, informants mentioned that.

> … academics do not have internet facilities at home for online tutorials via MyVista, the institutional online teaching platform or Microsoft teams. This challenge was made worse during the COVID-19 lockdown period when people could not go to the office for work.

Also, informants raised the issue of internet data bundles that were not provided by the institution for academics to work from home, specifically those with their own WiFi and internet facilities at home, particularly during the COVID-19 lockdown period. As a result, and as echoed by informants above, both academics and students had limited access to internet connectivity (see Burgess and Sievertson 2020). Moreover, informants showed resistance to change, as some academics and students were passing through a resistance phase. They were trying to resist the move from ODL to ODeL.

Other challenges raised by informants were those related to lack of the following skills which must be developed in both academics and students:

- *E-tutoring and e-learning skills.*
- *Academics need training in using both MyVista and Microsoft [T]eams to conduct live tutorials with students.*
- *Academics need training in creating and uploading audios on MyVista.*
- *Students need training on logging and accessing live tutorials on MyVista.*
- *The skills to navigate technology and e-resources available as well as good use of MyVista.*
- *Use and participation in Microsoft [T]eams.*

Informants also highlighted that both students and academics need training in ICT skills, such as e-tutoring and e-learning skills. Additionally, as alluded to above, academics need training on the use of the institution's online teaching platform, MyVista, as well as MS Teams to run tutorials with students. As with academics,

students require similar training so that they can upload assignments to and download them from the learning platform.

Moreover, as alluded to earlier, the following challenges of access to teaching and learning materials were raised:

- *Lack of connectivity for both tutors and learners.*
- *No access to data.*
- *There is absence of locally developed teaching and learning materials for students.*
- *Power outages and connectivity affect access to teaching and learning materials.*
- *The absence of internet in some areas provides challenges to access.*
- *Long distances from regional campuses where some computers and internet are available.*
- *Absence of connectivity, poor bandwidth.*

Furthermore, the study sought to understand the impact of ICT on tutorials or lesson delivery at ZOU.

6.4.3 The Impact of ICT on Lesson Delivery

Informants raised the following issues with regard to lesson delivery and the impact of ICT:

- *Minimal because only [WhatsApp] is being used at most.*
- *No noticeable impact so far due to lack of familiarity and skills to execute the tutorials.*
- *Not much has been done to conduct online tutorials due to lack of training on how to conduct online tutorials.*
- *There has been a shift from [face-to-face] to online teaching. The tutorial is retrievable and can be played again and again.*
- *Well felt impact especially to those who did not have ICT gadgets and connectivity.*
- *Unfelt impact for those who did have ICT gadgets and connectivity.*

As indicated above, informants felt that the impact of ICT in some cases was little, as some academics lacked familiarity and skills to execute tutorials (Burgess and Sievertson 2020; see UNESCO 2020). Moreover, informants felt that not much had been done to conduct online tutorials due to lack of training on how to conduct them. However, a noticeable impact mentioned by informants was that there had been a shift from face-to-face tutorials to online teaching and that the online tutorial could be recorded and replayed back many times to the benefit of students. Informants were of the view that the impact was unfelt more by those with their own ICT gadgets, hence, they were able to practise and work online.

Additionally, the study sought to understand the impact of COVID-19 on lesson delivery and student learning at ZOU.

6.4.4 The Impact of COVID-19 on Lesson Delivery and Student Learning at ZOU

Informants raised the following issues with respect to the impact of COVID-19 on lesson delivery:

- *Students are unable to get tutorials because they do not have access to gadgets, connectivity and data.*
- *Access to internet was limited due to lockdown measures.*
- *Limited time to access internet cafes.*
- *COVID19 restrictions did not allow both tutors and students to access ICT and internet facilities at regional campuses except those who are privately connected at home.*
- *COVID-19 prevented online lesson and face-face lesson delivery in ZOU.*
- *Impact was felt by those students who before COVID-19 relied heavily on [face-to-face] tutorials.*

From the informants' perspective, the COVID-19 pandemic had a negative impact on lesson delivery, as students could not get to internet connection points due to the lockdown measures that were put in place. In the same vein, face-to-face tutorials were not possible, hence, could not be held during lockdown. Internet cafes were also not accessible for students. Moreover, internet facilities at regional campuses could not be accessed by students during lockdown. All learning activities could not be accessed at ZOU due to lockdown, which resulted in the closure of the University. In the views of informants, those students who relied heavily on face-to-face tutorials before the advent of COVID-19 were most impacted, as such tutorials could not be offered. According to the UNESCO Report (2020), 89.4% of enrolled learners worldwide were affected by COVID-19-induced closures of schools and HEIs. Classroom teaching was replaced by distance teaching, or ODeL in the case of ZOU. There were no face-to-face lectures/tutorials due to closures, infrastructural challenges, pedagogies for distance learning, technological requirements for specific fields of study, competencies in ODeL, and examinations faced cancellation globally.

However, there was a silver lining to it, as it also offered opportunities for flexible teaching and learning packages—blended or hybrid learning, among others (see Burgess and Sievertson 2020). For ZOU, this was an enhanced opportunity to develop its ODeL model and perfect it further by developing ways in which both lecturers and students could be assisted to work using online tools. For example, the lockdown did not allow free movement of people, as it confined them to their homes for a lengthy period. For ZOU, the institution looked at ways of enabling the academic to work from home so that teaching and learning were not affected by the COVID-19 pandemic lockdowns. One such way suggested for implementation of a pilot basis was to install internet facilities at the lecturers' homes for those who did not already have them. A sample of such academics was going to be used for the trial period. If it worked and funds permitted it, such a scheme would then be extended to all teaching staff without internet infrastructure at home. Additionally, cheaper data bundles would be bought

for academics and organized for students through partnerships with providers of data bundles. As ZOU already had a running system in the form of its online teaching system, called MyVista, and students already used it to access modules, assignments and other reading materials as well as teaching aids, such as videos, among others, this was a major advantage ahead of other institutions which, before the advent of the COVID-19 pandemic, were using mainly the face-to-face teaching mode. All that was needed was to develop a purely online teaching mode, which included online tutorials as opposed to the face-to-face tutorials that were the norm before the pandemic. As regards other institutions, for most conventional institutions that used a face-to-face mode of lesson delivery, it was a steep learning curve. The COVID-19 pandemic and the lockdown periods that accompanied it caught these institutions by surprise, as they could not offer any teaching to students during the lockdown periods. Most were literally shut down for business.

Moreover, this study sought to understand the effect of the COVID-19 pandemic on teacher development with respect to the following:

6.4.4.1 Lesson Delivery, Assignment Writing and Feedback

Here are some of the informants' responses:

- *A few students are accessing tutorials through e-learning.*
- *We are currently administering many courses, e.g. 14 in some cases—lesson delivery, be it online or face-face, is not possible. No one can be an expert of so many courses.*
- *Part-time lecturers opted out of work as they could not manage due to lockdown.*
- *It has gone mostly online or use of audio lectures without face to face.*
- *Poorly researched assignments due to restrictions.*
- *Poorly typed assignments.*
- *Delayed assignment submissions.*
- *Delayed marking and feedback.*
- *Absence of [face-to-face] tutorials.*
- *Seemed like the institution had moved to "learning through correspondence".*

Furthermore, informants observed that due to the COVID-19-induced lockdown, only a few students were able to access tutorials through the e-learning platform. Additionally, they noted that it was not possible to offer many courses on the menu on the online platform or face-to-face. There were not many full-time staff members to be able to do so, as part-time lecturers had dropped out of the equation due to lockdown conditions. Additionally, informants mentioned the aspect of students submitting poorly typed and researched assignments. There were also delayed assignment submissions and feedback processes. Most learners who depended on regional and district campuses for internet access did not submit assignments, as feedback was online, and submission was done online. Informants further mentioned the issues of reduced observance of assignment due dates by students, leading to a lengthened

period to mark assignments. On examination writing by students, informants raised the following issues:

6.4.4.2 Examination Writing

- *Some students could not travel to examination centres because of travel restrictions.*
- *Poor preparations for examinations as there are no [face-to-face] discussions on examination tips leading to poor results in some cases.*
- *Invigilators were exposed to chances of contracting the virus.*

As alluded to above, informants said that due to travel restrictions, some students failed to write examinations, as they could not get to the examination writing centres. This point resonates well with international literature (see UNESCO Report 2020). Moreover, for those who wrote, poor results were recorded due to lack of preparation and face-to-face discussions, and invigilators were exposed to contracting the virus. Moreover, informants raised the following points as regards TP supervision.

6.4.4.3 Teaching Practice Supervision

- *Some student intakes/cohorts were not supervised effectively and to worsen the situation some were asked to come to assessment centres which were not familiar sites to them.*
- *Teaching practice could not be carried out as schools were closed and when it was done the model was revised and students had to do lesson delivery in other schools where lecturers could access them.*
- *Resources to fund TP were reduced, and visits were affected as to the timeliness.*

As mentioned earlier, the above issues surfaced with respect to TP supervision—for example, due to COVID-19 travel restrictions, TP supervisors failed to travel and supervise students on TP in their school setup. This was particularly the case with students in remote rural setups that could not be reached due to COVID-19 lockdown regulations. Affected students were accommodated in schools that could be easily accessed by supervisors for supervision and assessment instead of their job stations. This was a departure from the norm, and such students needed to be reassessed in their normal environment before they could be passed as teachers. Moreover, most students failed to pay their TP supervision fee, resulting in reduced resources to carry out the TP supervision process effectively. Additionally, because of the prolonged lockdown period, with schools closed to access by TP supervisors, some students were not supervised and assessed in their scheduled time for the completion of their training programme. As such, many would be teachers could not graduate on time, as their final assessment to be teachers had not been done. Informants also raised the following concerns under Research Project Supervision.

6.4.4.4 Research Project Supervision

- *Supervision was a challenge because of lack of connectivity, data and gadgets.*
- *Most part-time tutors could not afford to supervise electronically thereby leaving the burden to full-time staff.*
- *Supervision was now done online, and feedback was done online, leading to:*
  - *Poorly researched projects due to restrictions.*
  - *No effective supervision by tutors due to restrictions.*
  - *Late submissions due to restrictions.*
- *Delayed accomplishment of goals especially in cases where some supervisors insisted on marking hard copies and wanted students to bring the hard copies to them to be marked*.

The study also brought issues of research project supervision to the fore, as discussed above. Informants mentioned that the supervision of research projects was negatively affected. For example, in the past, supervision was a face-to-face activity; however, now it became an online activity. Students and supervisors did not work on research projects effectively, as internet connectivity was a challenge for most students. The issue of data bundles and ICT gadgets, such as smartphones and computers, were also a challenge to get for some students. The challenges of research project supervision were exacerbated by the withdrawal of services by part-time lecturers, as they had no access to internet facilities during the COVID-19 lockdown while they were at home. In that regard, a reduced workforce of full-time lecturers struggled with the many students who required research project supervision. Consequently, this scenario led to poorly-supervised research projects, late submissions or non-submissions, as well as a poor quality of research work. Moreover, as alluded to above, some non-native digital citizen supervisors resisted online research project submissions and insisted that students submit hard copies for marking. This resonates well with international literature (see Ertmer et al. 1999). People tend to resist new ways of doing things, and some academics and students at ZOU are not an exception. Consequently, goal achievement was delayed due to the ICT skills gap.

Additionally, the study sought recommendations from informants on the type of teacher development model that could be developed and used by the Department of Teacher Development to supervise students on TP in future.

6.4.5 Recommended Teacher Development Models for the Future

Informants recommended the following models for teacher development:

- *The existing model that was approved and is in place could still be utilized but limiting the number of visits per students by ZOU staff to one and leaving the rest to mentors in the school.*
- *The traditional model.*

As mentioned above, informants recommended to stick to the current 2-5-2 model of teacher development currently used by the institution. However, they recommended modification of the current model of teacher development (see Tarusikirwa, 2016, p 2710–2713). Their recommendations include limiting the number of visits to students for supervision by the Department to one instead of the current three and letting the mentors in the schools do the rest of the TP supervision.

The following section is from Tarusikirwa (2016, p 2710–2713) on the recommended 2-5-2 current model used by ZOU. In this model:

The Zimbabwe Open University student teachers are continually teaching in schools, while at the same time undergoing teacher development. Student teachers attend weekend tutorials where they do peer and micro-teaching, group discussions and meet the lecturers face-to-face. Furthermore, students are tutored in educational foundation subjects and primary school curriculum subjects by experienced lecturers. This is in line with other teacher development institutions in Zimbabwe. Additionally, students are provided with well—written modules authored by experienced university and college lecturers. These modules are highly sought after by university lecturers and students all over the country.

Modules are a very effective method of teaching because they are consistent in delivery, student—centred and well researched. Students have access to their tutors 24 h a day through ICT, modules, cell phones, etc. As ICT tutoring becomes a reality at ZOU through MyVista, an online teaching and learning platform, students have gained unlimited access to learning materials and tutors 24/7. Additionally, apart from learning while they are teaching in the schools which exposes them to more Teaching Practice under the supervision of school-based mentors, School Heads and Education Officers from the Ministry of Education, students undergo a 2 semester, 1-year Teaching Practice period supervised and monitored by the University's Department of Teacher Development.

ICT can be advantageous for the development of teachers through ICT-based methods of instruction to go with this ICT age.

Additionally, informants recommended what they termed "The Traditional Model". In the views of informants, "[t]he traditional model" is the 2-5-2 model currently used by teacher training colleges and all universities in Zimbabwe and is approved by the Ministries of Education. It has already been explained above.

6.5 Conclusion

In conclusion, the study unearthed a number of important issues that affect teacher development in the digital era. It is clear from the findings that teacher development must move with developments in ICT for the benefit of all stakeholders involved. The need for change has been accelerated by the advent of COVID-19, which has had serious repercussions for teacher development in terms of TP and research project supervision that have relied more on face-to-face interaction between the student and the assessor or supervisor as their cornerstone. With COVID-19 lockdown, such interaction is no longer possible. New ICT-based models of teacher development should be developed. We need to build on the existing teacher development models to infuse ICT-based supervision tools that benefit the student, at the same time fulfilling teacher development standards. It is also clear that there are skills gaps that need filling for both students and academics for the success of teacher development in this era. Additionally, there is a need for the provision of internet infrastructure, equipment, such as ICT gadgets and data bundles, among others, for the success of the new programme. A base for an ICT-based teacher development model already exists in that assignments and feedback, modules, lecturing and tutoring can easily be done online through the various modes of ICT tools of instruction.

6.5.1 Way Forward for the Future of Teacher Development in the Digital Era

As a way forward in the digital era and after the effects of the COVID-19 pandemic on teacher development, three models of teacher development that can form a way forward for the development of existing teacher development models to ICT-based models are as follows:

Model 1 revolves around virtual classrooms

In this model, student teachers teach students virtually in a virtual space. This can be done successfully through the MS Teams app or Zoom. A link is created for the students to link up for their lesson with the teacher. Through the same link, TP supervisors can be linked to the same lesson, and they can observe the student-teacher teaching. When the lesson is concluded, the supervisors and the student-teacher remain linked and the student teacher displays records such as the lesson plan, mark records, among others, for the supervisors to assess, discuss the lesson with the student and score the student-teacher on the lesson from wherever they are.

Model 2 revolves around live classrooms

In this model, the school head or other school official records the student-teacher teaching a live class, the spacing and everything, observing the COVID-19 regulations during the pandemic period. The recording is then sent to supervisors to assess the

lesson. Student teachers can then take their record books to regional campuses for assessment and mark scoring by supervisors at the end of the TP session.

Model 3 revolves around the broadcasting of pre-recorded lessons

In this model, the student-teacher prepares several recorded lessons for live TV or radio broadcast to virtual students and virtual assessors. These are viewed and scored by supervisors as they are beamed to students.

All the models (1–3) can be accompanied by one or two live visits by supervisors to live lessons by student teachers to assess the final grade before graduating where necessary.

Additionally, it is recommended that HEIs involved in teacher development invest in ICT infrastructure, make it a policy to supply students with ICT gadgets, train both staff and students in ICT skills so that they are able to learn, and teach using the available ICT tools for the digital era. They must enable them to teach and learn.

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Part III
Different Approaches

Chapter 7
Empowering Educators to Use Tablet Technologies Under the Early Digital Learning Programme

Avinash Oojorah and Waaiza Udhin

Abstract The Early Digital Learning Programme (EDLP) was introduced in 2017 by the Ministry of Education, Tertiary Education, Science and Technology (MoETEST). EDLP is about transforming the traditional teaching and learning environment in the primary sector through the introduction of tablets and projectors in the classroom. The tablets come preloaded with interactive learning resources and applications that allow students to create and share content. Under EDLP, the Mauritius Institute of Education (MIE) has been mandated to develop interactive learning resources, train different stakeholders in education to use the tablet ecosystem and to provide support to them. Support to teachers is given through school visits where the MIE team from the Centre for Open and Distance Learning (CODL) attends to technological and pedagogical issues faced by the teacher. The availability of tablets, projectors and associated tools in the classroom has prompted the MIE to devise training sessions to empower educators to use these technologies. The authors describe the two digitisation models in the primary school sector and their accompanying pedagogical strategies. They also describe the training and empowerment framework that is made available to primary school educators for effective use of technology in their classrooms. The chapter is reinforced with data from educators' feedback from training sessions. Data were collected by means of questionnaires and focus group interviews with educators. Data were analysed using the four-level approach of the Kirkpatrick Training Evaluation Model. Discussions were held around reaction, learning, behavioural change and organisational performance of educators being trained. The outcomes of this chapter allow us to improve the processes involved in conducting training of different stakeholders in education.

Keywords Teacher education · Digital learning · Tablets · Primary education · Technology

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7.1 Introduction

7.1.1 Background and Context

One of the pillars of the Nine-Year Continuous Basic Education (NYCBE) reforms in the Mauritian context is the transformation of the teaching and learning environment. Technology—as conceptualised by the policymaker—is a transformative force. Hence, tablet technology with associated tools (such as projectors, chargers, digitised curriculum) and services (such as training and support) have been implemented in Mauritian primary schools since 2017 for Grades 1 and 2, in 2019 for Grade 3, and 2021 for Grade 4. The key agency in the implementation of the Early Digital Learning Programme (EDLP) is the Mauritius Institute of Education (MIE). The MIE is mandated to develop digitised versions of the curriculum and empower educators to use the tablet ecosystem in classrooms.

With the introduction of the technology in the classroom, educators were faced with the challenge to retool their practice. The challenge is twofold. Firstly, educators must deal with years of on-the-job socialisation and formal teacher education that have shaped their notions of teaching and learning in a certain manner (not necessarily adverse to teaching and learning with technology). Secondly, Grade 4 educators had to work with a Classroom Management System (CMS). The CMS is explained in more detail in the next section on models of curriculum digitisation. The identification of these two challenges was the first step in the design of the training and empowerment framework for educators.

The aim of the study was to investigate the effectiveness of the empowerment sessions for educators under EDLP. The objectives of the study were as follows: (1) to assess teachers' understanding of the functionalities of the CMS; (2) to measure teachers' abilities to create, edit and push e-assessment activities; and (3) to explore the use of tablet technology by teachers at classroom level.

7.1.2 Models of Curriculum Digitisation in Primary Education in Mauritius

The primary education sector has known two models of digitisation since 2011. The first model, operationalised as the Sankoré project (Oojorah 2011; Oojorah and Udhin 2013), was about equipping upper primary classrooms with interactive projectors and laptops. Teachers were given training on how to use open-source software to teach with and design learning resources. Sankoré involved mostly frontal teaching (teaching from the front of the room, or teacher-focused teaching using direct instruction). The class was teacher-driven, and learners rarely had an opportunity to create or contribute to the body of knowledge of the class. It was a one-to-many (teacher: learners) model of teaching with technology in the classroom. This model, however, laid the foundation for further digitisation in the sector.

In 2017, the Ministry of Education launched EDLP. The initial phases of the project catered for the lower grades (Grade 1–3). The hardware provided consisted of tablets for educators and learners, a projector, charging racks, and other technological tools such as headsets and a stylus. The software that was provided for both educators and learners consisted of an Android operating system with applications. The MIE developed an augmented e-book with interactive learning resources, videos and audio files that was preloaded on the tablets on a content management system. The educator and the learner tablets were similar.

Presently, the Grade 4 educators are equipped with laptops and the students with tablets. The Grade 4 model hinges on a Classroom Management System (CMS). The CMS has been designed for promoting engagement and enhanced learning experiences in the classroom. The teacher plays a pivotal role in the Grade 4 digitised classroom, looking at the planning, organising, distributing of curriculum as well as monitoring of students' progress through the CMS. There are several modules (tabs) in the CMS application that have been designed for the above-mentioned purposes. These tabs include the following: the Curriculum tab; the Questions tab; the e-Assessment tab; the Reports tab; the Timeline tab; and the Upload tab. The Curriculum tab allows the teacher to plan and organise contents that need to be taught. It acts as a repository of all curriculum materials for Grade 4 subjects taught in Mauritian schools, and the materials are all aligned with the Grade 4 textbooks. The Questions tab is the module where teachers develop series of closed- and short-answer questions that are uploaded to the CMS and shared with students. The e-Assessment tab is where the students answer the questions set within time parameters, and teachers assess and provide feedback to the students. The Reports and Timeline tabs facilitate the teacher in reporting and monitoring the progress of learners on the CMS. The Upload tab is the module where educators may upload additional materials to use in class or share with other educators.

7.1.3 The EDLP Empowerment Sessions

The Grade 4 EDLP empowerment sessions were held in February and August 2021. A total of 834 educators attended the full-day training sessions. During the empowerment sessions, the CMS as well as the embedded functionalities were explained. Educators had the opportunity to engage with the CMS through hands-on activities. The training contents comprised of the following:

- An overview of the laptop and tablet (hardware and peripherals)
- Exploring functionalities of the CMS
- Exploring the "Curriculum" tab
- Exploring the "Upload" tab
- Exploring the "Reports" and "Timeline" tabs
- Exploring the "Questions" tab
- Exploring the "e-Assessment" tab.

Moreover, six training modules totalling 45 hours were developed and posted on the MIE e-learning platform to ensure sustainability in empowering teachers in learning about teaching with tablet technologies in classrooms. Modules 1–5 were relevant for the educators, whereas module 6 was intentionally developed for staff from administration such as headmasters, deputy headmasters, or inspectors. The training modules were as follows:

- Module 1: Getting started with tablets in school
- Module 2: Introducing Classroom Management System
- Module 3: Using tablets for content creation
- Module 4: Using tablets for collaborative learning
- Module 5: Using tablets for personalised learning and flipping the classroom
- Module 6: Supervision.

The last 2 hours in the empowerment sessions were dedicated to introducing the MIE online platform, the training modules on the MIE online platform and providing an overview of the training content in modules 1–5.

7.2 Tablets in the Classroom: Literature Review

The introduction of technology in teaching and learning prompts discussions on how to handle students and their usage of devices and teacher preparedness. In fact, some researchers feel that both students and teachers must receive some form of training (Chou et al. 2012). In recent years, tablets have been introduced in classrooms. It is believed that tablets have the potential to change the way teachers teach (Shelly et al. 2007). It could also enhance teacher–learner productivity by improving information transfer, presentation and extending human capabilities to communicate and understand (Gillies and Boyle 2010). Teachers should be ready to take up digital technologies for teaching and learning (Hennessy et al. 2010). However, to realise this potential mentioned above and to put teachers in ideal conditions to embrace technologies in their professional practice, training is key (Wangari 2008).

Focusing on teachers' training needs, Turel & Johnson (2012) believes that it is crucial as technology appears to change the role of teachers from direct provider of knowledge to an increasingly supportive role in learners' learning. Teachers can be quite unsettled by this evolution in their roles. It is not only about introducing a device in the classroom; it is more akin to a retooling of teaching and learning—a change in basic assumptions of teaching and learning. This is easier said than done. Indeed, some researchers have expressed some doubts as to whether teachers could really make the shift from traditional (without use of technology) teaching to teaching with technology (Yang 2012). In defence of teachers, the task does not seem to be simple. The expectation is to design meaningful learning activities with tablets that meet the curriculum goals (Neumann and Neumann 2014). The process of teacher development can be tricky and needs to include numerous aspects such as an updated

professional knowledge and new practices. Moreover, this must come with the right ethos (Leach and Moon 2002).

In this context, Training Needs Analysis (TNA) revealed that teachers requested training not only in technical aspects of handling tablets but also in terms of useful applications and discussions on pedagogy. They also asked for time to familiarise themselves with the technology (Balanskat 2013; Karsenti and Fievez 2013). In line with the request from teachers, giving a tablet to the teacher fosters more efficiency in the pedagogical handling of the device (Burden et al. 2019). This resonates with the findings of Beckman et al. (2014) and Hultin and Westman (2013). Accessing the technology is not enough. Teachers need to have guidelines for the proper integration of technology in the classroom (Njeru 2019). Writing in the Kenyan context, Njeru (2019) outlined some strategies that were used to empower teachers. Training workshops were organised where teachers were provided with training manuals. The workshops covered five major aspects, the first one being the major apps to be used by the teacher. Secondly, the teachers needed to understand the integration of the technology from a curricular viewpoint. This was reinforced by presenting the curriculum changes that were related to the introduction of technology. Fourthly, teachers were inducted into their new evolving roles in the digital era, and lastly, the educational underpinning of this change was discussed. In Hong Kong, the training was two-tiered (So and Swatman 2006). It consisted of 18 h of basic IT and 30 h of more advanced training. This shows how planning for training can be difficult in the context of technology integration in education. There are indeed variations in skills, knowledge, classroom practices and classroom management skills (Krumsvik and Jones 2013; Krumsvik et al. 2016) that make training for technology integration in classroom a complex affair.

However, their evolving role (with the introduction of technology) was not the only aspect of concern for teachers. Teachers were particularly interested in the control of the technology (Parnell and Bartlett 2012). In line with the above, teachers' level of knowledge and confidence in using the technology for pedagogical purposes were the focal aspects of training programmes. Indeed, Van't Hooft (2013) believes that, in the context of technology integration, Continuous Professional Development (CPD) should be a feature of teacher education. It is important to continuously support teachers, as they are engrossed in traditional ways of teaching and they are unable to bring the necessary change (Murray and Olcese 2011). This highlights the fact that tablet integration in the classroom does not only face technological challenges but also hurdles in terms of teaching methods and didactical practices.

Moreover, the teachers have been inducted into models of technology integration with the aim of infusing technology in didactical practice. One of these models is the SAMR (Fig 7.1) (Substitution, Augmentation, Modification and Redefinition) model of Puentedura (2013). The SAMR model can be used to gauge the level of technology integration in education (Wahyuni et al. 2020). The model is illustrated below. SAMR can be described as a hierarchical model, with the first two stages—Substitution and Augmentation—having the potential of enhancing the learning experience. Substitution is the lowest level of technology integration. Substitution simply means replacing the traditional learning experience with technology without any functional change.

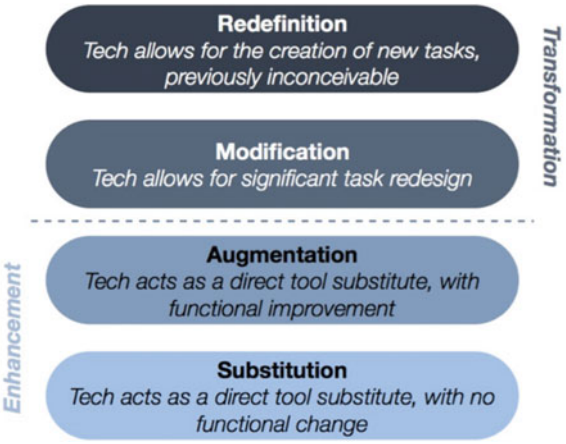

Fig. 7.1 The SAMR model Puentedura (2013). http://is.gd/QGMu51

Examples in this case could be replacing posters by projector display or providing the learners with a soft copy of their printed textbook. Augmentation refers to a learning setup where technology replaces the traditional learning experience with additional functions. For example, pictures can be accompanied with sounds or reading can be facilitated with immersive tools.

The two subsequent stages—Modification and Redefinition—propose to transform the learning experience. Modification implies the significant redesign of the learning activities, for instance, using Learning Management Systems (LMS) or social media. The use of such platforms opens new pedagogical and communication affordances for teachers and learners. The Redefinition stage is about the implementation of activities that are not possible without the use of technology. For example, the use of blogging or coding in an interdisciplinary manner is to learn about concepts in languages or science.

In the same vein, Kolb (2011) proposed the Triple E (Engage, Enhance and Extend) framework to support teachers to achieve learning targets using technology. The Triple E framework is a practical tool that focuses on pedagogy first and then helps teachers to select tools and devices that would be useful to realise learning goals. Engagement refers to strategies to promote active learning in the classroom setup. It is more than merely using technology to create perceptual and cognitive arousal in learners. Engagement is about keeping the learners focused on a given task, motivating them to initiate and sustain the learning process and collaborate, and to co-create in the classroom. Moreover, enhancement entails providing opportunities for learners to creatively express their learning. This resonates with the last level of the SAMR model. Redefinition implies that technology creates opportunities for learners to demonstrate their learning in ways that were not possible with traditional tools. Extension is about creating authenticity in learning experiences by connecting students with the real world. Extension also involves moving learning beyond the four walls of the classroom.

Even though the above-presented models appear neat and straightforward, they are not without critiques. For instance, while using SAMR to implement personalised learning devices such as tablets in the classroom, teachers tend to stagnate at the Substitution and Augmentation levels (Clark et al. 2021). These two levels seemingly represent rudimentary ways of integrating technology. Clark et al. (2021) also contend that teachers stuck at these levels are over-reliant on apps that encourage the consumption of content. As regards the highest level of technology integration in SAMR, Redefinition, Clark et al. (2021) believe that it should not be done at the expense of human connections. Regarding the Triple E framework that foregrounds pedagogy and then focuses on technology, teachers still need to skilfully craft their lessons. Technology is not a *magic bullet for learning* Geer et al. (2017). Good pedagogical practices, sound instructional strategies and lesson planning are even more relevant than before.

7.3 Methodology

This chapter seeks to understand whether the training framework was useful to help teachers use tablets in their classrooms. The quality of training was under the research lens. Therefore, an interpretive approach was used to reach a better understanding of the sense that teachers made of the training. The interpretive paradigm is useful in uncovering the meanings actively constructed by social actors (Phothongsunan 2010; Taylor and Medina 2011). The interpretive methodology helped in positioning the meaning-making practices of Grade 4 educators at the centre of the explanation on the empowerment of these educators in using tablet technologies (University of Utah 2009). Through the interpretive paradigm, the authors approached reality through interactions with the educators who followed the empowerment sessions by interviewing educators who intended to use the tablet technologies within their classrooms. The focus of the interview was on the use of the different functionalities, "tabs", of the CMS at classroom level and perceived pedagogical practices. Questionnaires were also used to generate qualitative data (Phothongsunan 2010) as the first level of interpretation.

The interpretive paradigm presupposes a set of methodologies. Focus group interviews are one of the most useful tools to collect qualitative data (Dilshad and Latif 2013). An interview, in the research context, can be described as a communication setup by the researcher between participants to discuss a specific theme (Anderson 1990). Interviews can be particularly useful to explore people's feelings, attitudes and experiences (Wisker 2007). This is in line with the qualitative and interpretive paradigm (Kvale 1996). A focus group interview is indeed a qualitative method to produce data, implying that the data are not just out there to be collected. The group here refers to a collective with common characteristics, assembled by the researcher to explore their opinions, feelings and attitudes regarding a specific topic (Anderson 1990; Denscombe 2017). In the case of this chapter, the group consisted of primary school educators that taught Grade 4 and who were willing to express themselves on

the topic of training under EDLP and its outcome. A group in this case would ideally consist of six to nine participants.

Moreover, focus group interviews have three characteristics (Denscombe 2017). Firstly, they are moderated by an interviewer that uses prompts to stimulate answers from the interviewees. In the case of this chapter, the researchers acted as the moderators. Secondly, researchers in this type of interview are not fully neutral, as they prompt and help participants to answer. Thirdly, this type of interview is highly interactive. In this setup, one participant may influence the other (Krueger and Casey 2000). The group composition was important here, as the researchers tried to find a balance between educators who worked in high-performing schools and those who worked in less comfortable contexts. MS Teams were used to conduct interviews with the participants. The researchers could not afford to have face-to-face discussions due to the prevailing situation caused by the COVID-19 pandemic. The discussion was recorded and transcribed for analysis.

The second instrument that was used to produce data for this chapter was the feedback questionnaire administered after the training sessions. Feedback is extremely important for the EDLP training team. Feedback is used to improve performance or to enhance the way training is delivered (Hattie and Timperley 2007). If feedback questionnaires are well designed, they can result in a significant improvement in learning processes and outcomes (Black and William 1998). For the questionnaire, data from all the educators who followed the Grade 4 EDLP empowerment sessions in the year 2021 were considered. The questionnaire design included both closed- and open-ended questions. The closed-ended questions referred to the confidence level of the educators to teach with the CMS. The open-ended questions focused on how to improve the training session. The data were presented graphically to facilitate interpretation and analysis. One key limitation of questionnaires is still the response rate (McGuirk and O'Neil 2016). To attend to this issue, the feedback questionnaire was administered just after the training sessions.

It might be problematic to include questionnaires in an interpretive research design, however. Questionnaires may usually reflect a positivist stance to quantify phenomena. Having said this, meaning-making is possible from data generated in questionnaires, though this would be anathema to the positivist thinkers, as it would create the possibilities of having more than a single truth (Marshall and Rossman 1999). Nevertheless, it is possible to study trends, people's behaviour, experiences, opinions and awareness of events through questionnaires (Parfitt 2005). To make meaning of the responses from the questionnaires, the Kirkpatrick Training Evaluation Model was used to analyse the data. The Kirkpatrick Training Evaluation Model provides one with clear evaluative steps to follow, and it works with digital learning programmes.

The Kirkpatrick Training Evaluation Model consists of four levels (Holton 2005): Reaction, Learning, Behaviour, and Results. Level 1, Reaction, measures the audience's satisfaction with the training. It is specifically how the educators felt about the training. The second level is about knowing how much of the content presented in the training was assimilated by the educators. The questionnaire tried to capture level 2 by asking the educators about their level of confidence to work with functionalities of the

CMS. For the Behaviour level, the target audience is asked whether they could apply the knowledge gained in the training in classrooms. The last level, Results, is about gauging whether the training had an impact on teaching and learning at classroom level. The two last levels were mostly dealt with in the focus group interview.

7.4 Findings and Discussion

Figure 7.2 shows that almost half of the educators did not follow EDLP training before. The online feature was new to all the participants in the training. The training design was a novelty for the educators. The training team had received reports from previous training that the face-to-face sessions were inadequate. Therefore, an online component was added to the face-to-face training. Educators could now access more detailed training content online. They were given ample time to familiarise themselves with the technological and pedagogical aspects of EDLP. This resonates with the findings of Balanskat (2013), Burden et al. (2019), Hultin and Westman (2013), Karsenti and Fievez (2013), and Njeru (2019) as regards the provision of support and guidelines to teachers.

The reaction of the audience to being exposed to a new training modality can be viewed in Fig. 7.3. Less than 10% of the audience found the new learning modality challenging or very challenging. Overall, in line with Kirkpatrick's model, one can say that the new training model was well received by the audience as shown in Fig. 7.3. This finding also relates to content assimilation (level 1 of Kirkpatrick's model). Learning online is a new skill that the audience acquired during the training sessions.

In the same vein, it can be said that educators assimilated the content of the face-to-face sessions on the CMS quite well. Using a rating scale, they indicated that they had a *very good/good/somewhat good* understanding of the CMS functionalities. A closer look at the chart in Fig. 7.4 shows that the level of understanding of the

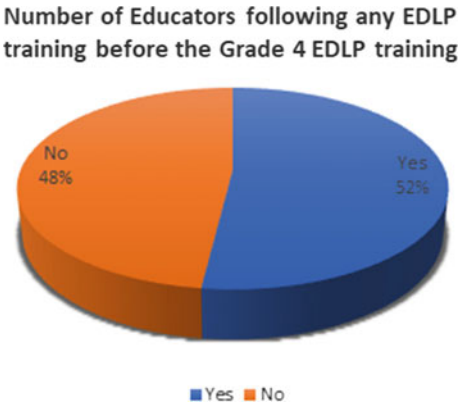

Fig. 7.2 Number of educators following EDLP training before

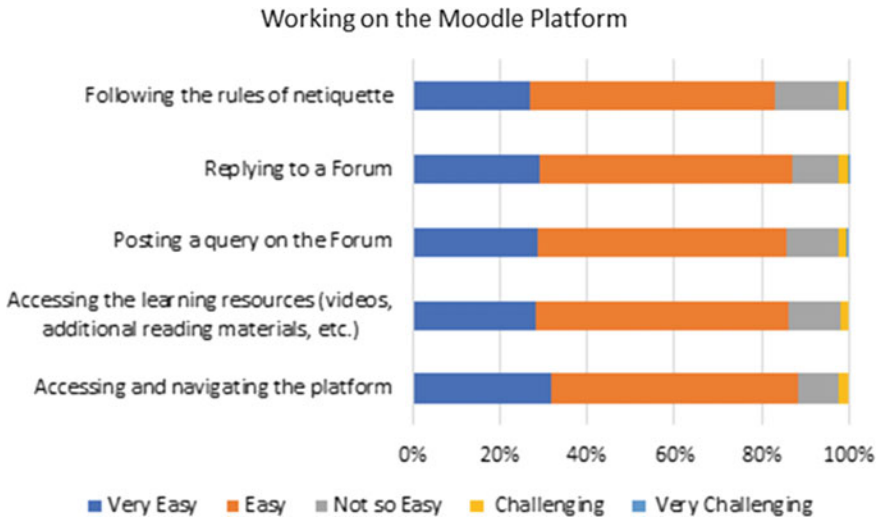

Fig. 7.3 Reaction of the audience to being exposed to a new training modality

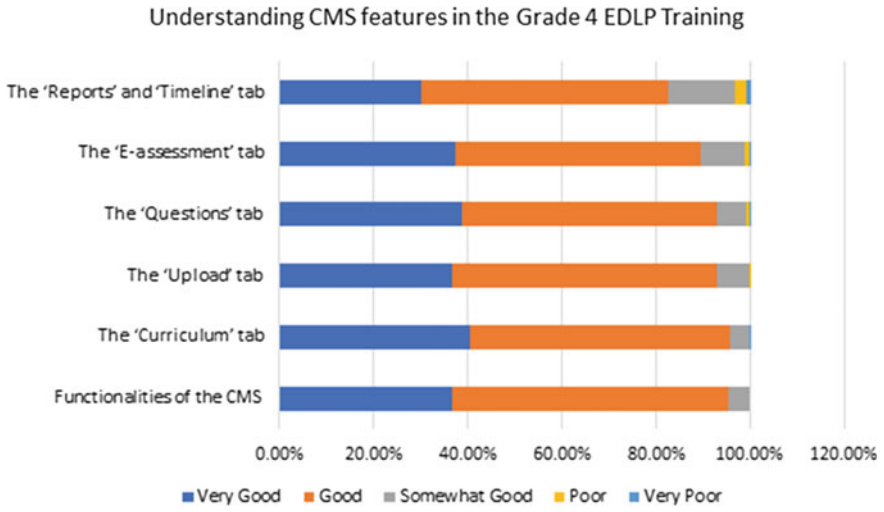

Fig. 7.4 Level of understanding of the functionalities of the CMS

functionalities of the CMS shows *poor/very poor* understanding of the more refined functionalities such as the e-Assessment tab and the Timeline tab. The functionalities allow the educators to have some control over what the learners do with their device. These types of functionalities were well received by the educators. It allowed them to stay within their teaching paradigm of being in control (Parnell and Bartlett 2012).

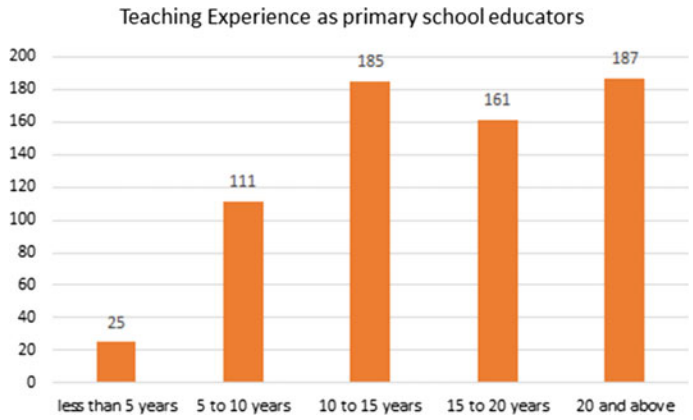

Fig. 7.5 Years of teaching experience of primary school educators

It is also interesting to discuss the number of years of working experience that the educators had. Most of them had over 5 years of teaching experience. Changing the practice of educators with several years in schools can be tricky. Indeed, some researchers have doubted whether teachers could really make the shift from traditional teaching to teaching with technology (Yang 2012). Experience in teaching could be both an inhibiting and encouraging factor (Fig. 7.5).

Nevertheless, the questionnaire also revealed that organising such training sessions could be an overly complex affair. The training was a balancing act between technology and pedagogy. The responses of the educators after the training on enhancing the sessions revealed that the internet connection was an issue at the sessions. Educators were asking for the training to be formalised within their CPD programmes.

Furthermore, disruptions to the school calendar had destabilised teaching and learning routines. This was apparent in the FGI when the educators explained that they could not implement the technologies, as many students were absent due to COVID-19. Moreover, educators also explained that they could not experiment with group or pair work in classroom because of prevailing social distancing rules, again due to the pandemic. Educators also complained about the training schedules in the questionnaire (see the word cloud in Fig. 7.6). The face-to-face sessions had been delayed due to the sanitary lockdown. Training sessions were organised in times when strict sanitary conditions were imposed. Therefore, owing to the disruption to the school calendar, some of the sessions happened at the end of the school year for a part of the audience.

In a way, educators understood that tablets had the potential to change the way they taught (as identified by Shelly et al. (2007)). From the word cloud below in Fig. 7.6, it is evident that the educators believed that continuous professional development was crucial to empower them to make the shift. Terms associated with training such as *regular, frequent* and *practice* indicate that the educators felt that they needed to

Fig. 7.6 Word cloud on ways to improve EDLP training programme

upgrade their knowledge and skills to better integrate technology in the classroom. This process can be difficult, as educators need to meet curricular goals, and the expectation now is that they use technology to do it (Neumann and Neumann 2014). The educators made it clear during the interview that they needed more and sometimes prolonged exposure to new pedagogical strategies to be able to make the shift.

Aside from being conscious of the potential of technology to enhance their practice, educators also displayed the right ethos to bring about change (Leach and Moon 2002). In the interview, they gave many examples of how they integrated the technological tools at their disposal and commented on some scenarios that were shared with them. The educators repeatedly mentioned that they used the projector and their tablet to display for reasons such as perceptual and cognitive arousal of the students. Projecting e-books was used as a classroom management strategy, as it grabbed the attention of the students. Displaying the e-book would amount to no functional change as per the SAMR model (Puentedura 2013): the substitution of the traditional method by technology. This would be at the lowest level of the SAMR model. However, some substitution can be very powerful and immensely helpful to educators.

In some cases, educators were able to move up one level of the model to Augmentation. The extract from the interview below is evocative:

> *For History & Geography, there is a puzzle activity in EDLP/Sankore on district of Mauritius. Students must assemble the puzzle to learn about the districts of*

Mauritius. This resource was very helpful, and each student came to the board one after the other to assemble the puzzle for them to understand where to locate the districts.

In the example above, there is functional improvement brought in by the technology. The districts are not movable in the traditional book, but they are in the e-book. The educator used the digital learning resource as a tool for vicarious learning—students learning from example. The educator also stated that she was using the technology as a reward for keeping students under control. She created more engagement in the learning of the concept of districts through this strategy by questioning and prompting students with regard to the concepts being taught. She could have realised the first E in the Triple E framework (Kolb 2011), as she made the class more active and participated in the learning process. Other educators were able to move a notch up the SAMR ladder by achieving the augmented learning phases. Below is an extract of the interview that illustrates this:

Interviewer: Wrt tablets also, we can do a good display, highlight words, so was this useful to you?

Educator: Yes, for reading, it was very encouraging for students, mainly when I taught with tablets with Grade 1 and 2 students, this helped in promoting reading skills among learners. The activities on syllables were very re-enforcing, especially when the students use the resources on karaoke reading.

The *karaoke reading resource* helps the students to read a comprehension by highlighting the words synchronously with an audio input as they go through the text. This is a functional improvement that relies on technology. Moreover, the educator was able to create more engagement at individual level by keeping the learners focused on a given task (Kolb 2011). However, in both examples cited above, educators seem to be stuck at the lower level of the SAMR model, as highlighted by Clark et al. (2021). In the examples of pedagogical strategies provided in the interview, educators could not move beyond the Engage phase in the Triple E framework.

In fact, during the interview, the educators were given a pedagogical scenario where they would be able to redefine and extend learning (as per both SAMR and the Triple E framework). The pedagogical scenario is provided below:

Interviewer: So, there are lots of engagement with technology in classes. We also saw that learning with technology helps in enhancing learning. Tell us how we can extend learning using technology, can your students use connectivity in class to work? An example is teaching the topic on spices, students will be working in groups of 2 or 4, each group must look at spices, put in on PowerPoint, write the name of the spices and show or share it with their friends. In the meantime, the teacher goes around the class to verify whether students are doing the work correctly, where the photos have been downloaded, etc.…Students can then present their work in front of the class. Is this example possible in your school context?

The reactions of the educators to this pedagogical scenario were lukewarm. They did admit that this would be the ideal pedagogical scenario to implement. They conceded that students knew how to use a browser, download from the Internet, and locate the files on the tablet. However, they cited a host of factors that would prevent them from implementing the above pedagogical strategy. Internet connectivity would be one of these factors. Indeed, in large schools, the connectivity is extremely poor when there are many concurrent users. This would impede students' search activities on the Net. Secondly, classroom management issues were cited. According to educators, this strategy could result in chaos and noisy classrooms, where students would be more inclined to play rather than focus on the task. The high teacher-pupil ratio in some schools was cited as a supporting argument here, especially in so-called high-performing schools. Related to the above, some educators felt that pupils would not be able to do a presentation or appear in a video because they were not used to it. Fourthly, the classroom setup was mentioned. The furniture and space were not conducive to the type of pedagogy outlined in the example above, the teacher explained.

Moreover, connectivity is also one of the crucial issues that is discouraging the use of the tablet and CMS. Educators have been unable to cast their screens and use the Internet simultaneously. This limitation of the technological setup has constrained the educators to exclusively use content preloaded on the tablet. In the same vein, poorly configured connectivity in schools with high number of students (hence, more Internet users) is not good news for educators who want to use the CMS to push assessment onto the student devices. Educators described their experience as follows:

Educator 1: Yes, we cannot even go to the internet to search for an image. We cannot post the questions on the CMS as it demands a good connectivity for all the devices being connected at the same time.

Educator 2: I am thinking about the internet connection, like my friends in the star school are saying. If I plan to use the e-assessment but other colleagues are also using the internet at the same time in their classes, it will be a problem. Actually, when we push the assessment, it takes time for the assessment to appear on the students' tablets. Finally, it becomes a problem. I encountered this problem last time. I prepared something to push on tablets on the topic plants. I took pictures from the school yard to show students in class, only when it was time to project the images on the board, I was not able to connect my laptop with projector. I had to improvise to do my class without the tool. So, it will be a problem if there is an issue with internet connectivity on the day, we want to use e-assessment.

Adding to the above, the educators felt that they needed to be adequately supported to prepare lessons and carry out e-assessment. They recognised the advantages of e-assessment as being paperless, reusable and providing them with instant feedback. They also stressed the multimodality of e-assessment whereby they can include pictures and other media in the questions. As a golden thread through the interview, the educators described the technology as both useful and disruptive. To resolve disruptions at school level, educators felt that they needed more support in terms of an *assistant teacher* or *a helper.* Help was indeed deemed necessary, as the educators said they struggled to give timely feedback through the CMS to students in the cases where they had implemented e-assessment. As regards feedback, the number of students was also problematic.

To this effect, educators asked for more support in school in terms of pacing and spacing teaching and learning and out-school in terms of policy decisions. Regarding the pacing of academic activities, educators felt that they needed time at school to discuss with colleagues and prepare lessons and e-assessment. They would need to be supported by school management in terms of preparatory time available at school. They felt that this could be possible if they got less replacement classes. Moreover, they identified overcrowded classroom as a thorny issue for the proper use of the technological system. Educators also wanted out-school support. They wanted to ensure continuity in learning by completing the learning cycle through feedback to the learners. This may be possible if they could take the laptops home.

7.5 Conclusion

The evidence presented above reveals that educators did not move to level 4 of Kirkpatrick's model (Holton 2005). Level 4 implies that educators would not only be able to implement the technology at classroom level but also bring some transformation in teaching and learning practices that could be captured by either the SAMR model or the Triple E framework. As evidenced by the above-presented data, educators

were able to work at Substitution and Augmentation levels, only enhancing their practice and learning as per Puentedura's model (2013). Researchers such as Clark et al. (2021) believe that educators tend to remain at these two levels of technology integration. However, educators have been inclined to remain at the Enhance stage in the Triple E framework. The evidence also pointed to a host of factors that could either impede or help educators to adopt and implement technologies.

Three sets of factors can be identified from the evidence. Firstly, there are in-school factors such as the teaching and learning space, and support from school management. The second set of factors is out-school factors. This set can be further unpacked in terms of the policy framework (for example, whether educators are allowed to take laptops home for preparatory work), the CPD available and technical support (includes connectivity configurations). Lastly, as stated by Geer et al. (2017), educators still need to skilfully plan their lessons. Therefore, their skills, knowledge and attitudes are critical. These sets of factors can be plotted on a radar diagram to evaluate the degree of technology integration in an educational context. The radar chart is shown in Fig. 7.7:

The WAVI (an acronym of the authors' first names) radar diagram shows the capabilities of educators to integrate technology in a given educational context. The exact metrics of the WAVI diagram need to be developed for a more accurate reflection of the uptake of technology. This could be the focus of another research study. However, though at this stage the figures are arbitrary, the diagram can help to understand the situation of educators with regard to technology integration in teaching and learning. For example, the factors for Educator 1 are listed in the table below.

	Factors	Remarks	Ratings
1	Teacher attitude	The educator wanted to work with the technology	6
2	Teacher knowledge	The teacher had limited knowledge of how to enhance and extend learning	3
3	Teacher skills	Her level of knowledge impacted on her skill, though she mastered the CMS functionalities fairly well	4
4	Support from school management	The lack of support from management to be able to have time for preparatory work at school	3
5	Teaching and learning space	The classrooms are overcrowded	4
6	Support	Connectivity is poorly configured at the school	2
7	CPD	Did not follow the online learning modules. Only F2F training	2
8	Policy framework	Teachers are not allowed to take their laptops home	2

From the above data, a new WAVI radar diagram can be plotted for Educator 1 (Fig. 7.8).

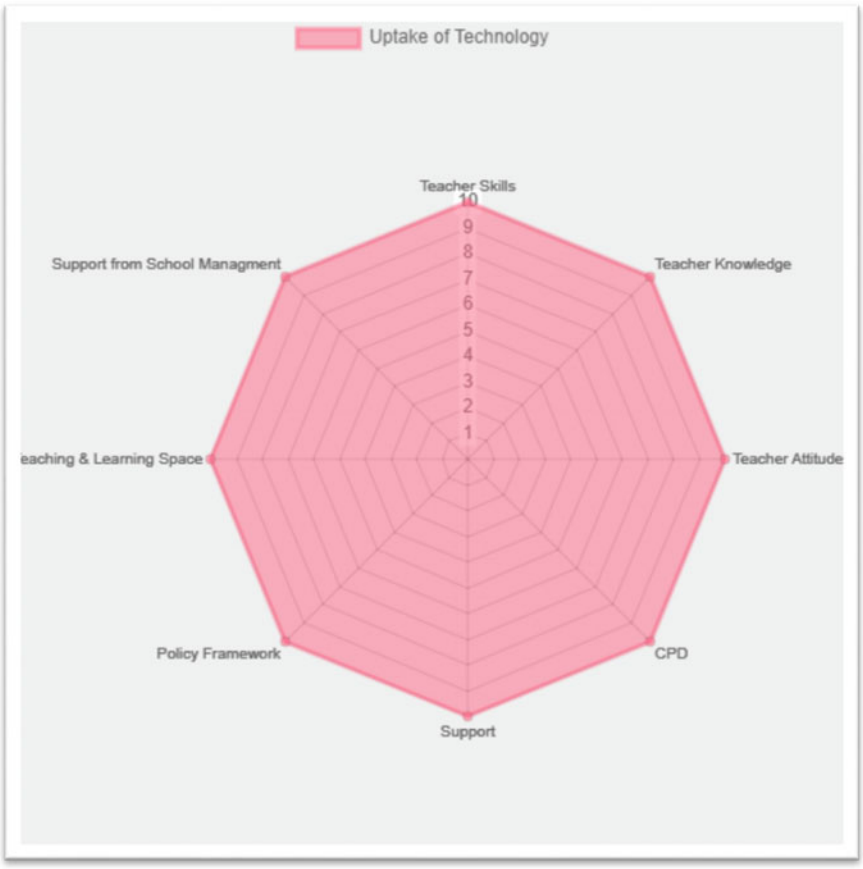

Fig. 7.7 The WAVI radar diagram

As mentioned previously, the figures are arbitrary and must be worked out thoroughly to reach a more accurate representation of uptake of technology in classrooms.

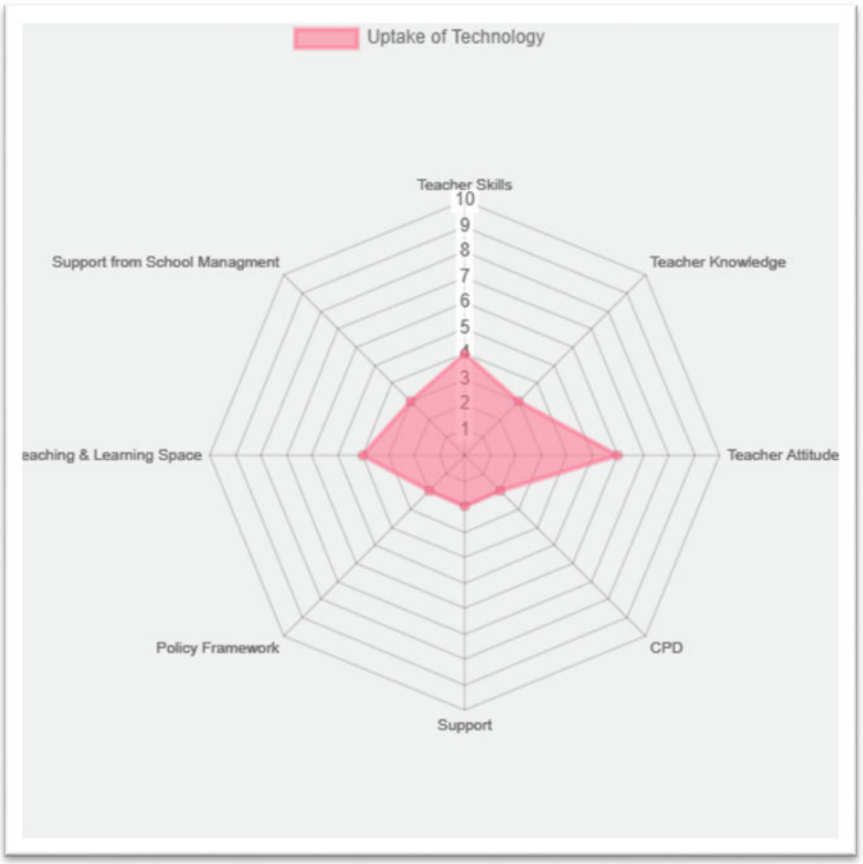

Fig. 7.8 Plotting the factors for Educator 1 in WAVI radar diagram

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Chapter 8
Teaching In-Service Primary School Teachers Through Webinars

Waaiza Udhin and Avinash Oojorah

Abstract The COVID-19 pandemic has ushered in a new era of innovation in teacher education. Many teacher educators around the globe have been forced to reconsider their practices. Forced lockdown across the globe meant that teacher educators and their audiences could not meet face-to-face in classroom contexts. This triggered an increased use of online tools such as Zoom and MS Teams, with live events (such as webinars) and asynchronous methodologies such as discussion forums. Beyond the mere use of online tools, we were also prompted by the pandemic situation to genuinely think about how we were delivering teaching and content to our students. In the context of a session on Global Perspectives on Teachers' Professional Practice in an in-service course for practising primary school teachers, we had serious discussions on what content would we offered to our students. Most educational institutions have since had recourse to webinars, and we rethought our content offering; a webinar would replace texts we plan to upload to our e-learning platform. There were many organisational considerations—some of them unanticipated—that had to be dealt with. This chapter gives insight into how we organised, implemented the webinar and assessed the learners' experiences of the event. The chapter relies on autoethnographic data from our notes, e-mails and other documents that chart the preparation and implementation of the webinar. We also relied on online ethnographic data of students' notes on the webinar to provide readers with insight into their conceptualisations of the event. While writing this chapter, we tried to foreground the conceptualisation of the webinar and its meaningfulness as a learning activity without downplaying the technological configurations that were involved.

Keywords Teacher education · Digital learning · Webinars · Primary education · In-service training

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8.1 Introduction

The Mauritius Institute of Education (MIE) was established in 1973 with the mandate to design and develop school curricula and to ensure teacher education and research in the field of education. In the fulfilment of its mandate, the MIE has had to integrate ICT in teacher education. The shift to online learning has been one of the most prominent contributions in terms of the mode of delivering teacher education courses at the MIE. Besides negotiating the technological challenges, the MIE also had to shift to pedagogies attuned to the affordances of an online learning environment. Furthermore, in the context of continuous professional development (CPD) of primary school educators, the MIE had to deal with an audience almost exclusively made up of digital migrants. Hence, the lived experiences of teacher educators as well as those of students are evocative of techno-pedagogical challenges they must overcome to make optimum use of digital technologies in teaching and learning.

Moreover, the COVID-19 pandemic brought another dimension to the above-mentioned challenges. Campuses and schools were closed. According to UNESCO, 1.5 billion students have been affected by schools and university closures worldwide (UNESCO 2021). Hence, the MIE had to suggest solutions for our students.

8.1.1 The Webinar Context

The pandemic situation around the globe has greatly disrupted academic calendars. In Mauritius, educational institutions have been closed twice for many weeks since March 2020. Even when schools and campuses re-opened, students and staff were encouraged to either work from home where possible or implement staggered classrooms with social distancing between students. It is within this difficult context that Bachelor of Education (BEd) primary students had to study for their Professional Practice Portfolio (PPP). The PPP is a learning experience spread over three semesters. The aim of the PPP is to provide students with opportunities to enhance their twenty-first-century educational skills while reflecting critically on the application of key concepts from different subject areas/disciplines to classroom situations. The webinar activity was scheduled for the second part of the PPP. Students accessed content on PPP through MOODLE and created their portfolios on MS OneNote.

More specifically, the activity was on learning about Global Perspectives on Teachers' Experiences using Technology in the Classroom. The learning resource for this theme took the form of a webinar with the same title. Two hundred and forty students had to attend the webinar on the Zoom platform and upload a critical essay on the presentations. The students were in-service primary educators with over 15 years of experience in the field. They enrolled in the BEd primary part-time course offered in a blended mode at the MIE for their CPD, even though most of them were not technology-savvy. The BEd primary programme allowed the educators to get an

online learning push, and they were able to experience new ways of learning through EdTech.

The researchers were the main organisers of the webinar activity. From their professional network, they searched for educators and professionals in the primary education sector around the world to talk about their experiences of using technology in their classrooms or schools. Interveners were communicated with via e-mails, WhatsApp and Zoom. Regular meetings were set with all interveners to ensure smooth running of the international webinar. The webinar was chaired by one of the researchers in this study, and the interveners were from the United Kingdom, Dubai, Nigeria, Bhutan and India. All students of the BEd primary cohort were invited to participate in the webinar activity to be able to discuss the activity in the discussion forum on Moodle thereafter.

8.2 Webinars in Education

Webinars are online tools that can transmit data in the form of audio, video images, text chat and sometimes include features such as whiteboards (Wang and Hsu 2008). *Webinar* is a blend of the two words *web* and *seminar*. Webinars exist in different formats and models. Webinar formats include presenter and multiple participants in one location; presenter and participants in many locations; multiple participants in one location; and multiple participants in many locations, and so on.

The discussion on webinars in education can be clearly demarcated along the pre-COVID and post-COVID line. Webinars have been identified as innovative and indispensable tools for online learning in higher education (Ahrens et al. 2016). They have been conceptualised as tools that would promote closer synchronous interactions among students and tutors, as higher education has transitioned to online learning. These tools have ushered in some changes in the higher education landscape since 2012 (Brooks 2012).

Digitisation has also impacted distance education so much that researchers now recognise that distance education technologies can broadly be organised over three models (Krivova et al. 2020). Firstly, case-based models encompass the use of websites to deliver content and the involvement of faculty for online tutoring. These include Learning Management Systems (LMS) (Barley 1999). Secondly, we have translational models that include video transmission that does not entail interaction among tutors and students. Thirdly, network models that require faculty to master the technology—cloud based. The latter model includes webinars.

We can infer from the evidence above that webinars are not a completely novel tool and didactic strategy (Clay 2012; Pluth 2010) in the higher education environment. However, they have not been well researched and theorised in teaching (Černý 2019). Webinars have been very promising tools as far as their interactive format and economic gains are concerned (Verma and Singh 2010). Indeed, webinars have been cited as innovative means to improve student understanding, enable productive

learning (Polanco-Bueno 2013) and reinforce the online social and technological presence of faculty members (Sweeny 2009).

What has changed with COVID-19? The pandemic situation was an enormous prospect for webinars (Hidayati et al. 2021). The pandemic compelled the education sector to find emergency solutions for remote teaching to face the massive disruptions to the school calendar (Toquero and Talidong 2020). The question that had to be answered was how we could proceed with education in times where physical distancing was lifesaving (Torrau 2020). The whole education system fell apart with the advent of COVID-19, and educators across systems and levels of education shifted to online learning (Mishra et al. 2020). *Lockdown* became a commonplace word. Suddenly, there was a scramble for platforms for Zoom and MS Teams. The actors felt compelled to embrace more convincingly digital tools and online learning (Lederman 2020). A re-think, revamp and re-design of education resonated somewhat with Illich's (1971) *Deschooling Society*. The sector needed to learn to master new tools: webinars.

Webinars have proven to be useful in education (Abdelhafez 2021). Firstly, webinars were used to provide remote teaching support in terms of video conferencing (Maher 2020). Global webinars were efficient tools that reached teachers globally (Shin and Borup 2020). This efficiency was augmented by the support of social media tools. Secondly, webinars were also used to provide teachers with crisis professional development and support to shift to innovative digital strategies (Canipe and Bayford 2020). Webinars also provided teachers and learners with much-needed alternative experience. In teacher education, webinars were pre-recorded and uploaded to LMS for students. This enabled students to have more time to reflect and critically analyse various interveners in webinars (Isacsson et al. 2018).

However, webinars are not straightforward to implement. Peuler and Mcallister (2019) highlighted the preparation involved to set up a webinar. Planning for teaching on a webinar mode can be complex. The timing, quality of interveners, hosts, chair and the questions-and-answers (Q&A) management are some of the aspects that need thoughtful consideration (Torrau 2020). The speakers could be subjected to the fear of presentation (Marks 2014). Untrained and unprepared webinar hosts and speakers can also be frustrated by technological issues (Genet 2013). Sometimes, lack of preparation results in stressful experiences for those who want to deploy webinars as learning tools (Lim 2020).

The affordances of this mode of delivery and pedagogy should also complement discussions of the uses and implementation of webinars. Affordances, as explained in the Affordance Theory of Gibson (1979), are the perceived possibilities of action that are offered by tools and objects (physical and on-screen). Affordances can be seen (Gibson 1979) or perceived. Sounds may also convey affordances (Gaver 1991, 1992). Furthermore, affordances are linked to emotions (Jensen and Pedersen 2016). Affordances are neither solely the properties of the human nor of the environment alone; they are dynamic interactions between humans and the environment (Chemero 2003). Face-to-face interactions can avail participants with possibilities of co-action, co-thinking and co-feeling (Jensen and Cuffari 2014; Pedersen 2012). Therefore,

opportunities that enable people to see other opportunities and horizons are themselves affordances (Hodges 2007). Visuals, sound cues and facial expressions are also elements that determine our affective involvement in a particular event and shape our responses (Colombetti 2014; Johnson 2007).

Technology affordances can be described as possibilities for behaviour that can achieve a concrete result, arising from the relation between an object and a goal-oriented actor (Volkoff and Strong 2013). Technology affordances can be broadly classified as either functional or social. Functional affordances can be further unpacked into visibility, persistence, editability and association (Treem and Leonardi 2012). Visibility means that users can make their behaviours, knowledge and preferences that were previously unseen, seen. This also refers to the possibilities available to the users to present information. Visibility can also trigger metaknowledge. Technology with strong visibility affordance can transmit who the people in a communication are and what they know. Persistence has also been conceptualised as *reviewability* (Clark and Brennan 1991) or *recordability* (Hancock et al. 2007). This affordance simply refers to the ability of the user to review or re-experience the event after it has taken place. Editability refers to the capability of the user to modify or revise the content. Lastly, association affordance can be defined as the possibilities for connection between users, user and content. Association can be elicited in social ties. On social media, these may take the form of "likes" and "tags". Social affordances are created by the technology's physical characteristics that invite social interactions. These affordances may be used to initiate and sustain social interactions. Social interactions may have a crucial repercussion on the creative capabilities of the user (McGrath 2016).

Aside from functional and social affordances, the concept of technology educational affordance is also making some inroads on the educational landscape (Badia et al. 2011). This concept refers to the real and potential usage of technology for educational goals. In this regard, five real and potential prospects can be identified. Firstly, technology can be used as a cognitive tool, helping students to think, construct and scaffold knowledge (Jonassen and Reeves 1996). Secondly, technology can underpin student-focused models of learning, as posited by Barab et al. (2000). In line with this model, students actively construct knowledge using technology. Technology also caters for personal interactions, relationships and a sense of belonging to support learning and motivation. Thirdly, technology can be used as a learning tool to promote skills, knowledge and understanding of students in a particular educational domain. Fourthly, technology can support students to enhance their learning capabilities and skills. Fifthly, technology can be an effective tool (Twining 2002), meaning that it will reinforce emotional and intuitive elements of learning.

In line with the above, webinars offer students the possibility to feel connected with the lecturer(s). The personal nature (viewing the speaker, hearing their voice) was critical in this regard (Exter et al. 2012). Instant communication and collaboration are also affordances that can be ascribed to webinars. This aspect offered students more collegiality, the freedom to discuss and ask questions. Students also felt that the webinar mode, being synchronous, offered more interactivity as compared to asynchronous online learning (Stephenson and Downing 2012).

8.3 Methodology

The aim of this study was to explore how webinars are used in teacher education, and the main objective was to examine the integration of a webinar in the learning experiences of educators. An exploratory research design was adopted, and an interactive approach was used to produce data, soliciting mixed methods. Exploration in the context of this study entailed investigative and innovative exploration (Stebbins 2001). As researchers, we attempted to investigate the use of webinars and gain insight into the use of a webinar for teacher education. Mixed methods refer to the integration of quantitative and qualitative data in a single investigation (Wisdom and Creswell 2013). This approach was enacted through a questionnaire in the first phase, followed by a focus group interview. Moreover, the responses to the webinar video and reflective data of the researchers were also collected. The instruments used to collect data were interview schedules and questionnaires.

Data were collected from various sources to ensure authenticity and trustworthiness of the research. The online ethnographic data were obtained from the focus group interviews, students' feedback through online questionnaires, e-portfolios of students and the researchers' journals. The quantitative data obtained from the questionnaires were compared, integrated and interpreted against the qualitative data obtained from the interviews and discussion forums.

The sequential design included a quantitative phase that was implemented through a questionnaire. A questionnaire was designed to capture appropriate analysis (Acharya 2010). A questionnaire consisting of five closed-ended questions and two open-ended questions was designed to capture data on the experiences of educators of the webinar. The questionnaire was compiled and hosted on Microsoft Forms. The link to the questionnaire was sent to 100 educators via the Moodle LMS. All the educators were enrolled in the professional BEd course. There was an acceptable response rate—52 educators submitted their views. A statistical analysis of the responses from the questionnaires was then conducted.

Subsequently, a focus group interview was conducted with a group of participants to collect multiple information about the phenomenon. The number of participants in a focus group interview can be as small as four and sometimes as large as 10 (Statistics Solutions 2021). For this study, e-mails were sent to 44 educators—10 responded positively, and informed consent forms were obtained from all of them. The researchers chose to use MS Teams to conduct the interviews because of the COVID-19 pandemic. Upon agreement of all participants, the responses were recorded, and polls were used to confirm generalities from the responses. The focus group interview comprised of six generic questions, guiding the educators to discuss their learning experiences of participating in the webinar activity. The duration of the focus group interview was one hour, and the moderators' goal was to initiate maximum discussion and opinions during the interview.

Furthermore, the contextual nature of this research warranted capturing the organisers'/researchers' stance. This would highlight how the event and meanings related to the event were co-constructed by the researchers and the participants (Guba and

Lincoln 1994). The researchers' reflexive stance can be crucial for the complete understanding of the webinar. Through an account of lived experiences, we can bridge meanings of the participants and the researchers (Rodgers 2005). This sharing of the researchers' perspective brings more openness to the study and towards others, as one searches for commonalities, differences and even absences (Sharma et al. 2009).

Lastly, students were asked to make sense of the webinar through an activity that had to be posted on their e-portfolios. E-portfolios have grown in importance as research sites in the Internet space (Prokopetz 2021). They are located within the array on online activities. The activity entailed choosing presentations of panellists from two different countries, summarising the chosen presentations and comparing them. We analysed the data from the e-portfolios both quantitatively (in terms of the choices students had made) and qualitatively (why they had made such choices). The researchers, as tutors in the Professional Practice module, had access to the students' e-portfolios and acted as unobtrusive observers. As tutors, the researchers read the students' texts regarding the webinar. In this context, the researchers were akin to *lurkers* (Salmons 2015).

The procedure for analysing data was done at three levels. At level 1, data obtained from the focus group interview were transcribed, and the researchers created the data set from the data obtained from various sources. The data generated from the questionnaires and interviews were anonymised by removing all identifying information and were treated confidentially by using a coding system. The questionnaire was pilot-tested to ensure face validity and construct validity. Moreover, the internal reliability of the data was ensured by reviewing the questions based on the responses from the pilot study and the external validity by asking other tutors who delivered the module to cross-check the questions. Only the researchers and persons who held an official and ethically bound role at the MIE in the context of this research had access to the anonymised transcripts. The initial themes and subthemes were extracted. At level 2, the themes on learning experiences of educators were analysed, and initial conclusions were drawn. At level 3, the qualitative data were analysed against the quantitative data. Methodological triangulation was done. Methodological triangulation is the "use of two or more research methods in a single study" (Kimchi et al. 1991). For this study, qualitative data were collected through the focus group interview, e-portfolios and researchers' journals to gain insight into the phenomenon of the study, and qualitative data were analysed against the quantitative data obtained from questionnaires to increase convergent validity of the findings. This combination of both qualitative and quantitative methods provided us with a deeper understanding of the learning experiences of in-service teachers through webinars. Finally, the final conclusions were drawn.

8.4 Discussion and Conclusion

8.4.1 The Organisers' Lived Experiences

We have just been through several waves of lockdown due to COVID-19. This has caused the school calendar has been disrupted. We could not have students on site for face-to-face sessions. We have also moved all our courses online. So, for the PPP2 module, we had to think out of the box. How could we provide students with a learning experience that would be able to connect them with their peers and foreign contexts that they had to learn for PPP2, simultaneously motivating them to learn?

The idea struck us as we were regularly being solicited to attend webinars by various higher education institutions locally and globally. Moreover, we organised an international webinar on the Zoom platform with the theme "Addressing challenges posed by mass closure of schools during the COVID-19 Pandemic: lessons from international context" held on 26 June 2020 (link: https://tinyurl.com/y94xkaz3). The panel consisted of speakers from South Africa, Malaysia, France, Cameroun, India, and Mauritius. We had the experience. We could do it again. We started planning for the webinar activity in the PPP2 module two months before, resonating with Macallister's (2019) recommendation for planning. The key challenge was to search for panellists with the necessary background and experiences from various parts of the world. We used our professional network and sent invites through mails to candidates with the appropriate profiles to participate in the webinar. Once the panellists were identified, regular meetings were conducted with each panellist to ensure that the objectives of the activity were met. Meetings were not straightforward. We faced many issues such different time zones and technical issues such as connectivity. Aside from polishing the technical issues (sound and screen sharing were all tested with the speakers), we also spoke to the presenters to make them feel at ease with the audience they were to encounter. We wanted to mitigate the technical issues (Genet 2013) and the fear of presentation that could arise (Marks 2014).

As D-Day neared, we delved into more organisational issues. We had to set up the webinar software and choose the persons who would be chairing and moderating the webinar interactions. The Zoom platform was chosen for the purpose because we had experience working with it. We re-activated the Zoom account created for the previous webinar and enabled the webinar feature through a paid plan. The account settings for the webinar were set to ensure that the objectives of the activity were met. Firstly, the waiting room was disabled to facilitate participants to join the webinar. Secondly, we opted for the webinar passcode and personal webinar ID to provide participants with an alternative to log in to the webinar. The link to the webinar as well as the passcode and ID were automatically generated by the software, and they were included in the invites sent to the participants. Thirdly, the video settings were set. Only the host and the panellists were given the option to enable their videos during the webinar. The reasons behind this decision were to reduce the bandwidth, thus optimising the internet connection during the webinar and for better control. The same was applied for screen sharing. Only the presenters (panellists) were able

Fig. 8.1 The webinar activity

to share their screen during the presentation. It should be noted that 240 students were invited to the webinar. Fourthly, the computer audio settings were enabled for the host and panellists only for better management. Fifthly, the participants were not allowed to join before the host out of respect for the panellists and the host. Sixthly, the chat feature was disabled but the Q&A feature was enabled for the participants. The panellists had the option to reply to all the participants or to specific participants. From our experience, we noticed that in the Q&A, formal communication was made rather than through the chats. The host was the only one who had administrative rights on the platform during the webinar. The host could manipulate the settings and provide necessary access as and when required during the webinar. The webinar was recorded with the permission of the different stakeholders and saved on a computer. All of these are in line with the writings of Torrau (2020) on webinar preparation. We had a few issues to deal with. For instance, the UK presentation was pre-recorded. We had to schedule it according to the programme. Also, we had to prepare a programme and a poster to invite students to the webinar. Figure 8.1 below shows the poster designed for the webinar activity.

Through this webinar activity, we as organisers enriched our networking with professionals in the field of education at international level. We did not know anyone from Bhutan or Dubai, for instance. Moreover, this webinar afforded both organisers and students the opportunity to engage in constructive discussions around the theme of teachers' professional practice at international level. The moderators grouped the common questions from the Q&A and at the end of the presentations, the webinar's chair asked common questions to the respective panellists. Moreover, the students had the opportunity to interact at an individual level with the panellists through the Q&A. It was observed that using such an activity in teaching and learning gives students exposure to global contexts. Students were able to gather rich information about teaching in diverse contexts and thus reflect on them from their own experiences and contexts. This webinar activity concurs with what Polanco-Bueono (2013)

put forward, as they were innovative means that helped in promoting students' understanding, leading to productive learning (Sweeny 2009). We really felt satisfied at the end of the event.

8.4.2 *Feedback from the Students—The Questionnaire*

The questionnaire administered after the webinar was used as immediate feedback from students on the activity. An overwhelming 97% were either satisfied or very satisfied with the event. A few students expressed their dissatisfaction, as they had technical issues and could not connect to the event. Technical issues such as poor internet connectivity, locating and using the Q&A on the webinar platform can be quite frustrating (Genet 2013; Lim 2020). However, the organisers ensured that an edited version of the webinar was posted on the e-learning platform so that students could view it again at their convenience. This follows the case-based model of delivering distance education (Barley 1999; Krivova et al. 2020). In fact, the use of the LMS reinforced the network model of using only the webinar. The mix of these two models of distance education ensured that students found the activity useful as primary school educators, even though some of them had difficulties following the live event. In this way, the webinar's potential as cognitive tool was optimised to promote students' thinking and knowledge construction (Jonassen and Reeves 1996). We also capitalised on *recordability* (Hancock et al. 2007). Figure 8.2 below shows that all of them found it useful.

Regarding the country presentations, the students positively welcomed the Dubai, Indian and Bhutanese presentations. Figure 8.3 below explains. The Dubai presentation was rich in visuals, capitalising on key affordances of webinars (Johnson 2007;

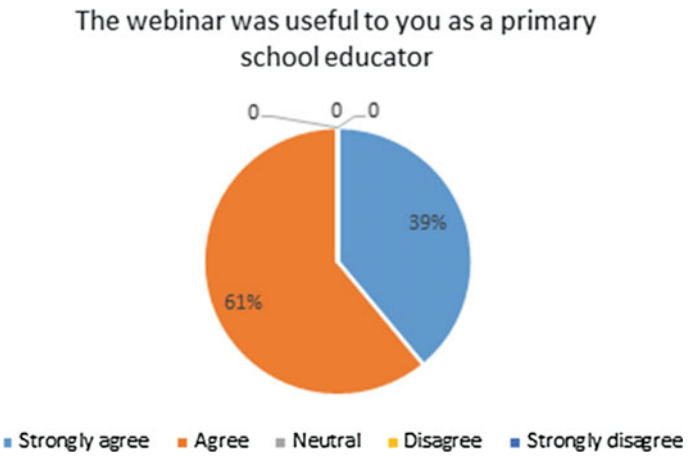

Fig. 8.2 Usefulness of the webinar activity

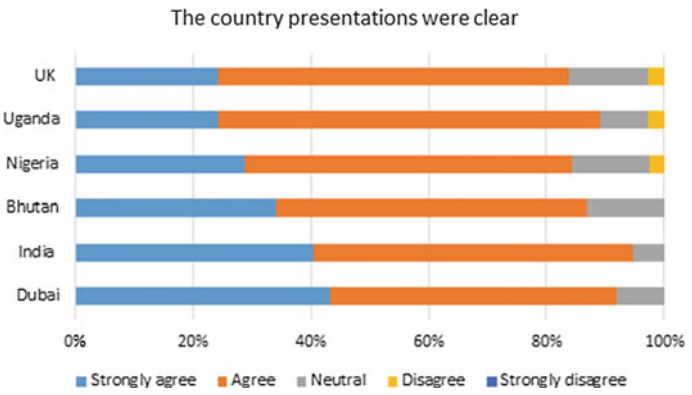

Fig. 8.3 Clarity of presentations in the webinar

Colombetti 2014). The UK presentation was pre-recorded. Therefore, this could have accounted for some disagreement on the clarity of the presentation. The presentation was less dynamic (Chemero 2003) than the live ones, offering less possibilities to co-feel (Jensen and Cuffari 2014; Pedersen 2012), hence, denting its appeal. Live presentations could have instilled an emotional element in the webinar (Twining 2002).

Related to the above, the students were also asked how interactive they found the event. Fifty-five per cent of the students agreed that the event was interactive, with 11% strongly agreeing, and 11% disagreeing. It is noteworthy that the students had only the Q&A feature to interact with the speakers, the chair and moderators of the event. We believe that the Q&A feature was adequate for promoting active participation and construction of knowledge. The panellists and moderators also personally replied on the Q&A, hence, bringing personal interactions and relationships to support learning (Barab et al. 2000).

8.4.3 Feedback from the Students—The Focus Group Interview

The focus group interview was lively and interactive, generating fruitful data for this study. The interview was conducted remotely on MS Teams due to the pandemic situation and social distancing measures. Nevertheless, it allowed us to delve deeper into the learning experiences of students who participated in the webinar activity in the module PPP2. The main themes extracted from the focus group interview were as follows: (1) Development of new skills and experiences; (2) Engagement through participation; (3) Broaden horizons; (4) Enhance knowledge; (5) Became a reflective practitioner and (7) Confidence in the application of skills.

Development of new skills and experiences was the most common response in the focus group interview. None of the participants had participated in a webinar prior this webinar activity. Eight out of the 10 participants stated that they became familiar with webinar tools during the webinar activity. Two participants further described the application of the knowledge and skills gained from the webinar in their professional practice. This resonates with the concept of "technology affordances", precisely "functional affordances", whereby students developed and applied new skills and knowledge (Treem and Leonardi 2012). Due to the COVID-19 restrictions on group gatherings, traditional models of information dissemination were not possible. Two teachers stated that they were able to optimise the skills learned in the webinar activity and conducted online meetings with parents and students during the pandemic. They said that they were confident enough to use the technological tools and empower their peers. These outcomes reveal that the learning experiences gained from the webinar activity allowed the teachers to embrace confidently and convincingly the digital tools and online learning to cater for teaching and learning during school calendar disruptions (Leaderman 2020).

The second theme that emerged from the focus group interview was *engagement through participation* in the webinar activity. All the participants agreed that they had the opportunity to participate constructively in the webinar activity through the Q&A feature. The webinar inspired them to broaden their scope of knowledge on how social and topical problems are dealt with in other contexts. The teachers claimed that they felt connected and motivated to share their experiences with others. These findings confirm the point made by Verma and Singh (2010) about webinars being very promising tools for (remote) interactions. The interviewees cited that they had achieved deep understanding of professional practice in different contexts through the webinars. This resonates with Polanco-Bueno's (2013) postulation that webinars are innovative means to improve student understanding and enable productive learning. Moreover, four participants explained that the originality and liveliness of the panellists during their presentations in the webinars allowed them to live the experiences compared to reading texts. This echoes active construction of knowledge through personal interactions, relationships and sense of belonging to support learning and motivation (Barab et al. 2000). Participants could also strengthen their emotional and intuitive elements of learning (Twining 2002). Another important point raised by one participant involved her own personal experience of having had to travel to China in 2012 to learn about the Chinese education context. She claimed that the webinar provided her with a similar learning experience without travelling and at no cost.

Another dominant theme of discussion in the focus group interview was the opportunity to *broaden horizons* and connect with new people and contexts. The teachers interviewed for the purpose of this study were able to build virtual global knowledge about professional practice of educators from varied international contexts. They commented that exposure to teaching from Bhutan, India, Nigeria, Dubai and the UK in the webinar permitted them to reflect on other dimensions and perspectives of teaching and learning in varied international primary school contexts. The data from the focus group interview helped to address the question raised by Torrau (2020) as

to how to proceed with education in times where physical distancing is crucial. Webinars can reach a large audience in real time and across diverse geographical barriers without the need to travel long distances. One participant added that connecting with people from various parts of world was made possible by just a few clicks in an online mode. However, good connectivity remains the key to reaching out to the world through webinars. Coupled with the notion of reaching professionals in the field at the global level, the webinar activity also proved to be convenient and lifesaving during the pandemic.

The aim of the webinar activity was to *enhance knowledge* of the students in their profession. The data reveal that the aim was successfully attained through the webinar activity. All the participants in the focus group interview believed that their knowledge in the field of education and technology was enhanced from varied angles. One participant suggested that through the webinar, she was able to learn and compare teaching and learning at primary levels from underdeveloped, developing and developed countries. These findings are in line with the concept of "functional affordances" where the participants could activate metaknowledge by comparing the information from different presenters in different contexts (Treem and Leonardi 2012). They were able to extract the similarities and differences from the different presentations and thus prove a critical examination. Besides, "association affordance" was present, as possibilities for connection between users and content were evident (McGrath 2016). Amongst others, six participants claimed that they could grow professionally and shed light on the new instructional strategies used in diverse contexts, and this could eventually inform the move towards an enhanced education system. Furthermore, one teacher in the focus group interview opined that webinars could also help in bringing together different specialists from different educational fields, for example, teachers, psychologists, curriculum development, and officers from the Ministry. So, once more, the findings confirm that webinars help in transforming the world into a global village whereby professionals in various fields can communicate and exchange knowledge, opinions and perspectives. Thus, the webinar activity allowed the students to reflect on improving their current practices and exchanging innovative teaching practices and methods.

Feeling connected to their professional counterparts and becoming aware of other professional contexts in education prompted students to *reflect on their own practice*. They became acutely aware that the environment/geography had a deep impact on how teaching and learning was organised (especially through the presentations from Bhutan, India, and Nigeria). The sheer number of schools and educators was impressive. Furthermore, the webinar also allowed them to conduct a comparative study in other contexts. The students stated that at times, they tended to believe that the issues they faced in teaching and learning were unique. However, during the webinar, they encountered issues that were similar, such as teaching using mother tongue, the integration of ICT, conceptualisations of basic education, and so on. In this regard, the outlier in the webinar was Dubai. The high standard of living in Dubai and a vibrant, privately funded education system meant that its residents could afford state-of-the-art schools.

Lastly, the participants in the focus group interview expressed their *confidence in applying the skills* and ideas that were transmitted to them during the webinar. When asked whether they would be able to host or participate as a speaker in a webinar, the interviewees responded positively and with great zest. The interviewees would relish opportunities to connect with their counterparts in other contexts. They felt that implementing a webinar would be doable for them, provided that they had technological support. They expressed that in times of isolation and lockdown, deploying webinars would solve some pedagogical issues. Moreover, the interviewees felt that it was imperative for them to connect with regional colleagues of the island states in the Indian Ocean to share professional practice regarding issues such as conflict resolution and classroom management, assessment and evaluation, school-based research, trends and challenges in the education sector. More specifically as regards the current pandemic situation, the participants believed that webinars could be used to interact with parents, especially those who were not vaccinated and could not enter the school premises.

8.4.4 Making Sense of the Webinar Activity

Lurking on e-portfolios enabled the researchers to gather a wealth of information on the webinar activity. Firstly, the choice of the students was analysed. Figure 8.4 shows the countries the students chose to complete their assignments.

Figure 8.5 shows that most of the students (31%) chose Nigeria, followed by Bhutan (25%), Dubai and India (17%). Uganda and the UK were both chosen by only 5% of the students. This data set from the e-portfolio is supplemented by the qualitative elements that were present in the write-ups. The major theme that drew students to choose Nigeria was the fact that the presenter foregrounded the nine-year basic

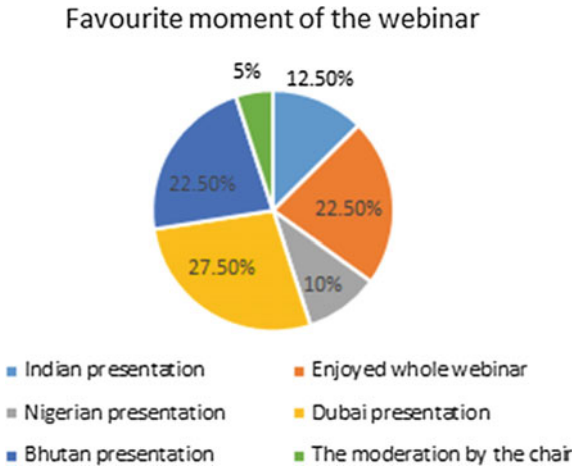

Fig. 8.4 Favourite moment of the webinar

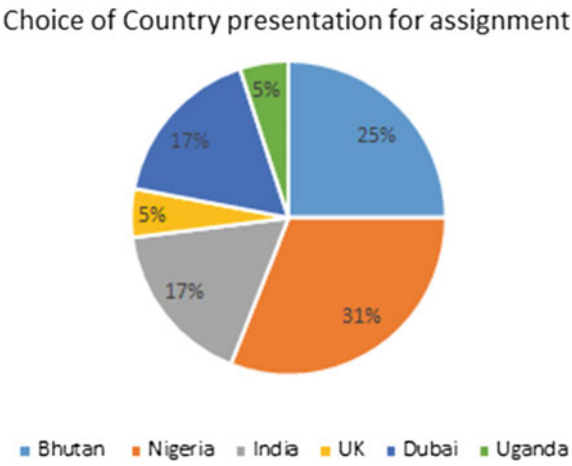

Fig. 8.5 Choice of country in assignment

schooling model. This resonates with the Mauritian context, where the educational reforms are known as the Nine-Year Continuous Basic Education (NYCBE). This could have enunciated feelings of sharing the same educational issues. This reflects the idea of co-feeling (Jensen and Cuffari 2014; Pedersen 2012). The Bhutanese presentation also touched a local chord. Twenty-five per cent of the students justified their choice for Bhutan by mentioning the fact that the country focused a lot on teaching using its mother tongue, Dzongkha. Mother-tongue instruction is a burning issue in the Mauritian context. Hence, the students felt connected (association affordance) to the above-mentioned contexts (McGrath 2016). The themes developed by the presenters elicited emotional and spontaneous connections with the audience (Twining 2002).

Moreover, those who chose the Dubai presentation cited that their choices were motivated by the pedagogical strategies used by the schools there. Project-based learning and inquiry-based learning were mentioned several times in the e-portfolio write-up. The choice of India, on the other hand, was motivated by the diverse nature of the Indian educational system. Students recurrently mentioned the multiplicity of examination boards, the number of languages, and the sheer number of schools in their write-ups. The reason for choosing these countries for the assignment could be different. However, they all point to an affordance created by the webinar. The activity broadened the students' horizons, reflecting Hodges' (2007) findings that the opportunity to see people and through them other contexts is an affordance of webinars. Moreover, the presentation from Dubai was rich with impressive visuals. This could have shaped students' choices (Colombetti 2014; Johnson 2007); sounds and visuals could be key affordances of webinars, confirming the data produced in the feedback questionnaires.

The presentations from the UK and Uganda were not very appealing to the students for the assignment. Going back to the findings from the questionnaire 24% of the students found the UK presentation to be their least favourite moment of the webinar.

8.4.5 Conclusion

The conclusion is two-fold. Firstly, we discuss how the event could have been enhanced from the feedback obtained from the focus group interview. Secondly, the affordances of webinars—namely functional, social and educational affordances—are considered. The concept of replication affordance is also put forward, as evidenced from the data produced in the focus group interview.

Though both students and faculty members were satisfied with the organisation and the outcomes of the webinar, we felt that there could be room for improvement. Indeed, students suggested a few ways in which the webinar could have been better attuned to their needs. For instance, some of them believed that students should have been allowed to intervene live during the event. However, as organisers, we do not think this is a good practice. All webinars we attended, especially during the lockdown periods due to COVID-19, were set on the same mode as the webinar under the research lens for this study.

However, the respondents in the interview may have had a point when they expressed that they had experienced information overload during the webinar. There were six presentations that each lasted for 10–15 min. The event duration was almost one and a half hour. Though the event was interesting, it could have been taxing on some participants. Taking into consideration the responses regarding information overload, fewer presenters would have been an ideal situation. In the same vein, participants also wished for more time to intervene and interact with the presenters. This would have been possible if there were fewer presentations.

This study explored the usefulness of webinars in teacher education. The data evidenced the presence of technology affordances in teaching and learning through webinar activity, especially related to the *recordability* (Hancock et al. 2007) of the event. Moreover, the behaviour of the participants in the webinar uncovered functional, social and educational affordances. The cognitive gains, collective construction of knowledge, skills and abilities through interactions and the emotional/intuitive elements of learning (Twining 2002) of the students conclude that webinars used as an educational activity have the potential to meet specific educational goals in the 21st century.

Moreover, the students also grew in confidence after experiencing the webinar. They responded positively when asked, during the interview, whether they would be able to organise and chair a webinar. They even proposed webinar ideas and potential participants with the aim of connecting educational practitioners of small island states of the Indian Ocean. Since the students felt that they could replicate the event with great confidence, it can be concluded that there could be another set of affordances called replication affordance; the technology and practices inherent to the webinar mode of teaching and learning could empower students to replicate it. However, this would warrant further research. If well-designed, webinars can be a very powerful tool in teacher education. We recommend that the design and implementation stages consider both technological and pedagogical aspects for optimal use of the tool.

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Chapter 9
The Contribution of a Collaborative Learning Approach to Education for Sustainable Development in Teacher Education in the Digital Age

Eveline O. Anyolo and Sirkka A. N. Tshiningayamwe

Abstract In this study, the contribution of online collaborative learning to Education for Sustainable Development (ESD) in teacher education was investigated. This was a qualitative study, focusing on student teachers' online collaborative tasks on sustainability education. Student teachers in the second and fourth year of their undergraduate studies were given assessment tasks based on sustainability content in their teacher education curriculum (specifically, the Social Studies Education and Environmental Education curriculum). They were expected to work on these tasks collaboratively using online platforms. Data were gathered through semi-structured interviews and individual reflections. Upon completion of these tasks, students were interviewed to explore if and how online platforms enable or constraint collaborative learning of sustainability content in teacher education. Students further reflected on if and how the ESD tasks developed their sustainability competencies. The sustainability competency framework was used to analyze the data. It emerged that the ESD tasks developed students' abilities to solve problems, collaborate, think critically, raise awareness, take action and clarify values regarding sustainability issues. It further emerged that poor communication, lack of connectivity, unequal contribution, conflict among group members, poor attendance and lack of collaboration were amongst the challenges of online collaborative learning. Sharing ideas, good leadership skills, communication and cooperative skills were some of the enablers of online collaborative learning. If challenges of online collaborative learning can be addressed, online platforms have the potential to enhance student teachers' knowledge and learning of sustainability content and ultimately contribute to the quality of teacher education.

Keywords Education for sustainable development · Collaborative learning · Teacher education · Sustainability competencies · Online collaborative learning

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9.1 Introduction

Namibia, like many other countries, is faced with a lot of sustainability challenges. These challenges include climate change and variability,[1] diseases, overfishing by commercial interests, gender-based violence, loss of biodiversity, inefficient and inequitable water use, poor governance, and poor quality and relevance of education, energy, disaster risk management and biotechnology (Republic of Namibia 2019). Therefore, Namibia is one of the countries that aims to achieve the 17 United Nations Sustainable Development Goals by 2030 (UNESCO 2017). In response to local and global sustainability challenges, upon political independence, in 1990, Namibia included an environmental clause in Article 95 of its constitution. The clause calls for the sustainable use of natural resources for the benefit of all Namibians (Republic of Namibia 1990). This implied an integration of environmental sustainability issues in the Namibian school curriculum. Other national education policies that inform the integration of Education for Sustainable Development (ESD) in the national schooling system include the National Curriculum for Basic Formal Education (Namibia Ministry of Education, Arts and Culture 2016). To further advance the integration and implementation of ESD in the Namibian education system, the country launched a national Environmental Education/ESD policy in 2020 (Republic of Namibia 2019). The policy is designed to support ESD integration and implementation in formal, non-formal and informal education processes across all sectors of the Namibian society, including higher education, teacher education, and general education. The policy also recognizes the Global 2030 Agenda for Sustainable Development of the United Nations and the Sustainable Development Goals. Namibian universities, including the University of Namibia, therefore, continue to enhance an understanding of sustainability and ESD in the Namibian context and its integration and implementation in teacher education. Research, however, shows that collaborative learning is fundamental to ESD, through which every student has a responsibility and accountability of for their own learning (Czippan et al. 2010).

Collaboration is a notion of interaction where individuals are responsible for their actions, including learning and respecting the abilities and contributions of their peers (Laal and Ghodsi 2011). It is an umbrella term for a variety of educational approaches mostly centred on students' exploration or application of course material. According to Hammond (2016), collaborative learning is crucial, as it allows students to explore and explain differences in opinions, reaching agreements that result in new knowledge creation. In learning ESD, students are active and take some degree of responsibility and control of the learning process. This develops independence and initiative among students. When students work together with complex issues and diverse viewpoints, they develop critical thinking, collaborative and communication skills (De Haan 2006, 2010; Scherak and Rieckmann 2020; UNESCO 2017; Wiek et al. 2011).

[1] Second- and fourth-year undergraduate students and Social Studies Education and Environmental Education were chosen for this chapter because the two authors of this chapter teach in this field. In the Namibian teacher education curriculum, ESD is a cross-curricula theme, thus integrated into all subjects.

Hence, a collaborative learning approach is crucial to ESD. ESD can be seen as a holistic approach, involving the integration of major sustainable development issues into all teaching and learning strategies (Scherak and Rieckmann 2020; UNESCO 2013). According to Boeve-de Pauw et al. (2015), ESD focuses on participation, cooperation and engagement in teaching and learning. It assumes that appropriate education for the twenty-first century must pay careful attention to the interlinked environmental, social and economic challenges (UNESCO 2017) facing humankind over the next 100 years or so (Bell 2016). Consequently, ESD is a means of promoting key competencies for sustainability, such as critical, systematic, strategic, normative, anticipatory thinking, etc., through collaborative learning (Taimur and Sattar 2019; UNESCO 2017; Wiek et al. 2011). Promoting key competencies for sustainability can be done through collaborative learning.

Due to the COVID-19 pandemic, various governments, including that of Namibia, ordered schools and institutions of higher learning to cease face-to-face instruction and switch to online teaching and learning in order to respond to the need to continue teaching and learning activities (Marinoni et al. 2020). While online teaching and learning have long preceded the pandemic, most students and lecturers were relatively new to this practice (University of Namibia (UNAM) 2018). Therefore, there was a need to upscale knowledge and skills on online teaching and learning. This implied that collaborative learning among students and staff had to be online. Studies have been conducted on teaching and learning within online environments (Hammond 2016; Moore et al. 2011) as well as ESD integration in higher education curricula (Kanyimba 2014; Scherak and Rieckmann 2020; Tshiningayamwe et al. 2021). However, despite the importance of collaboration learning, there is no evidence as to how online teaching and learning promote collaborative learning for ESD. Drawing on two subjects at the University of Namibia in the School of Education, this book chapter, therefore, aims to explore the contribution of a collaborative learning approach to the teaching and learning of ESD in the digital age.

9.2 Education for Sustainable Development and Online Collaboration

ESD is a dynamic concept that contains crucial issues for sustainable development (such as climate change, biodiversity, sustainable production and consumption, and reduction of poverty) and relies on stakeholders to use education as an instrument to achieve sustainable development (UNESCO 2017, 2018). It has been widely documented that ESD provides alternatives to reassess and evaluate education and learning in times of crises, promoting the necessary knowledge, skills, values and attitudes that nurture citizens for sustainable societies (UNESCO 2017, 2018). ESD relies on education stakeholders to integrate sustainability principles into education systems (Republic of Namibia 2019; Scherak and Rieckmann 2020). ESD is aimed at promoting students' personal development to become critical, creative, active,

competent and responsible students (Taimur and Sattar 2019; UNESCO 2018). It can help students make informed decisions and take action on local and global challenges as well as make sense of their own environments, predicaments and challenges, as it can empower and enable them to deal with these issues in a sustainable manner (Lenglet 2015). ESD has further been reported as a key enabler to the achievement of the Sustainable Development Goals (UNESCO 2017, 2018), thereby preparing the world for crises such as COVID-19 (UNESCO 2020). ESD is committed to education being inclusive of all learners, irrespective of their socio-economic backgrounds and gender (Didham and Ofei-manu 2018). Therefore, ESD suggests that the type of online learning offered should promote the well-being of all people and should be inclusive (UNESCO 2018). This contributes to the quality of education, as Tickly (2010) asserts that quality of education should be inclusive, democratic and relevant and should take into consideration learners from all backgrounds.

The teacher education curriculum is closely aligned with the school curriculum. For example, at the University of Namibia, ESD is integrated into different subject areas such as Environmental Education, Chemistry, Geography, Environmental Biology for Educators, Home Economics, Business Studies, Social Studies, and Economics curriculum (Kanyimba 2014; UNAM 2020). Concepts of sustainable development and sustainability challenges are thus integrated into the different teacher education courses. This is meant to stimulate students to ask questions, analyze, think critically and make good decisions on sustainability issues (Laurie et al. 2016; UNAM 2020). This, according to UNESCO (2013, 2018), encourages critical thinking, social critique and analyses of local context.

Lenglet (2015) believes that collaborative learning is essential for addressing the common sustainability challenges with which citizens are confronted in their own communities, countries and globally. The authors further contend that ESD collaborative learning promotes competencies like critical thinking, imagining future scenarios and making decisions. Online learning means using technology to access learning (Moore et al. 2011). This requires the use of a variety of technologies such as e-mails, the World Wide Web, chat, new groups and texts, audio and video conferences from computers (Dhull and Sakshi 2017). Most countries, including Namibia, have emphasized the importance of using technology in teaching and learning (Ministry of Basic Education, Sport and Culture (MBESC) and Ministry of Higher Education, Training and Employment Creation (MHETEC) 2001–2006). The University of Namibia has also introduced an e-learning policy to promote the use of technology in teaching and learning (UNAM 2018). Hammond (2016) argues that technology mediates collaborative learning among students and through the use of technology, students can share opinions and perspectives with others. He further argues that online collaboration and traditional collaboration have common theoretical underpinnings, and both have benefits of cognitive achievements. However, despite the emphasis, there have been numerous challenges regarding the integration of technology in education. These include inadequate online infrastructure, lack of capacity, provision and affordability of Information Communication and Technology (ICT) gadgets, and data (Mireku 2016; Tshiningayamwe et al. 2021).

9.3 Sustainability-Related Competencies

The study was framed within the framework of ESD or sustainability competencies. Competencies are associated with concepts such as capabilities, capacities and abilities (De Haan 2010; UNESCO 2017; Wiek et al. 2011). Competence is "a functionally linked complex of knowledge, skills, and attitudes that enable successful task performance and problem solving" (Wiek et al. 2011, p 204). This is the definition adopted in this chapter. De Haan (2006, 2010) argues that competence-oriented education focuses on the output of learning or what students should learn in the different subjects. In the case of this chapter, this means the output of learning in Social Studies and Environmental Education subjects. De Haan (2010) expressed that ESD competencies include the following, among others: ability to think and act in a forward-looking manner; dealing with incomplete and overly complex information; cooperating in decision-making processes; reflecting on own principles and those of others; and gathering knowledge in an open and interdisciplinary way. Wiek et al. (2011) observed that key competencies are critical for evaluating students' learning. They identified the following competencies as critical for sustainability: systems-thinking competence; anticipatory competence; strategic competence; and normative competence. UNESCO (2017) adds the following competencies: collaborative competency, critical thinking competency, self-awareness competency, and integrated problem-solving. All these competencies are defined in Table 9.1.

Table 9.1 Sources—UNESCO (2017, p 10) and Wiek et al. (2011, p 207–211)

Competencies and definitions
• Systems-thinking competence is the ability to collectively analyze complex systems across different domains (society, environment, economy, etc.) and across different scales (local to global), thereby considering cascading effects, inertia feedback loops and other systemic features related to sustainability issues and sustainability problem-solving frameworks • Anticipatory competence is the ability to collectively analyze, evaluate and craft rich "pictures" of the future related to sustainability issues and sustainability problem-solving frameworks. • Normative competence is the ability to collectively map, specify, apply, reconcile, and negotiate sustainability values, principles, goals and targets. • Strategic competence is the ability to collectively design and implement interventions, transitions and transformative governance strategies toward sustainability. • Collaborative competency is the ability to learn from others, to understand and respect the needs, perspectives and actions of others (empathy), to understand, relate to and be sensitive to others (empathic leadership), to deal with conflicts in a group and to facilitate collaborative and participatory problem-solving. • Critical thinking competency is the ability to question norms, practices and opinions; to reflect on one's values, perceptions and actions, and to take position in the sustainability discourse. • Self-awareness competency is the ability to reflect on one's own role in the local community and (global) society; to continually evaluate and further motivate one's actions; and to deal with one's feelings and desires. Integrated problem-solving is the overarching ability to apply different problem-solving frameworks to complex sustainability problems and develop viable, inclusive and equitable solution options that promote sustainable development, integrating all the other competencies.

The above competencies were used to analyze students' interviews and reflections to explore what sustainability competencies they were able to achieve in their collaborative ESD tasks done online.

9.4 Methodology

A qualitative approach with a case study design was followed to establish the extent to which collaborative learning approaches contribute to the teaching and learning of ESD in the digital age. A qualitative approach was chosen because it is best used to explore people's experiences (Creswell 2012) which, in the case of this study, entailed exploring students' experiences of working together on ESD tasks. A case study of the University of Namibia was used to generate deeper and detailed knowledge (Bell 2010) on collaborative learning. The University of Namibia has six campuses offering courses in the School of Education. For this study, second-year and fourth-year undergraduate students at two of the campuses were selected. The second-year students were doing Environmental Education as one of their compulsory subjects, whereas the fourth-year students had Social Studies Education as one of their major subjects. These two subjects and the two campuses were selected because the authors work at these campuses and teach these subjects. These subjects were further chosen because they cover a relative amount of content related to ESD, including topics such as water, sustainable development, biodiversity, natural resources, weather and climate (UNAM 2020).

Thirty out of 128 students participated in the study. Simple random sampling was used to select the students because every member of a population has the same chance of being included in the sample (West 2016). As part of the study, all second-year Environmental Education and Social Studies Education students were given assessment tasks to do in groups of six to eight. The tasks required students to identify one critical sustainability issue in their contexts and to explore the causes and impacts of the chosen issues. They were further expected to ensure that sustainability issues chosen were in line with the Sustainable Development Goals (UNESCO 2017) and to suggest possible solutions to the identified issues. Due to COVID-19, teaching and learning were online—thus, students were expected to explore ways of working together remotely and submit their tasks online. The aim of these tasks was to establish the extent to which online collaborative learning approaches contribute to the teaching and learning of ESD. Data were generated through individual students' reflections and semi-structured interviews. Reflections were done in line with suggestions by Elias (2010), who asserts that students should have chances to monitor their own progress, have choices in how they show evidence of what they have learned and share their learning with others. Student reflections promote students' approaches to completing their work for the sake of growth and learning rather than simply receiving a grade and are therefore helpful in creating a culture of intrinsic motivation to succeed (Cavilla 2017). Students further reflected on the successes and challenges of working on a collaborative task and how that promoted (if at all) their achievement

of the ESD competencies. The semi-structured interviews were designed to ascertain students' responses regarding their experiences of how online platforms enabled or constrained collaborative learning of the ESD tasks. The data were analyzed using the ESD competency framework (De Haan 2006, 2010; UNESCO 2017; Wiek et al. 2011).

Ethical issues were considered throughout the study (Fleming and Zegwaard 2018). An ethical clearance certificate was obtained from the University of Namibia. Students were fully informed about the purpose of the study as well as their rights to participate in the study. Written consent was obtained from students who participated in the study, and they were assured that the data would only be used for the purpose of the study.

9.5 Presentation of Findings

It was clear from students' interviews and reflections that the ESD tasks enabled them to develop different sustainability competencies. It further emerged that, even though there were challenges in working collaboratively online, there were also enablers that enabled students to complete their ESD tasks successfully. Sustainability competencies developed during the ESD tasks as well as the challenges and enablers of online collaboration on ESD tasks is presented below.

9.5.1 Developed Sustainability Competencies

As part of the ESD task, students identified different critical sustainability issues in their local contexts. Those included issues such as water pollution, air pollution, caring for the environment, sustainable development, quality education, clean water and sanitation, food security, as well as biodiversity loss. The students expressed that learning collaboratively in a digital age was an interesting but challenging experience. It was evident in their interviews and reflections that they were able to develop different sustainability competencies through the ESD tasks. Those include system-thinking competencies, normative competencies, collaborative competencies, critical thinking competencies, self-awareness competencies, as well as integrated problem-solving competencies. Evidence of how students developed these competencies are presented next.

9.5.1.1 Systems-Thinking Competencies

It was evident that students developed systems-thinking competencies through the ESD tasks. This was reflected in their reflections where they expressed that, through the ESD tasks, they were, for example, able to understand the value of education in

relation to solving community problems such as poor sanitation, enhancing thinking capacity and contributing to employment. Students were further able to reflect that learning about plants made them understand that plants are a complex system that needs water, sunlight, air, nutrients and optimum temperature to grow. Below are quotes from students:

> I learned that having education in a community helps people think and behave in a way that contributes to their people's success. Lack of education is the most challenging goal because in our community, we experience lots of problems just because people are not educated. I have learnt that if people are not educated in a certain community, they tend to suffer in so many ways like not having jobs, people tend to have poor sanitation and also their thinking capacity.

> I learned a lot about plants, I learned all the parts of plants and their functions. I learned that plants need water, sunlight, air, moisture, proper temperature and nutrients to grow. I also learned that plants are life for both humans and animals, they give us fresh oxygen and take out carbon dioxide from the atmosphere, plants also provide us with food, shelter, medicine and many more.

9.5.1.2 Normative Competencies

Through reflections, students revealed that the ESD tasks developed their normative competencies. This was particularly reflected in one student's reflection who expressed that the ESD task made them understand that human activities, religion and individual beliefs contribute to water pollution. The student noted:

> I have also seen how religion and beliefs can pollute the water to ridiculous extent, endangering people in the process. The river, dam and other open source of water had been heavily polluted, with people dumping waste, untreated sewage into the water, where some even cremate bodies of the deceased in the river.

9.5.1.3 Collaborative Competencies

All the students mentioned in their reflections and interviews that they enjoyed working in groups, as this was an opportunity for them to engage in constructive conversations with each other, which improved the quality of the tasks. Students were also happy to share their ideas with others and learned to appreciate diverse perspectives. They expressed that they had learned a lot of things through collaboration that they had not known before. This is what some students said:

> Group work taught me how to work together as a team where we had to help each other and work together to achieve our common goal or to collate our task in a most effective way. Teamwork makes the assignment of great or of quality.

> It is enjoyable to share my opinions with my fellow students and to learn from each other's ideas. The most amazing thing is our group leader knows how to guide and to lead us.

> We get to learn from others, and we get to communicate and learn to work with one another and engage in constructive conversations and we learn to appreciate diverse perspectives and challenging others is healthy as it develops your critical thinking too.

> It's really a good thing to work in groups because we educate each other by sharing ideas. I learnt most of the things that I didn't know before. It's also easy to work in groups because you give each other responsibilities.

9.5.1.4 Critical Thinking Competency

Students also demonstrated that the ESD tasks enabled them to develop critical thinking competencies. They reflected on sustainability actions happening within their communities and took positions in the sustainability discourse. Being part of the communities, students, for example, observed that community members polluted water, which threatened their lives because they were exposed to waterborne diseases. From this observation, students realized the importance of clean water. For example, three students remarked:

> Being part of the community, I have witnessed situations where people had to walk long distances to fetch water either from a community tap or from rivers which they had to boil or disinfect before consumption. Thus, at times the community is at risk of water borne disease if they don't take the necessary precautions.

> From this project I have learned that often people in the community are the main contributors to unclean water and unsanitary environments. By throwing litter or hazardous materials around their environment which ends up in water sources such as rivers or oceans, or urinating anywhere they want, this causes a once safe and clean environment to become unsanitary for humans to live in… I also learnt that we should use water sustainably. For example, try to use a small amount of water for consumption and use irrigation that does not waste water.

Another student reflected on the importance of a clean environment. They expressed that it is quite important to take care of the environment and its resources. The student further reflected that a clean environment is essential for a healthy living. The student said the following:

> I have learned a lot about our topics. Our first topic was Caring for the Environment and I learnt that a clean environment is essential for healthy living. It is important to keep the environment for our future generations and it preserves natural resources. Also, ways to start caring for the environment like compost and recycle, conserve water and save papers.

9.5.1.5 Self-Awareness Competency

Students' reflections revealed that they had developed self-awareness competencies from doing the ESD tasks. This was evident in one student's reflection who expressed that there was unequal distribution of opportunities in their communities. The student further expressed that reducing inequality within their communities would ensure equal opportunities for all, which would ensure that reduced inequalities, as one of the Sustainable Development Goals, is realized. This is what student said:

> Throughout the whole project I have learned that inequality is really playing a major role in our community and it is a serious issue in our community. Finding out what inequality is as an individual and looking at the community I have realized that the people are not equal at all and there is an uneven and unfair distribution of opportunities in the community. I have

> learned that reducing inequality in our community will be the most important sustainable development Goal to be achieved in our community because it will bring about too many changes in the lives of all people in the community, especially the people that were negatively affected. Reducing inequality will ensure equal opportunities and will reduce inequality of outcome, having it this way the lives of many will be improved and its important.

9.5.1.6 Integrated Problem-Solving Competency

One student reflected on how they could apply problem-solving strategies in schools. They expressed that, if they found themselves at a school where teaching and learning materials were lacking, they would improvise. The student further reflected that such strategies must be shared with other colleagues in the school in order to ensure quality education for all. The student said the following in this regard:

> From the project, I've gained an understanding that will be useful as I work toward becoming a certified teacher: how to play my position as a teacher in a school where teaching and learning materials are scarce. Meaning, if I find myself in such a situation, I should either improvise with local materials or buy with my own money ... Furthermore, because I have learned to share, I will share this idea with other teachers in order to meet the Sustainable Development Goals of quality education and resolve the issue of lack of teaching and learning materials. In addition, as a teacher, I have learned that I can use videos and other digital tools that are simple to integrate into the classroom as learners are more proficient with technical abilities, thus incorporating technological skills, so by integrating technology into the classroom, learners will learn better.

9.5.2 Challenges Experienced in Working Collaboratively Online

Challenges such as poor communication, lack of connectivity, unequal contribution, conflict among group members, disagreements and poor attendance were experienced by students in doing collaborative ESD online tasks. Students reported that it was very challenging to find a suitable time to meet and have group discussions. This made their communication among group members ineffective; hence, not all group members contributed to the tasks. Following are some of the quotes from students regarding the challenges experienced during online collaboration:

> Some of the challenges working together in a group is that not everyone is always online. So there is poor communication. Either they see things late on the group chat or they do not respond to anything. Not all group members contribute to the assignment or they do not give good work.

> I experienced a lack of communication, because sometimes you might comment on something or ask about something in the group but only one person will answer you each and every day. I don't know if others don't know too or maybe people are answering others based on their tribe.

Working collaboratively was also challenging, as some group members might not cooperate with others. They felt that it was not easy to agree on certain points, and

this resulted in conflict among group members. Students further revealed that time for meetings was a challenge, as not all students were available at the same time to meet.

> The challenges that I faced when we were working together as a group, the effort that some students put in the assignment was weaker than others. Agreeing to one thing as a group was also challenging because not everyone was happy with what one or two people agreed on. In short, finding a solution wasn't easy. It created conflicts among us … some group members might not agree to one decision being made. Some members did not contribute to the assignment, some relied on others and had no say in decision making and lack of effective communication.

> There were a lot of arguments about which points were to be considered important and included in the final draft also erupted. This resulted in some group members insulting each other on the WhatsApp group ... The whole project was filled with procrastination as a result of not sticking to the time agreed for discussion, this resulted in continuous delays in the finalization of the project. Based on our final draft, our second and third questions respectively were not addressed properly due to communication breakdown among the group members.

> It was difficult to discuss time because we were doing it online and not everyone in the group was available at all times.

As regards connectivity, students reported that they or other group members did not always have network coverage and were unable to communicate with others:

> We did our group discussion on WhatsApp group which was a bit challenging, when it's time to discuss on the group, some people are offline for some reasons like poor network coverage in remote areas. Some don't have data at all which led to poor contribution to the assignment discussion.

> I did not experience many challenges, but I noticed that some people are so lazy, they just wait to be pushed. And some of them are experiencing network problems and data. Most of the time they were offline, which caused poor communication on our WhatsApp group, as we are far from each other. And it delayed our assignment to be done on time.

Students also reported that not all group members were participating in the online tasks. They indicated that only a few group members were mostly doing the online ESD tasks.

> Not everyone participates in the discussions (unequal contribution), not sure if they are shy or they were not aware of the activities. So, we ended doing a lot of work for a group assignment, there's is sometimes conflict and tension some people think there are smarter than others and end up not using everyone input

> When we were working on the assignment, only few people were benefiting from this assignment, there was no communication between the leader and the participants in the group. The leader would do almost everything and just drop it on the group for us to go through, instead of dividing the assignment into parts and every participant will get a part to work on.

Students felt that it was not easy for them to meet on WhatsApp and virtual platforms, resulting in poor communication and lack of participation of some group members. They expressed the following:

> Challenges include poor participation from group members, sometimes we meet on the WhatsApp group for discussions but some of the students are offline ... some students will run out of data while you were busy discussing and some will drop off their answers late which makes it difficult for the person who compiles the assessment.

> I've learnt that when people in a group don't have face-to-face contact, it's more difficult for them to express their worries. Virtual communication, rather than in-person conversation, can lead to misunderstandings and miscommunications. As a result, resolving and preventing conflicts in virtual teams can be difficult.

> Some group members provided information on the group without acknowledging sources which made it impossible to consider them. After realizing that the WhatsApp discussion was not possible to finalize the whole project, we decided to meet on Campus, but still some group members were unable to make it, citing transport money as the reason for not being able to attend.

Students also felt that group members had different ways of doing things and were not able to cooperate with others. They revealed that some group members were not transparent, some were judgmental, and others did not want to share their opinions. They noted:

> Challenges were a lot to me or maybe it's because I don't like working in groups. Lack of trust. Trust is crucial to teamwork. Not sharing information. Low engagement. Lack of transparency. Since we all come from different backgrounds and some group members were at the village which took too many days to complete the assignments. People in the group rely on others, which is really stressful because they are forever giving unnecessary excuses, as if we all do not benefit from it… Some people are not team oriented.

> The challenges of working together were some of the group members were so judgmental – as every member uploaded their work to the WhatsApp group some of the group members were judging other's work instead of correcting their work. Few group members were selfish; they didn't want to share their opinion on the task given to the rest of the group members.

> The challenge is that working with people is not an easy thing to do. Different people have different ways of doing things and preferences. Sometimes people are not co-operating which makes working together difficult … maybe they don't know the purpose of group work because they don't like to work together. Some people don't like to participate, they only read and mute.

9.5.3 Enablers of Online Collaborative Work

Students highlighted various enablers of group work based on their experiences of doing ESD online tasks collaboratively. They reported that, in doing ESD collaborative tasks, they developed several skills such as problem-solving and communication skills, among others, which they could use in the future. Students also believed that such skills were relevant to both individual and group work and they may contribute to their learning within the university and beyond.

> Most of us gained skills for working as a team. We learned to solve problems and cooperate/respect each other. Sharing of ideas, debating, and getting to know new things were the most enjoyable things about working in a team. Furthermore, we only work at the agreed time, unlike the individual one

> Group work helped me to develop a lot of skills that are increasingly important in the professional world. Positive group experiences, moreover, have been shown to contribute to my learning and overall university success. Due to being properly structured, this group task reinforced skills that are relevant to both group and individual work, including the ability to break complex tasks into parts and steps, refine understanding through discussion and explanation and develop stronger communication skills.

> It was very good for me to work with my team because we helped each other in everything we were doing. Personally, I did not have any problem with my group members. We had good communications by phoning each other, we did everything together. I gained knowledge to work in a group and improved my speaking skills as we were having discussion for our assignment.

> The benefits, more work can be done in less time, two hands are better than one - group members tend to think critically thus promoting diversity in thinking-increases collaboration and allows brainstorming, as a result, more ideas are developed. Another benefit - two or more people are always better than one for solving problems, finishing off difficult tasks and increasing creativity. Group work can also teach essential social skills and essential communication such as active listening and effective speaking and lastly it can improve self-confidence.

Working collaboratively was also reported to make student work easier, as the work/activities could be divided among students within the group. Students also felt that group work was a good platform for them to share ideas and learn from each other. They believed that, in this way, they were able to finish their task on time. Following are some of the students' quotes:

> The success of working together in our group enabled us to pool our ideas together and see problems from different perspectives. It was a success because we divided the work amongst each other well and it makes work easier and faster to finish … you also learn a lot from others new things that you did not know before. It's also a good practice to communicate with different people. It makes work much easier … The most amazing thing is our group leader knows how to guide us, to work with us and to lead us.

> The success of working in a group was the work was less work overload as each individual had been assigned with different tasks, questions were divided among the group members to ensure that each individual contributed. For example, one of the group members has to do the introduction, the other one the body and so forth until everyone gets something to do and share it to the group after he/she is done by uploading it on the WhatsApp group for the rest of the group members to go through and edit where possible and the one person will compile and type the work together. Furthermore, we were working together as a team, even if it was not so easy, what mattered most is that at the end, we all agreed on one thing.

> A lot of pressure is taken off of one's back if everyone works together. My group was very cooperative and I had no difficulty in getting them to do their specific part. Sometimes I will forget to inform them about something and they will message me to remind me of certain things. We help each other where we can… Everyone in the group was really active, open to contribute as well as communicating without having the stereotyping or biases. Being part of this team is one of my purposes to achieve my goals … The success of working together is that teamwork builds morale. It's a lot of fun to work in groups.

9.6 Discussion

As part of the ESD tasks, students identified different critical sustainability issues in their local contexts. The identified sustainability issues were mainly in line with Sustainable Development Goal 1, 2, 4, 6, 14 and 15 (UNESCO 2017). It emerged that students were able to develop sustainability competencies (De Haan 2006, 2010; UNESCO 2017; Wiek et al. 2011) through doing online collaborative ESD tasks. In line with the Republic of Namibia (2019), working collaboratively enabled students to identify sustainability issues experienced within their communities and suggest solutions. This helped students to understand sustainability issues faced locally and to engage in sustainability practices (Glavič 2020; Republic of Namibia 2019). Taimur and Sattar (2019) and UNESCO (2017) argue that ESD promotes key competencies for sustainability, such as critical thinking, systematic thinking, strategic, normative and anticipatory, through collaborative learning. Thus, when students work collaboratively with complex issues and diverse viewpoints, they develop such skills. According to Czippan et al. (2010) and Scherak and Rieckmann (2020), a collaborative learning approach is fundamental to ESD, through which every student has a responsibility and accountability for their own learning.

Even though ESD tasks enabled students to develop various sustainability competencies, there were also a number of challenges encountered in working collaboratively using digital platforms (Mireku 2016; Tshiningayamwe et al. 2021). Lack of time, lack of cooperation, poor connectivity, unequal engagement of group members, lack of time management, lack of feedback on forum posts, unequal task divisions and disagreements were some of the challenges experienced by students (Strauß et al. 2018). Students found it difficult to find time where they were all free, as they had a lot of work to do. In cases where they found such time, they did not cooperate with one another. In some cases, some students were unable to connect because of poor connectivity (Mireku 2016; Tshiningayamwe et al. 2021). Hence, some students felt that there was a need for them to come together and work face to face. They assumed that, in this way, they would have a better discussion which may improve the quality of the tasks.

Apart from the challenges encountered, there were also enablers that enabled students to complete their ESD tasks successfully (Hammond 2016; Lenglet 2015). Students indicated that working in groups was very effective, as it prepared them to be collaborative, communicative, problem-solvers, good listeners, and critical thinkers. This resonates with Hammond (2016). According to Laal and Ghodsi (2011), this happens because students take responsibility for their own learning. In line with UNESCO (2017, 2018), students work together to solve problems—a good opportunity to both learn from and teach others on sustainability issues. This supports the idea that ESD is aimed at promoting students' personal development to become critical, creative, active, competent and responsible students (Taimur and Sattar 2019). Hammond (2016) and Lenglet (2015) agree that ESD collaborative learning promotes competencies like critical thinking, imagining future scenarios and making decisions.

9.7 Conclusion and Recommendations

The study sought to explore the contribution of a collaborative learning approach to ESD in teacher education in the digital age. Data were collected through individual students' reflections and semi-structured interviews. The results confirmed that students were able to develop several sustainability competencies from doing sustainability tasks using online platforms. Lack of collaboration is among the challenges encountered by students in doing the tasks. Other challenges included poor connectivity, disagreements, and poor participation. Thus, some students felt that working on collaborative tasks on a face-to-face basis could be more effective.

The findings also revealed that students acknowledged that collaborative ESD tasks were important and worth doing in that they enabled them to work together and learn from each other sustainability issues. They felt that two hands were better than one; hence, they were able to discuss and solve problems together.

To conclude, since it is important for students to develop sustainability competencies (systems thinking, normative, collaborative and critical thinking, interpersonal skills, self-awareness, and integrated problem-solving), collaborative learning in ESD should play a major role in attaining such development. It is quite significant that students be collaborative, communicative, problem-solvers, good listeners, critical thinkers and able to take responsibility for their own learning. This would certainly show that they are well-prepared for local, international and global sustainability problem-solving now and in the future. Based on the findings, the following were recommended: the need to capacitate students on how to work collaboratively. Such capacity-building should emphasize how to improve communication in group work, collaboration skills, equal participation in collaborative work, managing time as well as conflicts.

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Part IV
STEM and Language Learning

Chapter 10
Robotics Simulations: Developing Essential Student Teachers' Skills for the Digital Age

Marietjie Havenga and Jako Olivier

Abstract Technology and digitalization are ubiquitous in the Fourth Industrial Revolution. An important aspect is the emergence of robotics, especially within multimodal learning contexts. In this regard, this research drew on the scholarship of robotics in terms of multimodality and online learning. This chapter focuses on practices and reflections of student teachers studying a Postgraduate Certificate in Education through a distance mode. The aim of this chapter is to report on students' active involvement in online robotics simulations, as part of a module on Information Technology, with the aim of developing essential skills for the digital age. Such skills include problem-solving, creative and critical thinking, and innovation, among others. The researchers in the current study employed a general qualitative methodology which involved document analysis of student assignments, student-generated multimodal artefacts as well as reflections. In total, 11 students participated in this research. The findings show that students had some challenges working online and they experienced a steep learning curve, as they had not been introduced to robotics prior to the research. However, participants developed particular skills that are valuable for the digital age, and this was also evidenced through the multimodal artefacts. Finally, recommendations are made for skills development and practices of robotics simulations in a multimodal context.

Keywords Digital age · Essential skills · Robotics simulations · Student teachers

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10.1 Introduction

Teacher education and the wider education sector have been impacted by the needs and affordances of the digital age, and within the context of the Fourth Industrial Revolution (4IR), more changes are envisaged. According to Klaus Schwab (2015), this revolution will change the way we work and even relate to each other. In a review of research on robotics in South Africa, the relation of research with the 4IR was evident (Boje et al. 2019). Furthermore, in the South African Department of Basic Education's Annual Report 2018/2019, the implementation of the 4IR in schools was proposed (DoBE 2019). However, there are still some criticisms about whether South Africa, as a country, is ready for the needs of the 4IR (Sutherland 2020). These aspects have also had an impact on teacher education in the digital age.

Within this wider context, there has been a drive from the South African government to promote coding and robotics at the school level as part of an effort to support the learning of science, technology, engineering and mathematics (STEM) (Mondada et al. 2016). These efforts are part of a trend in education where, according to Seemiller and Grace (2018), "coding is the new cursive, and that teaching kids to code may be far more useful than spending time teaching obsolete cursive writing" (p. 191). In the South African context, there have already been attempts to promote robotics in schools to also support learning abstract concepts (Govender 2021; Mondada et al. 2016). Furthermore, universities have supported schools in creating cost-effective open-source robotics platforms (Ettershank et al. 2017) such as Open Robotics, Sparki, and Turtlebot. The draft Coding and Robotics National Curriculum and Assessment Policy Statements (CAPS) for Grade R–3, 4–6 and 7–9 was made available to the South African public for feedback. This document indicates that this topic/subject will be prominent in schools in the future, and therefore prospective Information Technology teachers should be introduced to and be prepared to teach this subject.

This chapter deals with practices and reflections of student teachers studying a Postgraduate Certificate in Education (PGCE) by means of a distance mode at a selected South African university. The aim of this chapter is to probe students' active involvement in online robotics simulations, as part of a module on Information Technology, with the aim of developing essential skills for the digital age. To this end, this qualitative study not only involved student perceptions but also related to the nature of skills such as problem-solving, creative and critical thinking, innovation and technical abilities in this context.

10.2 Literature Review

This section outlines relevant theoretical concepts pertaining to essential skills for the digital age, the digital context of teacher practice as well as robotics and multimodality.

10.2.1 Essential Skills for the Digital Age

Being digitally positioned prompts the need for certain skills within an interconnected world. Regarding the interconnected world of the 4IR, Schwab (2016) considers people's digital presence to be crucial in the near future. Online personal profiles and virtual social presences are expected to be pivotal for interaction and collaboration, building relationships, seeking relevant information and discussing work-related issues (Schwab 2016). The 4IR also demands that people are continuously skilled to be relevant in a dynamic world of work, be able to adapt to changes and develop the ability to be productive in a digitized society (Chakravarti 2020).

Sousa and Wilks (2018) highlight the following valued skills for career requirements and the work environment in the digital age: problem-solving ability; critical and creative thinking; people skills, such as emotional intelligence; adaptability; decision-making and judgmental thinking; argumentation; and negotiation skills. Regarding the relevant technological capabilities, they refer, among others, to artificial intelligence, robotics skills and digitalization. Desired skills for a demanding future also include intellectual abilities; cognitive and creative skills; technical competencies; practical dexterity and hand-eye coordination; social and interpersonal skills; perseverance; as well as the demonstration of specialized, integrated knowledge and applied learning (UNESCO 2018, p. 5, 7).

Fleaca and Stanciu (2019) examined digital requirements with the aim of enhancing teaching and learning in the fields of manufacturing education and business engineering education. They focused on learning needs in the digital era and mentioned specific dimensions and related features, namely: information and data processing (browsing, critical evaluation and data management in the digital context as supported by digital technologies); digital communication (management, collaboration and information sharing using digital technologies); digital content creation (development and integration of digital content, application of copyright principles/rules/licenses); and digital problem-solving (exploration of digital technologies to solve problems, and creative and interactive implementation of such technologies in the learning context) (Fleaca and Stanciu 2019). Chakravarti (2020) highlights learning as a "lifelong endeavor" (p. 1716) that is relevant for the digitized challenges of the future. Importantly, teaching practice will increasingly take place in a digital context.

10.2.2 The Digital Context of Teacher Practice

Digital technologies have impacted all aspects of life, and their role in education and teacher training is inevitable (Borba et al. 2018; Howard et al. 2021). Although digital technologies have been used for some time, the COVID-19 pandemic accelerated the transformation to online learning across the globe as an essential modality of delivery when face-to-face learning was not allowed because of lockdowns (Mhlanga and

Moloi 2020). This also prompted the need for additional teacher literacies (Sánchez-Cruzado et al. 2021). In this context, students are expected to work on their own and use appropriate technologies for learning. With this expanded scope of learning, it is essential to explore the digital context of teachers' practice in challenging times.

In the digital age, learning is characterized by the enrolment for online courses, use of online educational platforms, electronic textbooks and open educational resources (OER), Internet access, and the use of resources such as YouTube, wikis and Google Docs (Makarova and Makarova 2018; Olivier 2020a). Moreover, digital technologies in education provide opportunities for "equitable access" for those who aim to obtain relevant knowledge and skills and develop essential competencies for the future (Makarova and Makarova 2018, p. 57).

Already in 2010, Starkey discussed digital skills that are crucial for novice teachers in such contexts. She emphasized pedagogical reasoning and action, based on Shulman's model (Shulman 1986), as essential for the digital age and compiled the "Digital Age Learning Matrix" which was implemented with teachers in their first year of teaching. The digital skills include accessing information, presenting and processing information, gaming and the use of interactive programmes, and communication. These technologies were aligned on a matrix according to learning features such as doing, thinking about connections (comparing and sharing), thinking about concepts and "big ideas", critiquing and evaluating (limitations and potential), creating "new reality", and sharing knowledge (sharing new knowledge by means of authentic settings) (Starkey 2011, p. 22). Furthermore, she emphasized the importance of teachers to be knowledgeable about a digital society, which is part of this wider context, and that they should be able to apply digital skills in praxis based on their theoretical views regarding active learning in the digital age. Howard et al. (2021) have recently highlighted the specific digital competencies needed for student teachers. According to them, these require an integrated and iterative approach to developing competencies.

Future teachers need to develop knowledge and competences for a digital learning environment. Demeshkant (2020) refers to the interplay of pedagogical, technological and professional competences for professional practice. She argues that the ubiquity of digital artefacts/devices requires that teachers not only develop digital skills but also integrate digital technologies into the classroom for creative and innovative teaching and learning experiences.

In the teaching profession, teachers require a compendium of skills to be digitally competent (Artacho et al. 2021). These authors refer to digital teaching competence as the ability to activate specific skills to search and select relevant resources, employ ICTs to integrate new knowledge and the ability to communicate the acquired knowledge by using various digital media. Scholars emphasize the importance of adopting digital teaching-learning practices to engage students in a digital world (Fleaca and Stanciu 2019). Finally, in this chapter, the concept of multimodality is also highly relevant.

10.2.3 Robotics and Multimodality

In the context of this chapter, robotics—which also implies that this research links up with the extensive literature related to robotics as a means to learn programming (cf. Boje et al. 2019; Dolenc et al. 2014; Govender 2021; Hudson et al. 2020; Kucuk and Sisman 2018; Lück and Lareau 2016; Yilmaz Ince and Koc 2021)—is viewed from a perspective of self-directed multimodal learning. This involves both multimodality and multimodal learning, as "multimodality refers to the dynamic application of different modes, while multimodal learning refers to individual modal preferences, communicating through different modes, learning and teaching by means of different modes, and education taking place through different modes of delivery" (Olivier 2020b, p. 119). In addition, the need for self-directedness is evident, as students need to be able to take charge of their own learning and be able to manage their goals, resources and self-evaluation in an interdependent manner. To this end, the theoretical background of self-directed learning (SDL) (cf. Garrison 1997; Guglielmino and Guglielmino 2001; Knowles 1975) is also highly relevant to this chapter.

In this chapter, multimodal learning draws on the theoretical framework of multimodality (Bezemer and Kress 2016; Kress 2010) where learning is approached in terms of the meaning-making processes. Consequently, the semiotics and sign-making process of both programming and praxis of robotics are relevant. For Kress (2010), semiotics is relevant in any theory of learning, and this "sign-making is meaning-making and learning is the result of these processes" (p. 178).

Consequently, the creation and programming processes for robotics are considered as sign-making processes in themselves. Furthermore, in this chapter, both instructional multimodality and interactional multimodality (Olivier 2020b) are relevant. In terms of instructional multimodality, the learning itself happens through a distance education mode, whereas in terms of interactional multimodality, different modes of communication are employed in the process of setting up and handling the environment and programming itself.

In the next section, the empirical research conducted—to determine how student teachers can develop essential skills for the digital age through robotics simulations—is unpacked.

10.3 Empirical Research

10.3.1 Research Methodology and Paradigm

A generic qualitative approach was adopted for this research, conducted within an interpretivist paradigm (Bakkabulindi 2015; Tracy 2020). Such a generic qualitative inquiry investigates rich sources of data such as individuals' views, beliefs, reflections and experiences regarding a particular aspect by using an interpretive lens, for example.

10.3.2 Study Context, Participants and Activities

The distance mode of delivery involves that students who do not attend class and/or practical sessions could undertake their courses remotely. A prerequisite for enrolment in the PCGE programme with Information Technology as a major subject is that students have at least a qualification in Computer Science (as part of a Bachelor of Science or Bachelor of Commerce degree, for example) with a background in computer programming up to second-year level.

Although a total of 21 students enrolled for the PCGE in 2020 and completed all class activities, only 11 students provided informed consent, thus indicating that their data could be used for research purposes. The cohort comprised of a diverse group of students in terms of gender, mother tongue and age. The research project was approved by the relevant ethics committee and the University Research Data Gatekeeper Committee. Furthermore, this research adhered to institutional and national standards of research ethics in terms of independent recruitment, voluntary participation, confidentiality, privacy and safe data management.

Within the distance mode of delivery, interaction with lecturers took place using eFundi, a Sakai-based Learning Management System (LMS). The LMS was used to communicate, act as an e-guide to direct learning activities and for the submission of assignments, among others. Lecturers used a specific electronic marking tool to perform assessments and provide feedback to support students' learning experiences. As part of the course activities, PGCE students worked individually and had to submit four assignments to the LMS before the deadline. Note that only the last assignment focused on coding and robotics, where students worked with Lego Digital Designer (LDD) to build the virtual robot. LDD is free, like computer-aided design programs, and enables individuals to build a variety of models using virtual bricks. Although LDD is no longer supported by LEGO, it is still available for download and is deemed a valuable resource that can be utilized to introduce students to robotics through an online modality.

The assignment—relevant to this research—comprised both theoretical and practical aspects such as the following:

- discussion and motivation of appropriate teaching-learning strategies for active learning;
- design of a maker space learning environment for the school (e.g., drawings of floor diagrams; selection of appropriate furniture and types of devices to be used in class, e.g., robots/drones/eye tracking);
- designing and building one's own robot using simulation software (LDD). It was expected of students to copy five images in succession to indicate how they built the robot using various components. Upon completion, students were requested to write a two-page narrative reflection on their experiences and challenges regarding the building of the robot. Figure 10.1 shows an example of a partially built design.

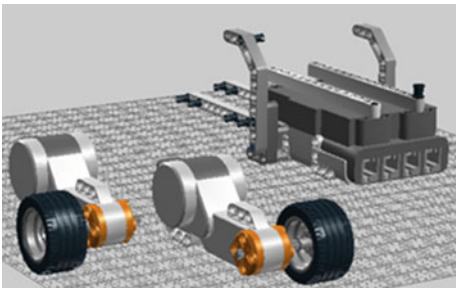

Fig. 10.1 An example of a partially built robot design

Fig. 10.2 Examples of student-generated multimodal artefacts

10.3.3 Data Collection

Data collection involved collecting students' robotics assignments, student-generated multimodal artefacts as well as their narrative reflections. Some examples of students' multimodal artefacts are shown in Fig. 10.2.

10.3.4 Data Analysis

Data were manually coded and analyzed qualitatively. This also included document analysis of students' data. In the current study, an open-coding approach was followed, codes were organized into categories, and main themes were identified after an inductive analysis of the data (Saldaña 2011).

10.3.5 Trustworthiness

Trustworthiness, or the rigor of a study, indicates whether the qualitative research findings are credible (accuracy and truth of the findings), transferable (applicable to other research contexts), confirmable (based on participants' feedback and responses) and dependable (findings are consistent and can be replicated) (Lincoln and Guba 1985). Credibility was assured by applying investigator triangulation (where more than one researcher analyzes the data independently) (Korstjens and Moser 2018). In this study, both researchers analyzed the data.

10.4 Research Findings

The following research question is addressed in this section: How can student teachers develop essential skills for the digital age through robotics simulations?

Table 10.1 summarizes some codes that emerged from the data. This is followed by a short discussion of the main themes, with some selected quotations that illustrate the views of the participants. Note that quotations are verbatim and were not language-edited.

It is essential that student teachers themselves develop cognitive and self-directed learning skills to assist learners in the future. Table 10.1 shows some responses where participants took responsibility for addressing an unfamiliar problem.

Reflective thinking is a valued skill, especially when making corrections and solving unknown problems. Table 10.2 demonstrates examples of reflection and control of one's thinking as indicated in some student responses.

Digital skills are crucial for the future and student teachers need to be knowledgeable about working in unknown and online environments to develop higher-order thinking abilities. Table 10.3 shows active involvement and some challenges that students experienced in building the digital robot artefact.

From the student responses, there was clear evidence of the importance of cognitive and SDL skills. There also seemed to be an awareness of their thinking processes and hints of metacognitive awareness; however, these were not specifically probed.

Table 10.1 Theme: cognitive and self-directed learning skills

Asking essential questions: where to start, what should I do? What? How? (P2)
What finally helped: think out of the box (P7)
Took a break: really think of a way that I can solve this issue: correct parts (P4)
Practice: familiarize myself with components (P2)
Learn: creative thinkers, learn problem-solving techniques (P1)
Understand computerization better: an effective way to learn (P3)
Improve critical thinking (P3)
Apply research skills to acquire more knowledge regarding the software (P9)
Triggered my critical thinking and problem-solving skills (P9)
I do not have the knowledge & skills to build the robot: enrol in a short course (P8)

Table 10.2 Theme: reflective skills

Wrong components: had to go back, change model (P1)
Deleted first attempt: started using the 'track' wheels (P6)
Won't be able to meet up with deadline: using backup plans: very demanding (P8)
After building for two hours: more familiar with controls and functions: became easier: enjoyed it (P6)
Finally managed, get components: build structure (P7)
Start all over again: building design was not coming right (P8)
Learned: putting knowledge & skill into designing of robots (P8)
Brick library difficult: had to study it to become familiar with every function (P9)
Reflect: very interesting: see my thought process, the progress of the robot to the final product (P6)

Furthermore, as is clear from the quotation below, students felt the need to take charge of their own learning.

> More practice is what I should do so that I can familiarize myself with other components. (P2).

This quotation emphasizes the importance of SDL as well as the student's engagement with the multimodal environment. The concept of SDL relates specifically to a dynamic process where students take responsibility for their own learning on their own or with the aid of others; by determining their own set goals and by identifying, and selecting resources that can be either material or relevant to others; then selecting and applying relevant learning strategies, and evaluating goals set by themselves (Knowles 1975). Furthermore, the responses also emphasize the importance of critical thinking (Garrison 1997; Gibbons 2002) and problem-solving (Guglielmino and Guglielmino 2001; Havenga 2016) in this context, and literature has shown that

Table 10.3 Theme: Active involvement in online robot simulations

Go cautiously: find parts I had to assemble with each other (P4)
Alignment on building mode: affect how components should be placed (P10)
Place components, change their direction, left, right, upward, downwards (P10)
Turned robot around: zoomed in and out: could see better (P6)
Look for correct parts: wheel with correct rim (P6)
Build truck robot: lift light and middle weight objects (P7)
Build robot: track a single source of light (P9)
Rotate components: fit together (P1)
Robot needs to sit on a base: connecting blocks in a particular way (P10)
Get some height: make arms for the robot (P6)
Fix problems, set the structure I wanted (P7)
Use different logs to build war robot (P8)
Put blocks using specific angle: have to redo as the angle was not correct, blocks were not aligned (P10)
Robot designed: change directions (left, right, forward, backward): using light sensor (P9)
Robot: two motors connected to rim, tyres: 3rd wheel balance, prevent from tilting backwards (P9)

these two elements can contribute towards fostering SDL. The following quotations are relevant in this regard:

> …when learners are taught robotics they will become creative thinkers and they will learn problem-solving techniques. (P1).
>
> I also enjoyed how it triggered my critical thinking. I also enjoyed how it triggered my problem-solving skills. (P9).

The data also showed the prominence of reflective practices for the students within this context. The importance of reflectivity in terms of SDL is also evident from the literature (Abdolhosseinzadeh Amini and Kruger 2022; Lee and Mori 2021). From the data, it was clear that the students had to constantly reflect and sometimes change their approaches to successfully solve problems they encountered. The following quotation is an example of how the students approached the process.

> I just took a break to really think of a way that I can solve this issue of not finding the correct parts. (P4).

Only through this reflective process could students identify problems and plan their further actions in the process of working within the different parts of the multimodal environment. Clearly, reflective skills are essential for learning about robotics, especially within this mode of delivery. Moreover, Straková and Cimermanová (2018) note the affordances of reflective skills for student teachers specifically in virtual learning environments and how these can be actively developed.

One of the students also noted how after struggling to start, they considered their immediate context:

> What finally helped me to think out of the box was then to think about my own school (school around my community), thinking about what the school is lacking, or things that can be done to get certain work done without doing it in a long way. (P7).

This quotation emphasizes the affordances of drawing from authentic contexts and resources. It is significant that in terms of SDL, the importance of authentic contexts (De Beer and Gravett 2016; Sutiarj et al. 2018) and authentic problems (Havenga 2016) are noted in the literature. Hence, prompting students to address real-life problems can also be supportive of their learning process and their own self-direction.

Finally, the data also showed the importance of active involvement in the online simulation environment. Some of the students noted that they still required further skills to work effectively with this software. The following quotation illustrates this point:

> I realized that I do not have enough skills and knowledge to approach this subject or project of building robotics. I then decided to enroll myself in a short course on how to build a robot so that I can then acquire the knowledge and skills which I might need in the nearest future. (P8).

In this regard, it is also important to note that only through the acquisition of the necessary knowledge of the environment and the elements that make up the tools and processes would students be proficient in building and working with the robot.

Table 10.4 Theme: challenges and perceptions

Choose which robot to design, need to come up with your own robot: not easy at all (P10)
Software: not know where to start, unfamiliar: stress (P2)
GUI: unfriendly, functions disabled (P2)
Challenge: difficult to assemble parts of the robot (P4)
Struggle: few times: how to get block twisted (P6)
Technical knowledge was a difficult part in the design process (P8)
First encounter with LDD: did not know what to do, where to go, unaware to click on the (+) sign, show blocks, (-) to reduce the number of blocks (P10)
Challenging: lots of time trying to connect parts that cannot be connected (P10)
Time consuming: a lot of time putting it together (P8)

Consequently, from an interactional multimodality (Olivier 2020b) point of view, understanding the semiotics of not only the environment and its constituent tools but also the semantics of the programming language would be relevant.

In Table 10.4, a summary is provided regarding the challenges and experiences of students as well as the resources they used.

Table 10.4 highlights some of the challenges that participants experienced. Although a manual was made available, they still had some problems in building the robot.

In retrospect, students evaluated their experiences regarding the construction of a digital artifact. Table 10.5 shows some examples.

Apart from the manual that the lecturer made available to students on the eFundi platform, they also searched for additional open education resources to assist them, as indicated in this theme (Table 10.6).

The challenges experienced by students were also probed in the data collection. Several issues related to students getting to know the environment and using resources within the environment were expressed:

Table 10.5 Theme: evaluation of experiences

Reflection: experience not good: very difficult (P7)
Software: had to familiarize myself with the software, different functions (P9)
Reflect: really learned something new (P8)
Worst part: could not physically move the robot, play with it, hold end product (P6)
LDD cute program: definitely want to use it again in future (P6)
Final product: looks much better than was initially anticipated (P7)
Glad I have tried: can do much better in future: confident, engage with learners: robotics topics (P7)
Great experience: building a robot online was really awesome: first experience (P10)
Willing to learn more about robotics: gained some basic knowledge (P8)
Comprehension: assembling of robots, enhance learning inspiration (P3)
New world of digital & robots: make life easier: introduction robotics in school very interesting (P8)
Software: enjoyed flexible library icons, resize that was suitable for me (P9)
Encourages me to learn new things: always works out for me (P9)
3D design program: enhance learning experience: hands-on exercises (P3)

Table 10.6 Theme: resources

Search: videos to install software (P2), (P7)
YouTube, Internet (P4)
YouTube, Brick System Brother videos: very informative, helpful (P9)
Tutorial: videos support: zoom in/out, to rotate, build robot (P9)
After watching tutorial online: things got better: much easier to work with (P6)
YouTube tutorials: read how to connect two parts: got it right: parts move into each other more easily (P6), (P8)
Websites: hoping to do better with next opportunity: design robot online: make sure to study the websites, and know all features and technicality before starting with design (P8)

> The challenges I experienced were locating the components and locating the right components that would fit into each and every block in the area where we build, though it was locating the relevant blocks the problem came with knowing which blocks to use because there are so many blocks you won't know which ones fit where. (P1).
>
> …that since I do not know where to start, I find it difficult to know what to do because I am not familiar with the software and that stresses me a lot. (P2).
>
> I think that I can say my biggest challenge, was finding the right building materials (components). (P7).

Furthermore, it was noted that students found it difficult to find the software and that it was, according to them, not really user-friendly.

The student's evaluation of their experiences of LDD varied from being very positive to quite negative. Interestingly, one participant noted that it was unfortunate that the physical robot could not be built. It seems the learning curve in terms of the environment and its tools, as well as challenges within the environment, were sometimes experienced as being quite negative, while for some, the overall experience seemed to be more positive, as they learned new things and found it interesting. This aspect would possibly need further investigation as to why different views were prevalent. The following quotations illustrate the divergent views:

> The experience of creating the robot was not too good for me, I found it very difficult to create the robot. My planning on how I wanted to build the robot did not work for me. (P7).
>
> But I am glad I gave it a try, it makes me feel like I can do much better in the future, provided I put the skills into practice and I am confident that I can be able to engage with learners in topics such as robotics in the future. (P7).
>
> The experience I had when I was building my robot was really good, seeing how I can build anything I want online using Lego digital designer was really awesome and this was my first time experience. (P9).

As was noted earlier in terms of SDL, being able to select appropriate resources is an important skill for students. The data also reflected student practices in this regard. It is clear that students had to act proactively in finding additional support for installing and using the software. The following quotations show the student activities in this regard:

> I consulted YouTube and the internet to try to resolve this issue then I found some way yet other parts were not appearing on my software. (P4).

> I was able to get tutorials from the YouTube videos that I watched but unfortunately, there aren't enough videos to watch so that I can come up with some groundbreaking robotics in that instance. (P8).

Consequently, access to appropriate resources seems to be an important prerequisite for effective learning in this context.

10.5 Discussion and Recommendations

The following research question is addressed in this section: How can student teachers develop essential skills for the digital age through robotics simulations? A synthesis of the discussion of the findings is provided, and recommendations are made.

Although the Information Technology student teachers did not have previous knowledge about robotics and the design thereof in an online simulation environment (in this case, LDD), they developed essential skills when working on the robot task. Students were required to manage their own learning processes, take responsibility and be independent learners. For example, they had to learn the software environment, select appropriate resources, and make decisions in planning, designing and evaluating their efforts.

SDL abilities enabled some students to have more success than others. This finding is in line with the findings of Dolenc et al. (2014) which revealed that students displayed similar behavior through robotics activities. Dolenc et al. also found that the activities did not only promote self-direction; the students also seemed motivated. In agreement with Dolenc et al. (2014), it is recommended that teachers or mentors take on the role of facilitator and give students more responsibility in the learning process when engaging in robotics activities. In the literature (Kucuk and Sisman 2018), the importance of motivation in terms of learning robotics is also evident. In addition, the advantages of considering authentic problems also seemed to have a positive effect towards progress in the programming process as well as student SDL. Consequently, opportunities should be created for students to be able to draw on their own experiences, contexts and authentic needs prevalent in this regard.

This research explored the way student teachers develop essential skills for the digital age through robotics simulations. From the data analysis, it is clear that students experienced skills development, as was also the case in the research by Dolenc et al. (2014) and Hudson et al. (2020). In this regard, the student participants in this study identified elements of cognitive and SDL skills as being relevant. This finding also corroborates with the experience related in the research by Lück and Lareau (2016). Despite their narrow view of SDL, it was clear that through their students' interactions with robotics, SDL was promoted. As regards cognitive skills, it is essential to consider that programming requires higher-order cognitive skills, which, according to Yilmaz Ince and Koc (2021), can be supported through robotics in terms of computational thinking skills.

Hence, for future implementation of robotics in similar contexts, supporting cognitive and SDL skills would be recommended. Furthermore, the fostering of computational thinking skills could also—in line with the existing literature (cf. Yilmaz Ince and Koc 2021)—be recommended.

The importance of reflective skills was also evident, and this prompted changes in the way in which students approached their problem-solving. This aspect ties in with the view of Hudson et al. (2020) that learning by reflection is an effective strategy that can be employed within the context of robotics. Furthermore, the environment involved very specific technical skills and innovation through active involvement in online robot simulations on the part of students as they had to navigate their way through a novel environment. It is, therefore, recommended that robotics interventions and the use of such new environments be scaffolded and support be put in place. In this context, a differentiated approach would be useful, as students had varied experiences in this regard.

Useful themes were also derived in terms of students' challenges, experiences and resources used. In this regard, the experiences of students varied greatly, and they had very different needs. The varying levels of difficulty experienced by students in this study also mirrors the research findings of Hudson et al. (2020) which revealed that students reported experiencing programming robots as both easy and hard. However, overall, despite some negativity, most students enjoyed the experience. Students also acted in a very self-directed manner in terms of finding and utilizing additional resources to support their learning.

10.6 Limitations

Notwithstanding the valuable findings from this research, the researchers identified certain limitations. First, the conclusions made from this investigation are not generalizable and relate to a very specific context at a selected South African university and only pertain to a specific group of student teachers. Second, only a small number of participants gave informed consent for their data to be used, and this limited the number of student views that could be considered.

However, despite these issues, this chapter opens up further avenues for future investigation through which real-time student views and perceptions, the role of metacognition and the significance of computational thinking skills, among others, could be explored.

10.7 Conclusion

This chapter explored how student teachers' essential skills for the digital age could be developed through robotics simulations. This multimodal environment lent itself to a space where student teachers could act in a self-directed manner towards developing

several skills. Problem-solving in this context relies on knowledge of the semiotic resources utilized in the robotics simulation environment, and certain cognitive and SDL skills, reflective practices as well as unique technical skills and innovation through active involvement in online robot simulations by the students. However, it is also clear that in addition to online resources that can be consulted, lecturers could also provide differentiated support through scaffolded interventions to aid student engagement specifically with the aim of enhancing teacher education for a digital age.

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Chapter 11
A Multimodal Approach to Language Learning: Wikipedia as a Tool for Language Translation in a Bilingual Environment

Aletta Mweneni Hautemo and Michele F. van der Merwe

Abstract This chapter explores the use of Wikipedia in presenting an educational design using a multimodal approach in structured environments in which interconnected text-based tasks are presented to stimulate dialogical interaction that could lead to a higher level of critical thinking in students. The multimodality of the Wikipedia website is discussed as a platform that involves students (through translation) in the use of authentic online materials to set out innovative language teaching methodologies that respond to the so-called 21st-century skills. Wikipedia was used in this study as a tool for language translation from English second language (source language) into Oshikwanyama and Oshindonga first languages (target languages), respectively, by pre-service language student teachers at a tertiary institution in Namibia. The study explicates the use of Activity Theory as a theoretical framework for the language mediation process. A qualitative research approach and a case study research design were followed. Non-probability sampling was used, and 24 pre-service language student teachers were purposefully selected. Data collection tools such as blogging and artefact analysis of the translated pages were used to obtain an in-depth understanding of the participants' experiences with the Wikipedia translation. The findings show how this Wikipedia translation task responds to the educational demands of the Fourth Industrial Revolution and the promotion and development of the languages of Namibia at the tertiary level. It reveals that Wikipedia translation functions as an authentic language learning tool within a communicative language teaching approach in a technology-rich learning atmosphere that leads to total learning of languages. The study recommends the application of Wikipedia translation as a multimodal method that highlights the notion that bilingualism is seen as an asset instead of a liability in language teaching and learning and that methodologies be developed that respond to the way pre-service language teachers process information in the digital age.

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11.1 Introduction

Web 2.0 tools present a live intercontinental connection and viable communication tools that are receiving wide recognition in academia (Godwin-Jones 2015; González-Lloret and Ortega 2014). These tools offer a wide range of support that contributes to technology-enhanced language learning. With recent developments in the use of the Internet and Web 2.0 tools, the multimodality of Computer-Mediated Communication (CMC) is seen as an illustration, or source, of enrichment, which has become the focal point for language teaching and learning with technology. According to González-Lloret and Ortega (2014:3), "Web 2.0 technologies create unprecedented environments in which students can engage in 'doing things' through technology-mediated transformation and creation processes". Further, Warschauer and Grimes (2007) posit that Web 2.0 communication tools, such as Wikipedia, provide opportunities for communication through audience authorship and the use of online artefacts, which allows the publication of content in creative and collaborative ways. The multimodality of the Wikipedia website may involve students (through translation) in the use of "authentic online materials that contain high amounts of 'flavourful' language, e.g. collocations, idioms, and humour" (ibid.). This, in turn, helps to enhance the students' real-time conversations and provides timely face-to-face feedback opportunities.

This study presented Wikipedia translation as a real-life communicative task in which fourth-year pre-service language education student teachers (majoring in English Language Education and Namibian Language Education) were engaged in choosing, editing and recreating content from the English language into a Namibian indigenous language. These student teachers were second language speakers of English, a second language they were being trained to teach in the Senior Primary phase (Grades 4–7) at the time of the study, in addition to a Namibian first language (Oshikwanyama and Oshindonga). Thus, in this study, Wikipedia was used as a tool for language translation from English second language (source language) into Oshikwanyama and Oshindonga first languages (target languages), respectively. This means that these students made use of English Wikipedia articles on the Wikipedia site, then translated those into the Namibian languages (Oshikwanyama and Oshindonga) and later reposted the translated articles on the site with the purpose of displaying them for a wider readership on the Internet or using them in the first languages classroom.

For student teachers to benefit from technology in the language classroom, they need to be imparted with knowledge related to the use of technologies available at their disposal so that these influence the way they communicate with one another. They also need to be introduced to communicative language teaching techniques that integrate tasks in the technology-rich classroom to develop the ability to devise

classroom tasks in a way that leads to total learning of languages in a bilingual environment. Bloch (2002:19) asserts that "meaningful education comes through recognising that the various aspects of language in multilingual contexts (speaking, listening, reading and writing, as well as interpreting and translating) are not learned in separate and mutually exclusive ways". Thus, it was relevant for the pre-service student teachers involved in this study to find the value of using Wikipedia translation in the bilingual education context while still at university so that they would be able to integrate technology successfully in their future classrooms.

Swarts (2002) maintains that bilingual education should not be seen as an obstacle to communication but rather as an iterative process whereby both the first and second languages complement each other. This study is embedded in the LCE methodology of Communicative Language Teaching (CLT) to develop oral and written communication skills while working in collaborative groups. The emergence of CLT in language learning points to translation as a skill that allows students to be more flexible, analytical and interactive (Leonardi 2010). According to Cummins (2007), translation plays an important role in enabling bilingual students to actively participate in their learning. Moreover, translation highlights the need to explore the appropriate application of language within a communicative language classroom (Leonardi 2010). Translation is a task that involves negotiation for meaning and problem-solving through social interaction (Hautemo 2014). This study was motivated by indications in the body of knowledge that the extent to which translation is done in first language learning is limited. Much emphasis has been placed on second language acquisition (Leonardi 2010). Other studies conducted on translation are limited to language translation in the language classroom, and very few attempts have been made to study the impact of online translation as a tool for localising online content into African languages (Dalvit 2009; Hautemo 2014). A more sociocultural research approach to translation through e-Learning lenses was sought, whereby Wikipedia translation is seen as a social phenomenon in which pedagogy is socially situated and culturally mediated.

The premise of this study was to use translation as one of the tools through which students could transmit their cultural knowledge and information about the native societies to the world in their first languages, using technology. This bridges the gap of the digital divide through the translation of online content (Hautemo and Dalvi 2014) by providing written narratives in the students' native languages. This could be done as both a synchronous and an asynchronous activity inside and outside the classroom. Pedagogically, it could be done as a task that students undertake in the classroom to learn different languages so as to promote language learning (Dalvit 2009; Hautemo 2014).

The objectives of this study were to:

- explore the use of Wikipedia translation as a tool for mediating dialogical communication between pre-service first language student teachers;
- explore the use of Wikipedia translation as a tool for language learning through communication, involving negotiation for meaning in a collaborative environment;

- explore the use of Activity Theory as a framework for integrating technology in the translation of languages in a tertiary learning environment.

11.2 An Overview of Technology and Translation Tasks

The knowledge society (KS) presents the world of innovation and technologies to be incorporated into the education of the 21st-century student. Consequently, many researchers are trying to integrate the different modes of online learning into first language learning (Hautemo and Dalvi 2014; Lai and Li 2011). In the light of these developments, González-Lloret and Ortega (2014) warned that, no matter how exciting new technologies for language learning may seem, they can become nothing more than entertainment, unless their design, use and evaluation are guided by viable educational and language development rationales. Consequently, Gonzalez-Lloret and Ortega (2014: 4) identified definitional features of a task in the context of technology and task integration: (1) primary focus on meaning; (2) goal orientation; (3) learner-centeredness; (4) holism; and (5) reflective learning. In the light of this, Long's (1996) interactional hypothesis stresses the process of negotiating for meaning to elicit corrective feedback that primarily focuses on generating meaning through clarification requests, recasts, confirmation checks, reformulation of utterances, etc. Negotiation for meaning—which occurs in the context of performing tasks—permits students to engage in the cognitive process needed for language acquisition and learning. The use of technology in translation tasks should enhance the development and organisation of goal-oriented tasks, which enable collaborative learning in a communicative context (Thomas and Reinders 2010: 18). These could have communicative outcomes through the production of oral or written messages as well as non-communicative outcomes that allow students to have a sense of achievement at the end of the task.

The features discussed by Gonzalez-Lloret and Ortega (2014) are essential in the educational context that especially tries to inculcate new methodologies and pedagogies in the higher education context. These features were integrated into the training of and research on the participating language student teachers to develop the learner-centred principle in the teaching of languages, which enables student teachers to develop authentic goal-oriented tasks that are focused on meaning-making, using technological tools. This study made use of the same technological tools that the students were using at the time in their daily lives, such as the computer, the Internet, and Wikipedia.

11.2.1 Translation Revitalisation Through Technology

Leonardi (2010: 17) observed that "translation plays a very important role in an increasingly globalised world and in increasingly multilingual Europe where it is

used on a daily basis". In recent years, the world of technology has been experiencing a surge in translation innovation, using developed applications for language translation and editing—such as Google Translate, Wikipedia, Lexiphone, Vocre, etc.—which recognise both print (written) and vocal (speech) translations. These are accompanied by some linguistic rules that enable the translator to detect grammatical rules and vocabulary. Importantly, these innovations in translation programmes are made accessible to education sectors around the world through the integration of ICTs into education systems. In this digital world, some university students are increasingly using their roles as digital natives by interacting with other students in different areas of the world in the languages of their choice, using internet devices and applications. These were the types of students involved in this study: students who are hooked on the use of Web 2.0 social-networking tools that enabled them to communicate with other people around the world in the language of their choice.

Technology should be used in translation to enhance the development and organisation of goal-oriented tasks which enable collaboration and the mediation process of language learning in a communicative context. Therefore, the translation task should:

- have communicative outcomes through the production of oral or written messages as well as non-communicative outcomes that allow students to have a sense of achievement at the end of the task;
- address the students' linguistic and non-linguistic needs, and, thus, it needs to be analysed well to fit into their learning context or situation. Such analysis may lead to the recruitment of students' own linguistic and non-linguistic resources and skills that allow them to execute the translation task with "flexibility and diversity" (González-Lloret and Ortega 2014: 3) which enable them to learn two languages simultaneously;
- have a sense of authenticity and reality in the task that enables the students to experience real-world relationships in a real-world context;
- require students to evaluate and assess the learning experience. Assessment should be embedded in the translation task and should present opportunities for both lower-order and higher-order reflective learning.

11.2.2 Contributions of Technology to Language Translation

Technology has become a prominent subject in language research, with many researchers contributing to this discussion (Hautemo and Van der Merwe 2021; Gonzalez-Lloret and Ortega 2014; Thomas 2017). The use of technology in translation encourages language development of digital literacies needed in the 21st-century, and it also activates and demands the use of cognitive, attitudinal, social and behavioural mechanisms for language learning (Hautemo and Van der Merwe 2021). A technology-enhanced language learning environment entails:

- a selection of several avenues and resources needed to perform and execute a task. Lai and Li (2011: 501) argue that tasks in a technology-enhanced environment represent "holistic activities in which students make use of their language and cross-cultural communicative resources to achieve some non-linguistic outcome through stretching their linguistic, internet-based communication and digital literacy skills";
- the use of technology tools that aid the exploration of instruction through collaboration and communication. Through this, real-life tasks are designed to represent real-life content being executed in real-life contexts;
- the use of different objects, mediating tools and artefacts that enable the students to use their receptive and productive skills to explore, collaborate and communicate. These tools are needed in a sociocultural learning environment that needs to cultivate dialogic communication in the language classroom.

Hoven (2006: 238) postulates that a technology-enhanced learning environment does not only include the physical space but also consists of the "intangible conflux of teachers and their pedagogies, beliefs and roles. It includes the students as individuals and as groups with their need-driven goals, competencies, learning styles and strategies". There are physical resources, which include libraries and technological equipment, and soft or virtual tools, which include internet facilities, software, networks, and others. Thus, using a Web 2.0 tool serves as a point of departure where students would see Wikipedia as a language learning tool but not as a social tool as it is perceived to be. This study intended to locate translation, which, at the time of this study, was a neglected concept in the first language learning context in technology. Consequently, translation is considered as a pedagogical task which is complex for language students, who do not perceive it as a task that leads to communication in the classroom.

11.2.3 Wikipedia as a Technological Tool for Language Translation

Increasingly, synchronous and asynchronous Computer-Mediated Communication (CMC) has been incorporated into language learning. Thomas and Reinders (2010: 84) presented a broad differentiation between the two CMC concepts. According to them:

> [synchronous CMC (SCMC) refers to] situations where participants involved in the communication take place virtually in real-time, while asynchronous CMC (ACMC) refers to communication where participants do not need to be online at the same time and can read and respond to messages in their own time.

With the recent adoption of technology tools in education—which emphasises multimodal capabilities—CMC use is also changing to accommodate the use of the Internet as a communicative tool for language learning. SCMC exposes students to

real-time language learning interaction, and it uses real-time communication tools such as chats, forum discussions, video conferencing, etc.

SCMC has been criticised by some linguists as putting a heavier load on students because they have less time to plan their responses since they are doing the activity in real-time, which results in less accurate outputs (González-Lloret and Ortega 2014; Thomas and Reinders 2010). On the other hand, ACMC is deemed to allow more time for students to read, organise and compose their output, as they do these at their convenience with no restrictions (Thomas and Reinders 2010). This allows students time to search for physical resources and references that often result in well-composed and organised output. Media use in CMC is categorised as multimodal, which includes the media employed to communicate and the channels used by students to interact with and within the media (Hoven 2006). It is necessary that these media be used in a first language classroom where students are presented with authentic tasks that aid authentic language use, which also aids communication between students in the classroom. These include:

- the available media that could be used with activities around them;
- skills development and related subskills; and
- the media as illustrations or enrichments that promote cultural and linguistic awareness.

According to González-Lloret and Ortega (2014:3), "Web 2.0 technologies create unprecedented environments in which students can engage in 'doing things' through technology-mediated transformation and creation processes". Hoven (2006) claims that the emphasis on the use of technology is on:

- exploratory learning, such as task-based approaches such as Wikipedia translation;
- learning through communication, involving the negotiation for meaning through chats, blogs, etc.; and
- collaborative and negotiated learning of problem-based learning such as computer-mediated collaborative learning and/or Web-supported collaborative learning.

Web 2.0 technologies present students with the resources needed to interact using more than one form of communication. It uses real-world tasks from the daily lives of the students that resemble real-life. This may include tasks such as creating a blog page to engage fellow bloggers to contribute to discussions of social issues; creating a Wiki page for peer collaboration; writing in the language classroom; or creating a Facebook page or a WhatsApp group for class information sharing, etc. University students are generally acquainted with these tasks. This is where many students' interests lie; hence, using these tools could stimulate their interest in learning because it is done on the platforms with which they are most familiar. Both SCMC and ACMC tools introduce students to social orientation, instead of only cognitive orientation, and this, in turn, shifts students' participation from passive to active, as it is in a naturalistic setting that enables them to use language for meaning-making and learning.

11.2.4 Wikipedia as a CMC Tool for Language Translation and Learning

A wiki is "an asynchronous web-based environment where students could log in at any time and generate, add, change, delete and edit text, while the system tracks the history of all user activities and created content" (Elola and Oskoz 2010: 52). A wiki presents a collective and collaborative writing process that entails a range of topics, from content development, language localisation and translation of content, cultural topics, and language writing development tasks. Wikis present an educational design that uses a multimodal approach in structured environments in which interconnected text-based tasks are presented to stimulate dialogical interaction that could lead to a higher level of critical thinking in students.

According to Godwin-Jones (2015: 11), "much of the activity in globalised online spaces is within genres that are primarily text-based". One of the Web 2.0 tools used in the language classroom, which is primarily text-based, is Wikipedia, which provides a text-based CMC that "creates affordable learning conditions to support both meaning-oriented communication and reflection" (Lee 2010). Text-based CMC also presents a self-paced setting that increases students' "opportunities to take notice of errors and make output modifications", including self-correction (ibid.). Godwin-Jones (2015) observed that students use Wikipedia as their sole reading source, whereas they can also use it to learn the other four language skills. According to Lai and Li (2011: 502), a text-based CMC such as Wikipedia is found to "increase the amount of language that students produce during task performance because they found this context more motivating and themselves less anxious in producing the target language". Wikipedia can be used for both oral communication and written discourse, which are technologically enhanced to erect complex language structures and obtain greater grammatical accuracy in students' performance. Blake (2016) suggested that Web 2.0 tools, such as Wikipedia, can be used in learning contexts because they allow users to comment or elaborate on someone else's written entries, thereby promoting the practice of collaborative reading and writing, and in so doing, creating opportunities for translation of languages.

Wikipedia translation affords the teacher and the students a chance to interact with digital tools and use technology to "learn by doing" in the traditional face-to-face context (Blake 2016). It presents a learning context that stimulates students to discuss and communicate with a "fluency that more closely mirrors the spontaneous turn-taking behaviour found in real-world, face-to-face" conversation (Blake 2016: 130). The multimodality of the Wikipedia website may involve students (through translation) in the use of "authentic online materials that contain high amounts of 'flavourful' language, e.g. collocations, idioms, and humour" (ibid.). This, in turn, helps to enhance students' real-time conversations and provides timely face-to-face feedback opportunities. This further helps students to have a limited understanding of the source or target language to work in groups to increase their linguistic capabilities and development.

According to Blake (2016:136), "any digital tool that helps L2 learners engage in the editing process is bound to produce an improvement over the long run, as students are engaged in an iterative design process". Wikis like Wikipedia combine the essence of reading and writing, which are necessary for the translation classroom and, more broadly, in a language learning context. As a digital tool, Wikipedia can be used to plan and revise the translation process and gives a reflection using other Web 2.0 tools, such as blogging, whereby students can have synchronous discussions and review their projects using either L1 or L2. This presents students with a multicultural and multilingual space, which also enables problem-solving and negotiation for meaning, while personally investing in language acquisition and learning.

The process of implementing Wikipedia translation could be challenged by teachers' inability to find relevant activities on the Internet that enhance students' ability to communicate. This could necessitate negotiated interaction as well as develop learners' language identity. In considering methodological approaches, teachers should adopt a holistic approach that bridges the gap between what is done online and what happens in real-life. They should thus identify the different responsive ways of using a variety of multimodal data sources in effecting students' holistic language acquisition and learning.

11.3 Theoretical Framework

This study adopted sociocultural theory (SCT) as its theoretical framework. Both SCT and Wikipedia translation attempt to re-contextualise the classroom as a place for studying and developing language, with a focus on meaning. Duff (1994:175) clarifies a translation task as "the behaviour that is produced when an individual (or group) performs a task. It is a process as well as the outcome, where the task is examined in its sociocultural context". In this study, SCT was used to link tasks to the language mediating tools (Vygotsky 1978) by investigating the social interaction between student teachers, negotiation for meaning, and the use of artefacts, such as English Wikipedia articles, through the computer and the Internet. Considering SCT, Wikipedia was used to promote a Web 2.0 language learning exercise, which was deeply rooted in the adaptation of online content through careful planning, coordinating and configuring of technological materials, in this case, the Wikipedia site, for online language translation.

Furthermore, framed by SCT, Activity Theory (AT) (Engeström 1987) was used to provide a framework for analysing the student participants' reflections on the translation activity. The Activity System (AS) community comprises the subject (student teacher), the subject collective (students in the collaborative groups), the object (Wikipedia translation), and the mediating tools (computer, the Internet, and language tools), and the outcome (translated Wikipedia pages). Vygotsky (1978: 40) defined mediation as the "part played by other significant people in the learner's lives, people who enhance their learning by selecting and shaping the learning experiences presented to them". According to him, cultural artefacts, such as instruments,

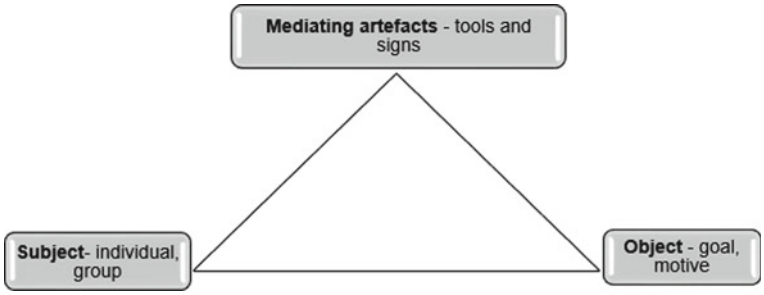


Fig. 11.1 Mediation triangle (Vygotsky 1978: 40)

concepts, diagrams, structures and language, facilitate human activity. Symbolic tools are used to mediate people's relationships with one another and the objects around them. Vygotsky (1978) describes the subject, mediating artefacts, and object to human actions as well as their effect on human cognitive development. As such, he developed a basic mediation triangle to describe human activity. The mediation triangle is illustrated in Fig. 11.1.

Activity Theory (Engeström 1987; Leont'ev 1981) emanates from Cultural-historical Activity Theory (CHAT), a paradigm that has its roots in Vygotsky's SCT (1978). This paradigm regards the history and culture of the context as a holistic entity where humans, as agents of change, interact using different tools that comply with or break the rules, which operate within the community, which are directed to managing tasks through the division of labour (Blin and Appel 2011). Vygotsky (1978) developed the notion of mediating artefacts or tools, which asserts that the individual can no longer be understood outside of culture because they interact with the tools and objects embedded in that culture or society. The forms of cultural practice are used in the activity to provide educational affordances. These affordances include technological, social and linguistic elements that support the development of new pedagogies and skills for 21st-century students. Lantolf and Thorne (2006: 210) argue that CHAT is in the "practices of everyday life, including the cultural and material structuring of environments, as well as the manner of our participation in them". In educational environments, language learning pedagogies may present problems, such as developing new collaborative teamwork that uses Web 2.0 applications to open possibilities for collaborative writing through Wikipedia translations.

This study first examined the generation of CHAT, which is based on Vygotsky's (1978) concept of mediated actions, which investigates the role of tools and human labour as the means of transforming nature and individuals. Figure 11.2 shows Leont'ev's (1981) hierarchy of activities, actions and operations.

In order to apply Leont'ev's activity hierarchy (1981) in a study that dealt with technology-enhanced translation tasks, we needed to look at the motives for the activity. Lantolf and Thorne (2006) explain that (1) *activity* asks why something is done (what motivates the involvement in the activity); (2) *action* describes what takes place (what are the goals or product of the activity); and (3) *operation* says

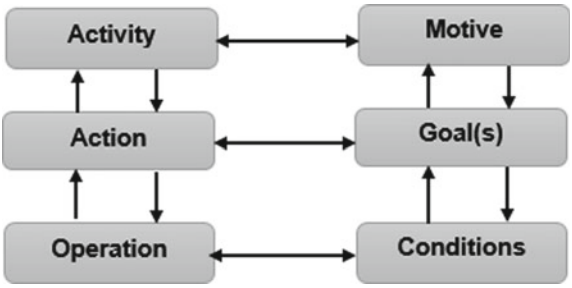


Fig. 11.2 The activity hierarchy. 1981 Adapted from Leont'ev (1981: 161)

how it is carried out (what are the procedures and conditions under which something is done). Students have different motives that encourage them to become involved in language learning activities. In some cases, students get involved to develop their communication skills or to learn languages using computers, etc. Some students may just focus on task completion, just to prove a point that they can translate successfully, but for others, it might be that they want to develop translation skills for future language use. For the task to be meaningful to students, it should be located within their authentic sociocultural contexts and goal-oriented to meet their needs and respond to their conditions.

Furthermore, this study considered the use of second generation CHAT (Engeström 1987). Engeström re-organised the structure of the activity described in the first generation of AT by illustrating the "role of cultural mediation, the social-cultural-historical context of the activity, and the relationship between the individual and collective" (Westberry 2009: 62). Engeström (1987) found that the activity system (AS) enables an analysis that focuses on the entire collective AS of a language translation task, which has a complex mediational structure that is shaped by its subjects and objects. Duff (1994: 175) explained that activity "comprises behaviour that is produced when an individual (or group) perform a task". This indicates that there is a strong connection between the motive for the activity and the goal. Motive describes the impetus for attaining a certain outcome by the subject through enacted rules which are established and decided by a community of people who decide on who does what in performing the task. As such, AT forms a unit of analysis for executing a mediation activity within a certain sociocultural system. Figure 11.3 presents Engeström's (1987: 78) second generation of AS for this study.

Engeström (1987) presents an activity system which is based on a triangular structure that is constituted of multifaceted interconnections. The six components of Engeström's model present a good analytical base for technology-enhanced translation tasks. The Wikipedia translation task served as the unit of analysis, which was directed at an object in the form of a communicative outcome. According to Engeström (2008: 26), an activity is "a collective systemic formation that has a complex mediational structure". The Wikipedia translation task presented a collective, artefact-mediated and object-oriented activity which was enacted between different components of the activity system. These components are discussed next.

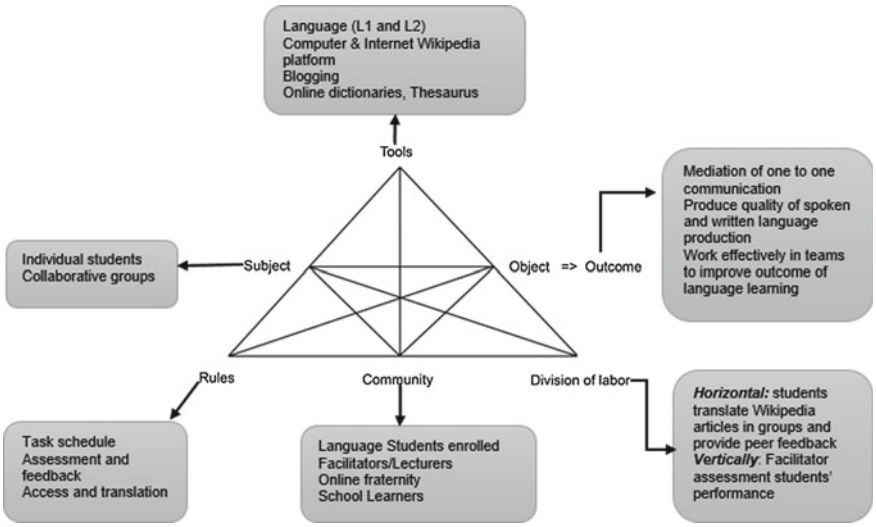


Fig. 11.3 Representation of Activity System of translation task based on Engeström (1987)

- The *subject or subject collective* is the individuals or collaborative groups of people whose viewpoints are adopted for use. In this task, the subject collective refers to the student teachers who were tasked with doing the Wikipedia translation, using their linguistic and communicative skills to negotiate meaning verbally or in written forms using English L2 as the source language and Oshikwanyama/Oshindonga L1 as the target language.
- The *object* refers to the raw materials or problem space, which is moulded or transformed into the outcomes at which the activity is directed, with the assistance of physical and symbolic external or internal tools. Lantolf and Thorne (2006: 223) posit that the object of the activity is "the nexus of power and resistance in language education context which describes how the outcome will be evaluated, by whom and with what effects and how tightly the actions and operations will be monitored". In this task, the object is the successful translation of Wikipedia pages using L1 and L2 linguistic features to aid communication and negotiate meaning.
- *Tools and mediating artefacts*—Engeström (2008) proposes four categories of mediating artefacts: (1) what artefacts are used to identify and describe objects; (2) how artefacts are used to guide and direct processes and procedures on, within or between objects; (3) why artefacts are used to diagnose and explain the properties and behaviours of objects; and (4) where artefacts are used to envision the future state or potential development of objects, including institutions and social systems. In this task, mediating artefacts included technologies such as the Internet and the Wikipedia platform that enable students to collect and retrieve information or texts for translation. The technological tools included Web 2.0 platforms, such as blogs, which are created for further interactions and symbolic tools, such as

language resources, which, in a bilingual environment, may refer to the use of L1 and L2 to communicate and negotiate meaning. Physical linguistic tools, such as dictionaries, thesauruses and online language translation programs, are applicable.

- The *community* refers to all members of the AS. It comprises the multi-voiced social constructors such as the facilitator of the Wikipedia translation, who is a language expert and who orientates the subject collective to the task. It also refers to the external users or benefactors of the translated Wikipedia content, uploaded to the Wikipedia platform for a wide audience outside the framework or social context of the subject collectives. These benefactors may include the language students at the university, school learners, lecturers, and all the people who will access the translated pages on the Wikipedia website.
- The *rules* can either be explicit or implicit norms that regulate actions and interactions within the system. In this translation, the rules are extended to the expected mode of interaction, translation strategies and online etiquette and behaviour.
- Lastly, the *division of labour* involves the division of tasks and the roles of the subject collectives within the activity system completion. In this task, this may refer to the roles of collaborative group members, the individual contribution towards a collective effort, and the role of the community in offering mutual facilitation. Division of labour includes the vertical and horizontal division of power and status among different group members—in this case, motivated by their pre-technological and linguistic skills and abilities. This means that, among the participants, there could be students who are knowledgeable about technology and its use in language learning and would want to demonstrate their technological skills to others, whereas others may be more linguistically-oriented and would be more inclined towards using appropriate language translation strategies. Regardless of the power and status that comes with the division of labour, all roles are allocated to support both task design and execution.

Through the enactment of AT, systemic tensions, breakdowns and contradictions may occur (Kuutti 1996). These, according to Engeström (2008), are essential actions that deviate from the unexpected course of normal procedures that offer potential lenses for understanding the interplay between the different components of the activity system. In translation, these tensions, breakdowns and contradictions could be caused by a multitude of competing voices, also referred to as multivoicedness (Cole and Engeström 1993). Multivoicedness is related to the multiple perspectives, interests and traditions of the subjects; as members, they carry diverse histories which are related to the tools and mediating artefacts and rules employed. These contradictions are necessary for peer/self-reflection, which may lead to the actual self-regulation.

Concerning technology use in the language teaching context, tensions may arise because of the introduction of a new tool into a community, which might lack an appreciation of how to use it (Westberry 2009). In Wikipedia translation, this could relate to some students' lack of awareness of the Wikipedia platform as a translating tool, or because of students being technophobic, i.e., having a fear of breaking or even dealing with some aspects of technology, such as typing on the computer, anxiety and

eagerness to complete the work, and doubting one's capability. These tensions may cause conflicts and stress to develop between the subjects and subject collectives.

11.4 Methodology

The study is underpinned by the interpretive research paradigm and its associated philosophical assumptions. The empirical research design method used was a single exploratory case study, as informed by the qualitative research approach. This study used non-probability sampling techniques to select the sample purposively (Sarantakos 2013). A sample of 24 student teachers was purposefully selected from a population of 56 Namibia Language Education and English Language Education year-4 groups. The participants were selected because of their good level of proficiency in both the spoken and written source and targeted languages (i.e., English as SL, and the Namibian language as TL). In addition, these student teachers were at the intermediate level of ICT literacy, since they had completed both the Integrated Media Education and Computer Education Modules 1 and 2. The student teachers were divided into 8 collaborative groups (three students per group; five groups were Oshikwanyama translators, and three were Oshindonga translators).

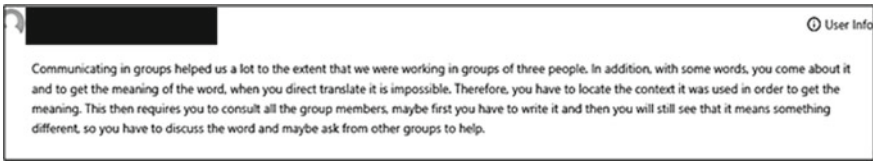
Data for the study were gathered using artefact analysis (of the translated Wikipedia pages) and blog reflection entries. The data gathered were coded into themes using Atlas.ti and were later interpreted and discussed to address the research aims. The trustworthiness of the data and ethical considerations were ensured throughout the research process. For this study, ethical clearance was sought and obtained through the application submitted to Stellenbosch University (PN1913). In addition, permission to access the participants was sought and obtained from the Research and Publication Committee of the university (Ref. EXT/390/2018). Information letters were written using Stellenbosch University's approved format and guidelines (PN1913), explaining the aims and duration of the research, and letters of informed consent were given to all the participants to complete for their voluntary participation. Anonymity was ensured using pseudonyms.

11.5 Presentation of Findings

The analysis below provides insight into how technology was used as a medium of communication and a tool through which the language was translated, used and learned. The discussions are embedded in both the CLT and AT frameworks, which are shaped by the participants' blog reflections on the learning environment.

11.5.1 Subject Approach to an Interactive Language Learning Activity

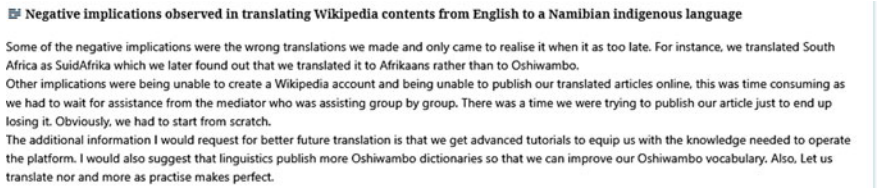
The participants approached the Wikipedia translation activity interactively, where they worked in small groups of three to make a total of eight groups of translators. The study revealed that working in small groups helped the participants to become more critical and inquisitive in giving a detailed analysis of the learning issues, concepts, strategies to use and, most importantly, to participate cooperatively. The participants remarked that working in groups provided an opportunity for them to learn and gain knowledge and experience from one another. One group member remarked:



The reflection indicates that collaborative group work helped the participants as the subjects of the study to scaffold one another's knowledge and skills and build good communicative abilities in the process. It also shows that, in a communicative language learning exercise such as this, participants are not only required to communicate verbally but also need to use their writing skills to translate the pages.

11.5.2 Rules and Division of Labour During the Task

Under the guidance and support of the research coordinator and the research co-observers/co-facilitators, the participants were introduced to the task in which they were organised into groups of three members. The rules were more concerned with the roles of individual group members. It was decided that one member should serve as the team/group leader, and one member should be the scribe, who acts as the group secretary and the lead typist. The last member served as the group convener and the lead researcher, who was responsible for research and information gathering. The roles of each collaborative group member were well explained to the participants and the role of the whole translation community as being facilitative members. The students reflected that they did not have any prior experience of translating on Wikipedia. This translation was a first for them, but because of the clear rules and instructions given to them, it was not so difficult. One student reflected that, due to the lack of knowledge about the platform, many things needed to be done to allow successful translation:


Negative implications observed in translating Wikipedia contents from English to a Namibian indigenous language

Some of the negative implications were the wrong translations we made and only came to realise it when it as too late. For instance, we translated South Africa as SuidAfrika which we later found out that we translated it to Afrikaans rather than to Oshiwambo.
Other implications were being unable to create a Wikipedia account and being unable to publish our translated articles online, this was time consuming as we had to wait for assistance from the mediator who was assisting group by group. There was a time we were trying to publish our article just to end up losing it. Obviously, we had to start from scratch.
The additional information I would request for better future translation is that we get advanced tutorials to equip us with the knowledge needed to operate the platform. I would also suggest that linguistics publish more Oshiwambo dictionaries so that we can improve our Oshiwambo vocabulary. Also, Let us translate nor and more as practise makes perfect.

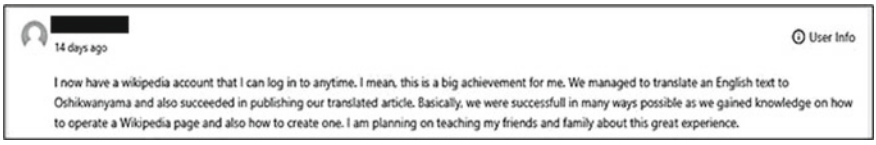
The above reflection highlights the view expressed by Leont'ev (1981), who recommends emphasising the relevance of activity, action, and operations for the execution of an activity. Leont'ev postulated that there is a need to look at the motive of the activity and explain the motivation behind involving the participants in the activity. The findings of the study indicated intrinsic motivation, which includes the need to learn two languages, i.e., Oshiwambo and English, through bilingual interactions, consequently leading to an improvement of communicative, interpersonal and technological skills. One participant reflected:

> This was my first time translating something in written form from one language to the other, so this was an amazing thing to do. At first, it was not easy but, in the end, all was falling into place. I was doing this activity whole-heartedly because I have been living with a question in my heart as to why we do not have something published in Oshiwambo on the internet and finally my whole question got answered. I felt so honoured that for now, we will be reading things on the internet in our mother tongue. Having this platform, for now, will not just end here but I will try to publish as many articles as possible. (BR18)

The rules set for this task enabled the action to be facilitated in such a way that a series of operations was enacted within a finite duration of time, and the participants were allowed enough time to plan, practise and execute the task. This then helped to place the participants in their sociocultural realm, where they had time to interact in their groups with the mediated artefacts and tools that transformed the learning context.

11.5.3 Interacting with Mediating Tools

This study made use of real-time Wikipedia translation, which the students had to execute in small groups. It was noted that, right from the beginning, many students had no idea that the Wikipedia website could be used for content translation. Some students had an idea that the content could be uploaded, although none of them had ever tried to upload content before. A reflection on students' prior experience with the Wikipedia platform is shown below:


[redacted]
14 days ago
User Info

I now have a wikipedia account that I can log in to anytime. I mean, this is a big achievement for me. We managed to translate an English text to Oshikwanyama and also succeeded in publishing our translated article. Basically, we were successfull in many ways possible as we gained knowledge on how to operate a Wikipedia page and also how to create one. I am planning on teaching my friends and family about this great experience.

In their reflections, the participants indicated that it had never occurred to them that they could learn first languages using ICT tools. One participant reflected on the historical background of African indigenous or first languages by indicating:

> Long time ago, people were reluctant to use ICT tools because they feared that they do not know how to use them, and the language they use (English) was not understandable to them. ICTs were not used in African written languages. I guess this has changed in the modern world. (BR7)

This reflection indicates that the fear of ICTs, which were deemed to be European tools, was also accompanied by a lack of knowledge and understanding of European languages. One student reflected on the factors that caused teachers to use technology in the language classroom by saying:

> Oteknologi iha i longifwa unene mongulu yofikola okuhonga, shapo ongeenge omuhongi oye a hala oku i longifa mefimbo lonhumba ngeenge ta hongo oshihongwa opo i ulike omafano taa kwafele ovahongwa mokuudako. (**Technology is not used for teaching in the classroom unless it is when the teachers want to use the projector to show pictures that may help students to understand certain aspects very well).** (HR3)

Furthermore, the participants felt that Namibian first (home) languages are not languages of the Internet. One student reflected:

> Our language is not on the internet because we do not have people who are capable of translating them into English. In history, our language was overlooked because of colonialism and the lack of development. We have a scarcity of words, thus making it difficult to translate. (HR13)

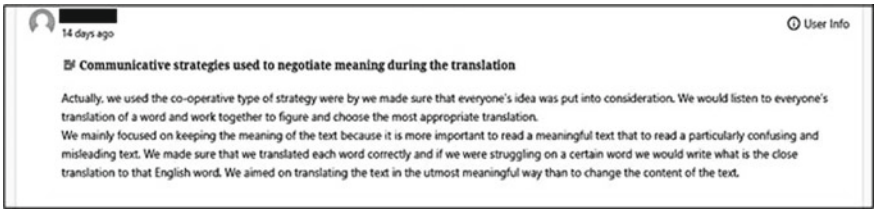
This assertion shows a deep reflection on the history of Namibian languages, which are underdeveloped compared to English. It also points to political factors that applied before independence and immediately after independence, when English was selected as the official language and medium of instruction in all Namibian schools. Participants asserted that these factors had led to a lack of English equivalents. According to the participants, English and Oshikwanyama/Oshindonga differ in the sense that, if they are directly translated, the meaning might be lost or get distorted. This also affects the syntactical structure of words in that the phrases and arrangement of the clauses will no longer be logical. Moreover, it was found out that Oshikwanyama/Oshindonga languages do not have sufficient terminology, which then led to omission, borrowing and adaptation of terminologies from the source language/text. The students used dictionaries to help them translate. This assisted the participants to search for the meaning of words that could not be comprehended in English to simplify them for use in the Oshiwambo language. The findings also indicated that the use of e-dictionaries and online thesauruses produced a substandard translation, since the participants opted to search for any meaning of terms in a Google search engine, which led to a lot of pages popping up and giving diverse meanings, of which some were not really from credible (authentic) sources. Thus, the provision of diverse meanings led to many debates concerning which meaning was correct and appropriate to use.

11.5.4 The Community in the Working Space

The community comprised of the student teachers, who shared a common object, which was to translate the Wikipedia pages successfully for the benefit of their language learning and the enhancement of their communicative skills. The community shared common rules for executing the task as well as the horizontal division of tasks among members and the vertical division of power and status in the group. One group member reflected on the use of group work:

> There is nothing sweeter than working in groups. Working in groups was the best thing ever and we really learnt from each other because what you know is not what the other person knows. The work was not that difficult because we were sharing it among ourselves. (BR14)

Students reflected that working in a community provided an opportunity for them to interact positively and share ideas, experiences and knowledge on how to translate a text into a readable standard.



The community also included a well-established internet platform which had online dictionaries, Google websites, an online encyclopaedia, meaning finders and platforms such as Web 2.0 social network tools which provided online resources for the participants to consult on the meaning of the terms. This shows that the tasks and language learning are mediated using technological devices and platforms available in a virtual learning space. Regarding human-machine interaction, students observed that it had never occurred to them that they could learn first languages through technological platforms such as Wikipedia, and they were amazed and overwhelmed by the experience. A student reflected:

> Some people believe technology is only useful when it comes to the English language, and they do not really use technology for other languages. However, here we tried to use technology to translate the English words into Oshiwambo. It is such a good feeling. (HR7)

Another student reflected:

> Technology should be used more in African language classes, to give a deeper understanding to scholars. It will also help them to search for meaning and definition of words, as quickly as possible, using the internet rather than just waiting to carry a dictionary or even go to the library. (HR14)

This reflection affirms that the virtual learning space has become such an important part of the physical world in a way that it offers reliable benefits, which makes learning

social, interactive and supported by a network of contributors. This Wikipedia translation task confirms Donnelly's (2008) opinion that communication technologies have made it possible to compress the space-time dimension and helps in breaking through barriers of national and regional boundaries. Thus, it was essential for the translators involved in this project to have a sense of concern and responsibility towards their audience so that the translation they uploaded to the website was relevant, truthful and contained accurate information.

11.5.5 Object or Outcome of the Study

The focus of this study was on the Wikipedia platform on which the translation task was performed. Wikipedia created a space where the task was directed and moulded to be transformed into appropriate outcomes with the help of the mediating tools and instruments. The study generated different outcomes that benefited language learning and the enhancement of communicative skills. The participants learned how to successfully translate the Wikipedia content from English into Oshindonga and Oshikwanyama and to repost the article on the Wikipedia platform. One participant postulated:

> The whole Wikipedia translation exercise was not really an easy task to execute, due to the lack of skills in using ICTs, but with proper guidance, we were able to translate and have our article online. We felt good that at least we can now go back to the site and find something that we have created ourselves. It is such a good feeling. (BR23)

This outcome revealed both the positive and negative sides of Wikipedia translation. First, one needs to be knowledgeable on the use of ICT or rather be guided well by a knowledgeable peer or adult to be able to translate successfully. Second, the remark was influenced by the inner sense of gratitude that the participants had in knowing that they had recreated content in their language, which they could proudly use and read. This reflection was complemented by another student who realised the following:

> Monghalamwenyo yopaife otwa teelela ovahongi va honge ounona okudja pedu, ooi va dule okulihonga okukufa elaka loshiingilisha tave li tula mOshiwambo. Eshi oshinima shiwa lela (**In this life, we expect teachers who will teach learners from an early age to learn how to translate from English to Oshiwambo. It is such a good feeling**). (HR16)

This translation was a good task to exemplify using tasks as the basic building blocks to execute online classroom activities and allowed the participants to both sequence the task and assess their outcomes. At the same time, the participants created reasonably authentic parameters within which they could communicate with each other. Most importantly, the findings indicated that this activity allowed the participants to focus on what was said to each other rather than on how it was said. This had a significant impact or influence on the outcome of their written dialogues, as it is evident in the translated pages posted on the Wikipedia portal. Moreover, the students were given a good platform to assess their work: five out of eight groups

confirmed that teachers could use the translations in the class, as they are reliable. The participants cautioned that, in case their articles would be used in the classroom, they should be compared with the latest English version, since Wikipedia is an open-source platform on which content could be updated and edited by anyone, anytime. This is important, since the Wikipedia content can change anytime, due to the openness of the platform, and this has an impact on the translated content. Furthermore, the participants also alluded to their dissatisfaction related to the lack of technological skills and vocabulary in Oshiwambo as compared to English, which was deemed to be more advanced than the Namibian languages. One group member reflected:

> Due to the scarcity of words in African Languages, some words were written repeatedly or copied exactly as they were, while at some point, they had to give a detailed explanation just for one word, to convey correct meaning, for instance, marble – **oumanya hava vema voumaaabulu,** tarred road – **opate ya kolongwa yoteya.** (HR19)

Participants reflected on how they debated the use of certain words or phrases—some indicated that they sought help from a third party (another group); some had to use opposing opinions on the word choice and the phrasing of sentences. Students also revealed that it was difficult for them to translate into well-phrased sentences because some of them had never translated the English words into Oshiwambo, even when they were at school. Thus, they resorted to word-for-word translation, which they later found had completely changed or distorted the meaning of the original text.

The participants stated that the scarcity of words in African languages compared to English made it difficult to do the translation. Many groups ended up writing the same words repeatedly or writing out descriptions or illustrations in the TL to provide the full meaning of the SL. Another reflected on how the language that was used in the text influenced their selection of the text:

> In some cultures, people are lazy to change words in their own language and thus, end up borrowing words. Our text was Namibian, everything said is part of our Namibian culture and most of the words used are familiar, making it easier to translate. (HR22)

Although the findings revealed that the texts selected were culturally friendly for the students as they incorporated many Oshiwambo cultural words, some participants complained that some words from the SL were not from Oshiwambo culture. This fact prompted them to borrow words which did not fit their culture, i.e., marble = ***oumaabulu***, turbines = ***eetubine***. Some ended up adopting the words exactly as they were in the SL, i.e., *Heroes Acre*, since they totally and completely failed to translate them.

Conflicts and contradictions were observed in this study in the sense that they influenced the outcomes of this study. One contradiction was related to the hegemony of English in the world of ICT and its dominance over African languages. The English language culture and the fact that English is deemed to be the most popular language-diverse vocabulary resulted in more advanced terminology and vocabulary which were not easily available in the Namibian indigenous languages culture. This meant students were unable to translate some of the English words, and they instead omitted

them or transferred them to Oshiwambo, which, in the end, compromised the quality of the translation and hence the outcome of the study. Another contradiction arose in the students' lack of experience to use technological tools, which then caused them to delete the first translated articles. This was a contradiction, because as much as the participants wanted to translate, they were conflicted by their lack of expertise to save the content on Wikipedia. Consequently, the groups had to restart and retranslate the text. This experience had both positive and negative outcomes. On a positive note, the students may have written improved translations, since they were doing the task for the second time. On a negative note, some students may have been frustrated and angry that they had to repeat the translation, resulting in a compromised quality of translation.

Overall, the students developed great respect and appreciation for this Wikipedia translation task, as they regarded it as an eye-opener in respect of their association and communication with other class members and the development of African languages in and out of the classroom. Some of their reflections are indicated below:

> I am very much content with the experience that I have gained from the Wikipedia platform as well as with the whole translation process. I feel quite overwhelmed to have been involved in such a wonderful practise. As this was a first time experience, I surely gained new knowledge on the translation of articles through the Wikipedia platform as well as skills on how to operate that very platform. Regarding recommendations, I would indeed recommend my translation to be used in the language classroom as I believe it would make a useful teaching resource. Although, our translated article may not be 100% like the source text which is in English, I highly believe that we kept its meaning. So, yes, the translated article is a true reflection of the English source text. (BR3)

> The truth remains that it was my first time to come across with something like that. But ever since I got introduced to it, I realise that this is an amazing experience ever. Am very much satisfied and happy that my own mother tongue will be on the internet. Of course, yes, I would urge/ recommend language teachers to make use of this platform in their teaching and learning process. The translated article gives a true reflection of the source text because nothing much changed except the language, but the content remains as it is. (BR5)

These positive comments point to the value of the outcome of the translation as an activity that the students would like to incorporate into their teaching.

11.6 Discussion of the Findings

The aim of taking part in this translation task was to use Wikipedia as a mediating tool that facilitated dialogical communication between students. The findings indicated how the activity was used to enhance the students' spoken and written communication, leading to overall improved language learning outcomes. It also showed that the translated pages would reach a wider range of community members in the real-world, who would be able to read them and share them with others, either in their physical space like schools or in their virtual space using Web 2.0 tools. The findings showed how the use of the Wikipedia website for language translation had created a new language learning environment by assisting the pre-service language

student teachers to interact with the mediating tools (i.e., ICT tools, virtual tools, and online resources). The participants made use of online dictionaries and thesauruses to extend their vocabulary and for confirmation checks on the meaning of terms or phrases.

The study postulates AT as a helpful tool in a language context, as it analyses goal-oriented actions that look at the action and mediating artefacts to reach the objective. It further explicates the action of the collective within their community or social environment as well as the motives or goals for that activity. The motive of the study was more connected to the use of CLT in a technology-enhanced language setting. AT did not only provide an analytical framework but also the theoretical lenses that are located within the sociocultural context in which students collaborated using both SCMS and ACMC in the classroom. This facilitated language learning in the classroom, as students had an opportunity to develop both procedural and declarative knowledge that is induced through language use. The intersubjectivity of language learning in this study was not only located in the interactions between the subjects of the study but also within and through all the people accessing the translated articles on the Wikipedia website.

The findings showed a good example of using Web 2.0 tools, such as Wikipedia, which is an open-source software that has been seen as a controversial subject in the body of research because its content is not peer reviewed. The findings indicated that using AT helps to redefine the identity of the Wikipedia platform as an online language learning environment that assists students to write collaboratively, and facilitates the acquisition of new communication skills by students. Blin and Appel (2011) argue that computer-supported collaborative writing fosters greater awareness of the writing process to help students to gain a sense of audience and create opportunities to focus on form and negotiate meaning. This task required collaborative behaviour that entails collective effort and the motivation of all group members within their sociocultural setting.

11.7 Conclusion and Recommendations

The Wikipedia translation task sets a good example of how teachers can apply translation in a technology-enhanced setting for language learning. This emerged in the way that the student participants collaborated well and negotiated meaning through constructive debates. It is concluded that SCT facilitated sound language learning methods that develop students' metacognitive skills that enabled them to focus on the language task and transfer their skills to the real-world context. The skills attained helped the participants to translate in a bilingual setting and to communicate effectively and competently using both L1 and L2. The outcome of the translation task influenced the way the whole learning community perceived translation in the classroom for teaching and learning languages. The results of Wikipedia translation show how translation, which is seen as an almost rejected and abandoned language learning method in school, could be revived using well-structured tasks. It is recommended

that language teachers use technological instruments such as the Wikipedia website to mediate the kind of language learning that may be derived from different kinds of mediation. This would enhance the use of 21st-century pedagogical skills required in the language teaching and learning process.

Theoretically, this study posits AT as a suitable Wikipedia translation framework which involves models of knowledge building, perspectives and artefacts to guide the design of computer-supported collaborative learning activities. This serves as a good model that presents student teachers with insights into their own classroom practices and into the way they can restructure their translation tasks to focus on communication and innovation. The use of AT is significant in addressing internal conflict and doubt in bilingual students when dealing with new learning concepts. This task served as a transformational tool for accommodating bilingual education within a modern framework using modern research tools and pedagogies. Finally, the study recommends the application of Wikipedia translation as a multimodal method that highlights the notion that bilingualism should be seen as an asset instead of a liability in language teaching and learning environments.

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Chapter 12
Educating French Teachers in the Digital Era

Karen Ferreira-Meyers, Albertus Barkhuizen, and Karin Schmid

Abstract The COVID-19 pandemic has greatly influenced teaching and learning in and of French and has propelled all stakeholders towards integrating easily accessible digital technologies in their endeavours. One of the important shortcomings made visible since the advent of the pandemic is the apparent lack of appropriate skills to teach online on the part of teachers in general and French teachers in particular. It was, therefore, essential to find out whether teachers of French had been trained in the past and whether any continuous professional development had assisted them during the pandemic (and possibly beyond). Thus, in this chapter, we examine the ways in which teachers of French in Southern Africa (in particular in South Africa and neighbouring Eswatini) are trained at both pre- and in-service levels. It is noted that, for a long time (more than 30 years), French teacher education has undergone little or no change (curriculum, pedagogical approaches, etc.). Digitisation of teacher training and professional practices is needed to ensure that teachers are well equipped to assist learners from various socio-economic backgrounds to become fully-fledged 21st-century citizens, able to contribute to societal development. In order to adapt teacher training to the current demands of technological transformation, we first need to understand the levels of training obtained regarding teaching with technology, the skill sets acquired and the ways in which they were acquired. We gathered data through a survey sent to 200 French teachers and lecturers in Eswatini and South Africa. After data analysis, we recommend that further training is necessary to adapt to the digitisation of teaching and learning and to implement pedagogical approaches suited to the current (and future) digital era. Our recommendations further include the importance of creating digital spaces for teachers to engage, share and collaboratively

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develop content as well as the raising of awareness of the benefits of Open Educational Resources (OER).

Keywords French teachers · Southern Africa · Digital era · Competencies · Teacher education

12.1 Introduction

Using ICT and multimedia resources in teaching, foreign languages has a number of important advantages which mainly stem from the multidimensional presentation of educational information and the creation of a more natural—albeit virtual—environment for learning a foreign language, especially in countries where a particular language is not part of the linguistic ecology (in the countries under study here, a non-Francophone context). This is the case with the French in South Africa and Eswatini. Offering online platforms to learners gives them an opportunity to see, hear, write and speak a foreign language which they would otherwise not frequently encounter in their personal and professional environments.

While the importance of using ICT and multimedia resources has been highlighted by numerous researchers (see our literature review), it is not evident to find teachers who are well equipped to apply these tools efficiently and effectively. Indeed, we hypothesise that little is done to adequately prepare French teachers before they start practising (pre-service training) or even during their professional life (in-service training). This lack of appropriate, timely training became even more apparent when the COVID-19 pandemic hit us hard in March 2020. Schools and university campuses were closed and teaching and learning had to go remote/online.

In this chapter, we look at how well (in terms of teaching experience, teaching qualifications, knowledge, and skills relating to the use of technology for education) teachers were prepared, before the pandemic and how they were able to adapt (during the pandemic) when confronted with curriculum changes, a shift in teaching methodology, and different personal and professional challenges due to the COVID-19 pandemic. We also take a closer look at whether the French teachers were offered any (online) workshops/continuous training to assist them in dealing with the transformations brought about by the pandemic.

12.2 Context

As indicated above, our focus is on Southern Africa—in particular, South Africa and Eswatini. French is taught in both countries as a foreign language (FLE—Français Langue Étrangère), in addition to a first language and a second language. In 2017, there were over 225 public and private educational institutions in South Africa offering the opportunity to learn French. This included a network of approximately

13 Alliances Françaises, 197 high schools and 14 universities. In Eswatini, French is part of the school curriculum (in selected primary and secondary schools) and the language is taught in teacher training colleges (2), at universities (2), and at the Alliance Française de Mbabane.

In both countries, public and private schools use different curricula. They have human and infrastructural resource differences, too. This has an impact on the quality and outcomes of teaching and learning in these institutions.

12.3 Literature Review

12.3.1 Changing Times

There are several factors that can be associated with the noticeable shift towards the deepening of the use of ICTs in education. Amongst these factors is the 21st-century skill set required by learners to be global citizens and to find employment in a post-industrial economy. This set of skills comprises elements such as "creativity and innovation, critical thinking and problem-solving; communication and collaboration; autonomy and flexibility; and lifelong learning", all of which are made possible through the use of ICTs and competencies in digital literacy (Warschauer 2011, p. 13). In order for learners to be fully equipped to succeed in the digital world, educators need to be adequately trained and prepared for the integration of ICTs in the teaching and learning environment. Malinina remarks that "the most important thing about ICT in education is not the government policy but teachers themselves, their attitude towards ICTs, their knowledge and skills to work with it, their willingness to use it and readiness to further education in this domain" (Malinina 2015, p. 75).

12.3.2 International Teacher Training Benchmarks

Several frameworks for teacher training that involve the use of ICT have been developed since the 1990s in an attempt to create policies and set standards for international benchmarking. These frameworks aim to accommodate the rapidly changing role of technology and to ensure its successful implementation in educational environments. Several key frameworks have been developed by organisations such as UNESCO and the European Commission (Murotova and Kavilova 2020). The European e-Competence Framework provides a broad overview of skills in ICT that are required in various sectors (including education), and these are divided into five e-competence processes, namely: Plan-Build-Run-Enable-Manage (European e-Competence Framework 2014).

A framework that is perhaps more relevant to the area of language teaching is the ICT Competency Framework for Teachers (ICT-CFT) developed by UNESCO. This

framework describes three phases of knowledge acquisition (technology literacy, knowledge deepening, and knowledge creation) over six main areas:

- Understanding ICT in education (understanding and implementing policies)
- Curriculum and assessment (knowledge acquisition)
- Pedagogy (integration of technology)
- ICT (use of tools)
- Organisation and administration
- Teacher professional learning (regarding digital literacy) (UNESCO 2018).

This framework is an invaluable tool for evaluating the current policies and teachers' competencies with regard to the use of ICTs in education. Once the needs in each of these areas have been determined, the direction that teacher training needs to take will become apparent. This will ultimately allow educational institutions to bring their goals in line with the new requirements of the digital age.

12.3.3 Digital Literacies

With regard to the various competencies for the use of ICTs in education, these can be considered in terms of digital literacies. According to Hockly et al. (2014, p. 2), digital literacies are "the individual and social skills needed to effectively interpret, manage, share and create meaning in the growing range of digital communication channels". These skills can be categorised into four main groups: "language and the communication of meaning" (examples include "print literacy, multimedia literacy and mobile literacy"); information (involving "search literacy, information literacy and filtering literacy"); connections (such as "network literacy, participatory literacy and intercultural literacy"); and (re-)design (which is primarily "remix literacy"). In simple terms, a person who is digitally literate is not only able to use various technologies but also able to search, filter, evaluate and use information retrieved through digital channels, participate in online communities through the sharing and distributing of information, and create resources by using digital media (Jose 2016).

The need for these literacies came about due to the development of Web 2.0, consisting of a range of tools (blogs, wikis and various social networking sites) that allows for the active participation in the production and sharing of knowledge by members of a worldwide community. Web users are, therefore, no longer "passive consumers of information" but "active contributors to a shared culture" (Hockly et al. 2014, p. 3).

Digital literacy in the field of language teaching and learning can be further subdivided into digital technical literacy, digital linguistic competency, digital multimedia competency, and telecommunication competency (Biletska et al. 2021).

12.3.4 Recent Developments

One of the most noticeable shifts in education in recent years which was further accelerated by the COVID-19 pandemic is the inclusion of social networks such as WhatsApp, Telegram, Signal, Facebook, TikTok and Instagram in the pedagogical domain. These networks can be seen to "enhance pedagogical communication, facilitate interactive learning organisation, and strengthen communities of learners and teachers" (UNESCO 2018). However, one of the common risks associated with the frequent use of these networks is a strain on mental health. Other possible effects are "online bullying and harassment" and "discriminatory speech" (ibid.). Teacher training programmes, therefore, need to address these issues and prepare teachers to mitigate the negative effects of social networks.

The use of mobile technologies in the sphere of education has also seen an increase in recent years. Devices such as smartphones and tablets allow for easy access to the Internet and have the added possible benefit of offering a personalised learning environment (ibid.). Their inclusion in the teaching and learning environment can greatly increase access to education if the necessary infrastructure such as WiFi is in place, or data is made available at a reasonable price. Consequently, teacher training needs to develop the knowledge and skills to adequately incorporate these devices in teaching methodologies.

Another promising development in the digital domain is the possibility of using or adapting Open Educational Resources (OER). These resources support educational transformation in that they are readily available to teachers on the Web without any payment or licensing required (ibid.). They can be adapted by teachers to their own educational contexts, which saves time, thereby offsetting one of the main drawbacks of the use of ICTs—time consumption. However, knowing how to access and filter the various resources that are available is a skill that needs to be acquired by teachers.

12.3.5 Offerings in Professional Development

Institutions such as the International Society for Informatization in Education (ISTE) have offerings in professional development that address the needs of educators in areas such as designing courses, assessment, creating a sense of community, and ensuring equity and inclusion in online teaching and learning environments (ISTE 2021). This categorization shows that the integration of ICTs goes far beyond the scope of knowledge and skills regarding the mere manipulation of technological tools and that the entire teaching environment together with its various components (technological, socio-ethical, pedagogical and professional) need to be reconsidered. Ravenscroft (2001) alluded to this in the early 2000s when he stated that the rush to include maturing technologies in distance learning could very well be downplaying the opportunity to re-evaluate our pedagogical practices and to truly consider processes of learning. He also argued that "e-learning initiatives have been

technology-led rather than theory-led" (ibid., p. 134). To this aim, Hafner et al. (2015) formulated several important questions for pedagogy. These revolve around how we can "effectively manage information with digital tools", "effectively communicate using hypertext and combinations of word, image, graphics and text", "how we can use digital tools to manage relationships, attract the attention of an online audience, and collaborate with peers", "what the mindsets are that lead to the most productive uses of digital media", "what identities are possible in digital spaces" and, finally, "how these identities relate to those that are possible in the classroom spaces" (ibid., 2015, p. 2).

12.3.6 Teaching of Foreign Languages and Use of ICT

Face-to-face contact in the teaching of foreign languages is considered to be important due to the communicative nature of the discipline and the interpersonal relationships that are formed amongst peers and with the language instructor. Nevertheless, studies conducted with foreign language teachers after the onset of the COVID-19 pandemic show that the online environment had several positive and negative effects.

In a study conducted by Gao and Zhang (2020), some teachers expressed that their teaching was limited by the shift to online learning, as the full participation of students was difficult to bring about. They also felt that "self-management and metacognitive ability" became increasingly important for the students to master in the distance learning environment (ibid., p. 7). This was seen to decrease the influence of the teacher on the learning environment. Other participants in Gao and Zhang's study expressed more positive views, stating that the use of ICT expanded the traditional classroom due to the inclusion of useful resources, platforms that allow for easy and effective follow-up and the various channels of communication that livens the learning environment (ibid., p. 7). All the participants mentioned anxiety and psychological pressure during the initial stages of the pandemic relating to the choices they needed to make in terms of learning platforms and resources. This was in addition to the worry about the correct functioning of these tools (ibid., p. 7). MacIntyre et al. (2020) also report that, amongst the biggest stressors for teachers were workload, family health and a sense of loss of control over the work environment. In the Netherlands, Van der Velde et al. (2021) report that the shift to online learning was rather positive all around due to the country being relatively well equipped for online learning.

There is limited research published on the teaching and learning of French in Africa during the pandemic. Opaluwa (2020) noted the importance of all stakeholders working together to ensure continued French language teaching and learning during the pandemic, while Ferreira-Meyers and Dlamini-Zwane (2021) highlighted the need for the inclusion of socio-constructivist, collaborative and active learning paradigms in the online teaching and learning of French, as well as the adoption and/or adaptation of policies on the shift (or extension) to online education.

12.4 Methodology

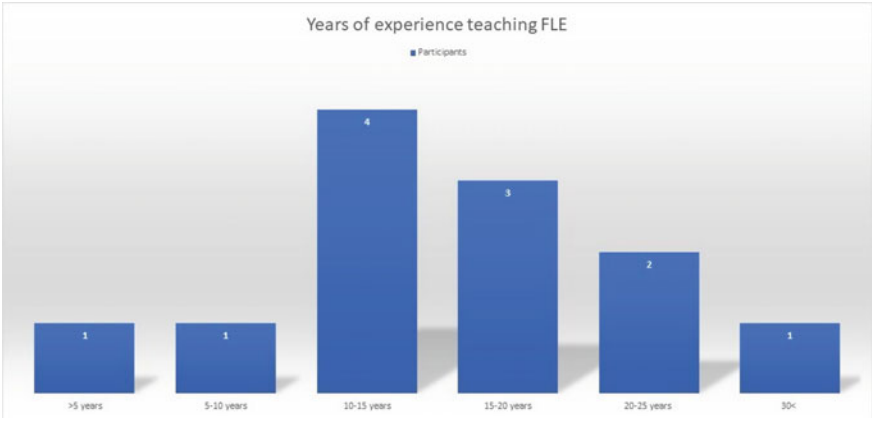
Our main research question was whether teachers of French in two Southern African countries—namely, South Africa and neighbouring Eswatini—received adequate training to teach and support their students' learning through the use of technology and digital resources. In order to respond to this question, we intended to find out which teaching and learning methodologies and principles were used before the COVID-19 pandemic started and how the pandemic has had an impact on these.

In this study, we chose a survey research design as our procedure for collecting, analysing and combining both quantitative and qualitative data to better understand the uptake and usage of technology and digital resources by practising French teachers in Southern Africa before and during the COVID-19 pandemic.

A questionnaire, consisting of 28 multiple-choice and open-ended questions, was sent to 200 participants, and responses were collected from 14 participants from private and public primary and secondary schools in South Africa and Eswatini. The respondents were identified through convenience sampling. We adopted this method because of "proximity"; in this case, proximity referred to the fact that we had the e-mail addresses of the sampled 200 participants. In addition, convenience sampling is uncomplicated and economical. It was impossible, especially during the pandemic, to reach the entire population of French teachers in South Africa and Eswatini.

Out of the 14 responses, we received, after gentle reminders for participation had been sent out, 12 responses were from practising teachers in public schools, while two were gathered from private schools; 10 responses came from South African teachers and four from teachers located in Eswatini.

The study participants (hereafter referred to as P1–P14) came from a wide age range with an equally large distribution of experience. The collective teaching experience of roughly 95 years was divided as follows:



The low response rate (14 out of 200, or 7%) is regretted but was probably influenced by the pandemic. Nevertheless, it has been noted, pre-pandemic, that mailed

surveys yield a considerably lower response rate than surveys that are distributed personally (Roth and BeVier 1998) and "using electronic administration modes (e-mail) may result in lower response rates due to concerns of Internet security, the receipt of electronic 'junk mail' or 'spam', and lack of personal relationship between researcher and respondents" (Sills and Song 2002).

All respondents participated on a voluntary basis, and informed consent was obtained from all of them. In addition, ethical clearance was sought and obtained from the South African university where one of the researchers was permanently employed at the time of the study.

12.5 Findings and Discussion

12.5.1 Teachers, Methods and Changes

Various degrees and courses were completed by the participants in preparation for a career in teaching FLE. Where some participants held only primary education teaching diplomas (one participant), some had PhDs in French linguistics (one participant). Nine participants indicated that they had obtained a BA degree in French or language-related fields. Four participants completed the South African Diploma in Higher Education (DHE)—a requirement to teach at the high school level in South Africa for individuals who have not completed a degree in education but rather in a subject field (e.g., French). The South African DHE programme is restricted to university graduates. Seven participants indicated that they had completed a Master's degree in teaching FLE.

Of all the cited qualifications, only one participant indicated that the course (MA TFLE, Université Lyon 2) included some type of digital environment teacher training for a module for Teaching French for Specific Purposes (FOS). P14 stated that this module catered to online pedagogies like teaching through Skype and + Moodle. The same MA course included modules that were specifically designed to teach students how to create video material and pedagogical resources from multimedia sources. This course structure directly aligns with the ICT-CTF framework as proposed by UNESCO with regard to pedagogy (integration of technology), ICT (use of tools), and teacher professional learning (digital literacy).

Before the start of the COVID-19 pandemic, most participants had attended various workshops related to the teaching of FLE. Three participants (P2, P8, P11) mentioned having learnt about online teaching tools during these workshops. Only two participants indicated that they had not attended any workshops before the outbreak of the pandemic.

Among all participants, the overall understanding was that teaching should be learner-centred and an attempt to broaden horizons while instilling a passion for the subject matter.

The communicative and action-based approaches represent the two main foreign language teaching approaches used by the participants without necessarily alluding to the inclusion of ICT in the classroom and broader learning environment. Two (P10 and P11) of the 14 participants explicitly stated that they used a mixture of these two approaches. P3 admitted not knowing what approach was used in class, P8 indicated that a variety of approaches were used, whereas P4 claimed to use an original personally developed approach without giving further details as to what this approach entailed. In addition to using the communicative approach, P14 claimed that they attempted to include the neurolinguistic approach that focuses mainly on the implicit grammatical acquisition, whereas P7 expressly focused on traditional grammar-based teaching. P2 simply described the approach as being FLE without further deliberation. As regards the third category of the ICT-CFT framework (pedagogy), there was very little consensus among teachers about the most relevant pedagogical approach in foreign language teaching. Considering the preceding information, we can infer that there is even less consensus about the best pedagogical approach to undertake where ICTs are concerned.

As the COVID-19 pandemic struck, Southern Africa and teaching moved from face-to-face to remote and often fully online environments; important changes in pedagogy were expected. However, only four participants adopted new teaching approaches and methodologies that they believed were better suited for online environments. Eight participants categorically denied that they had made changes to their teaching methods, but two participants (P7 and P13) highlighted that, although there were no changes in the methods, the mode of delivery changed from face-to-face to online, and thus this naturally included an enhanced use of ICT. Two other participants (P2 and P4) mentioned that they were not certain about a change in method but that they had started including more digital resources. Based upon the evident abrupt inclusion of more ICT in the learning environment and by taking the teachers' previous training (where little attention was given to ICT) into account, one could estimate that a number of issues arose due to an absence of a competency framework for teachers (see Sect. 12.3.2 for more information on the ICT-CFT). This sudden shift would not have allowed teachers to undergo the required training prior to implementing ICT in their teaching environment.

Furthermore, although they represented the majority of the participants, only eight teachers adapted their syllabus due to factors relating to the COVID-19 pandemic. In most cases, fewer assessments and compressed syllabi were presented. P14 indicated that assessment types changed to include more oral than written work to stop students from presenting machine translations as their own work. These point to UNESCO's category 2 (Curriculum and Assessment).

12.5.2 Recent Training

In the first 14 months since the start of the COVID-19 pandemic and national lockdowns in South Africa and Eswatini, eight participants attended a variety of

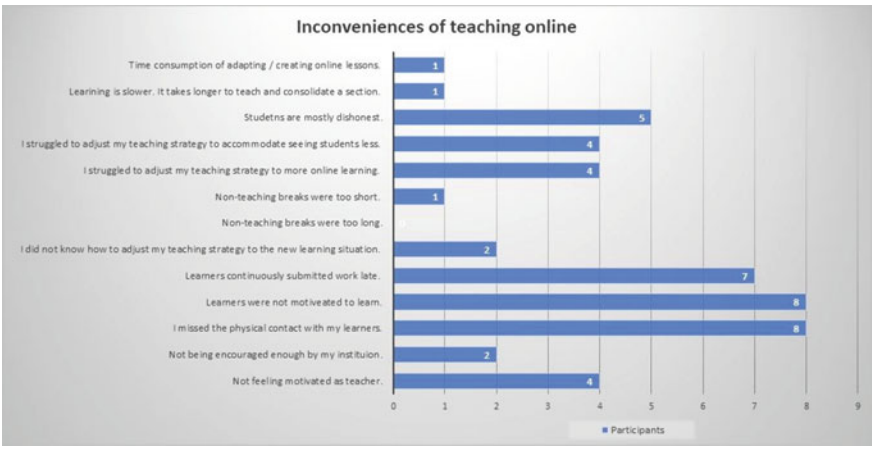
teaching FLE workshops. P14 was in the process of completing a Master's degree and participated in two extra workshops.

Of the workshops attended during this period, two workshops were on preparing learners for language benchmark tests; three dealt with online teaching (practice and theory), of the workshops did not include adapting strategies for online and remote teaching; and one dealt with the adaptation of curriculum to the adjusted academic calendar. Unfortunately, five participants did not attend any workshops.

Twelve participants indicated that they used more digital resources in their teaching since the start of the COVID-19 pandemic. Two participants claimed they used the same number of digital resources. One of the latter, P14, started using social network platforms like WhatsApp in teaching even before the start of the national lockdown in South Africa and claimed the transition to fully online teaching was smoother because of this. Unanimously, the participants agreed that using digital tools in teaching was a positive experience. Importantly, we note that an increase of digital resources in the classroom does not automatically translate into their effective use, whether it be by teachers or learners. The relatively low number of completed training sessions on the use of ICT and adaptation of curriculum for the digital learning environment in addition to the existing confusion as regards teaching methodologies should be seen as a matter of concern. It is also possible that a surflux of digital resources in the classroom for the sake of including them without proper understanding of how to use them could contribute to adding to the issue.

12.5.3 Inconveniences and Advantages of Using ICT in the FLE Classroom

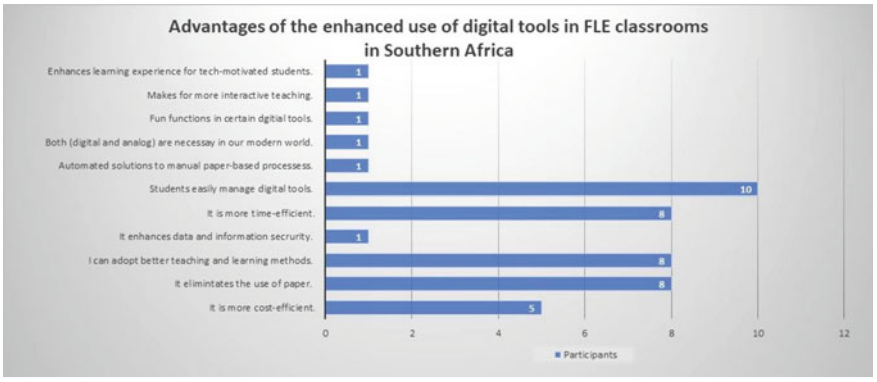
The participants indicated the following challenges linked to teaching in an online environment during the COVID-19 pandemic:



In general, the support given to the participants by their institutions was welcomed. Only one participant (P9) indicated that the institutional support was poor. Two participants (P1 and P10) mentioned that the support was developing, and P13 and P14 received no extra support from their institutions. The random administration of institutional training only underlines the need for a framework, as suggested by UNESCO, to benchmark training across institutions. Once such a framework exists, training focused on digital literacy development becomes an attainable goal.

Despite the general belief among the participants that the use of ICT would encourage learners to participate, eight participants claim that learners were not motivated (as was the case in Gao and Zhang's study highlighted in Sect. 12.3.6). Given the 2020/2021 health crisis, during which this study was conducted, we have to consider that it was not necessarily only the use of ICT that negatively impacted learners' will and motivation to participate in learning and that the mere integration of ICTs does not automatically equate to motivated high school learners.

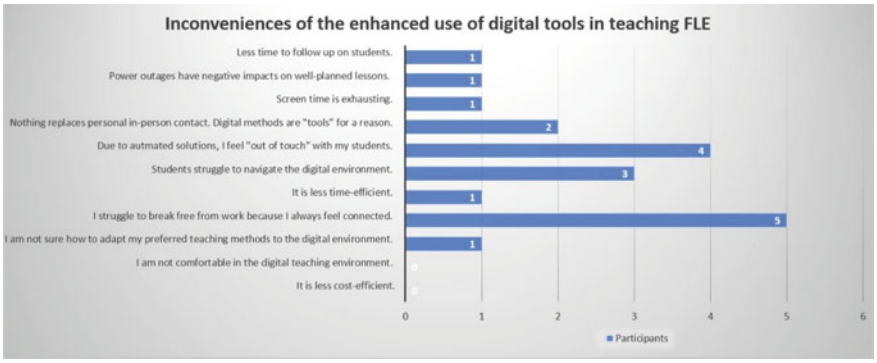
The participants indicated the following advantages of the enhanced use of digital tools in teaching:



The use of ICT in the FLE classroom appears to be a positive addition to the teaching experience (P3, P9, P12). As the COVID-19 pandemic forced many teachers to enter the digital era (P10), the benefits are numerous and widely appreciated. Time saved on marking and other menial administrative tasks (P1) can now be repurposed to make the overall process more efficient (P5). The participants were also convinced that, while the use of ICT in the FLE classroom environment allowed learners to be more independent in that they could easily access required resources (P11), it also encouraged student-resource, student-student and student-teacher engagement and participation (P4). P5 and P8 made special mention of the detailed individual feedback that was easier when using video and voice recordings as marking tools.

Digital native learners also find it easy to navigate online learning tools and platforms, and this could be used as an advantage by the teachers who can rest assured that navigating ICT would not distract learners from the content.

The following inconveniences linked to the enhanced use of digital tools in FLE teaching were highlighted by the participants:



When it comes to student-teacher interaction, the biggest concern from the teachers' point of view was the sudden lack of control over activities and progress (also see findings by MacIntyre et al. (2020) in Sect. 12.3.6). Previously, in-class human interaction gave the teacher the opportunity to encourage, evaluate and track learner progress. Furthermore, judging from the questionnaire answers, the participants seemed concerned that the online environment favoured a lack of student participation over which teachers had little control, as it was easy for students to "disappear" from the learning environment by switching off their cameras (P14). This lack of participation also limited spontaneous language production (P7) and promoted delayed thinking and problem-solving, which, according to P9, forced learners to become more reliant on "gadgets as […] sources of information" instead of fruitful student-teacher interaction. One would like to see teachers having the skill to accompany learners to develop digital literacy through conscious interaction around digital tools and subject matters. These findings are in direct contradiction to the findings discussed in the paragraphs that deal with the advantages of including ICT in the teaching environment, as our study participants also indicated that interaction was rather stimulated by technology. The gap possibly exists between initial participation and use of ICT that is met with enthusiasm and later use when the novelty has worn off, and students and teachers alike start experiencing screen fatigue that could put unnecessary strain on the student-teacher relation and has a negative impact on the mental health of both parties (see Sect. 12.3.4). The notion that interest fades as the novelty of ICT in the FLE classroom wears off could point to the unsuccessful integration of digital tools and necessary adaptation of pedagogy.

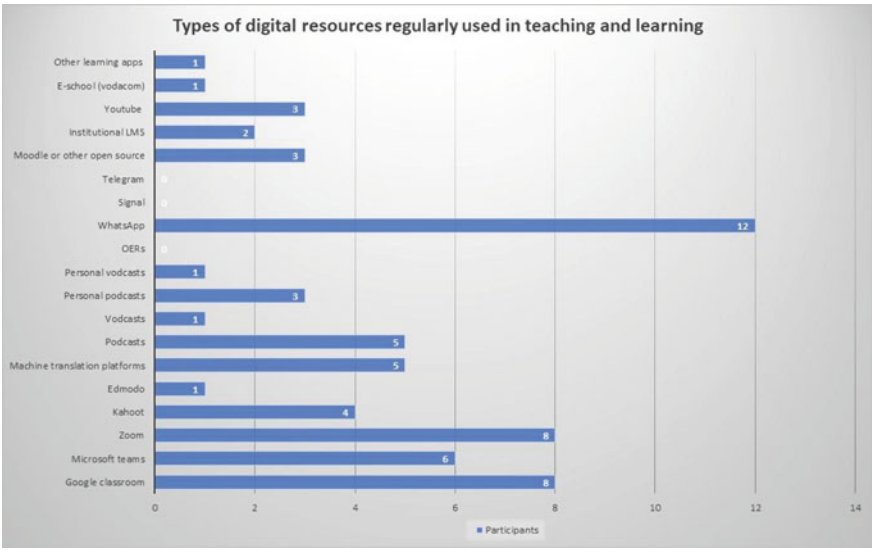
Without suitable adaptation of learning material, teachers could also fall "into the trap of online quizzes" as the sole means of evaluation (P1). With this type of evaluation being done at home, there is little control over the honesty of learner participation. This issue ultimately highlights the need for teachers to be well equipped and fully digitally literate in order to manage all ICT aspects in the teaching environment. Furthermore, continuous training and lifelong learning become a requirement

for teachers to keep up with developing ICT trends and how these trends could be used in the foreign language classroom. These preliminary suggestions all point to the six categories listed in the UNESCO framework (see Sect. 12.3.2) namely, understanding the role of ICT in education, knowledge acquisition, integration of technology, use of tools, organisation and administration (also of training), and digital literacy (UNESCO 2018).

12.5.4 ICT Tools, Applications and Platforms

The teacher participants in this study made use of a variety of both interactive and one-directional platforms to engage with students, communicate information, stimulate learning and request students to complete assessments.

The following ICT tools were indicated as most frequently used by the teachers.



The telecommunication smart-device application WhatsApp is currently the most popular digital tool used by FLE teachers in Southern Africa; video-conferencing applications such as Zoom and Google Classroom follow suit. It is important to note that the most popular applications and platforms are mostly communication or video-conferencing applications and not teaching and learning management platforms per se. The use of podcasts and vodcasts—whether personally created or third-party content, including YouTube channels and vlogs—could underline an interesting blend between real-time contact lessons via the various communication platforms and audio-visual material that the learner would be able to access without immediate intervention from the teacher.

Despite the rapidly growing OER databases, high school teachers seem reluctant to use these resources in their teaching. The relative newness of OER in Southern African pedagogical circles could be a reason for its absence in the participants' classes. Although only one participant (P1) commented on the idea that creating ICT resources is time-consuming, the easy access to OER could still be an underplayed factor that leads to reluctancy among teachers. The fact that none of the participants indicated the use of OER leads us to believe that not enough is being done to promote the use and benefits of these valuable, time-saving resources. The skill to source OER successfully is also questioned, and further investigation is needed to understand the extent of the participants' digital literacy (see Sect. 12.3.3) with regard to information processing.

12.5.5 Need for Adequate Training

Although some participants said that they were not interested in further training (P3, P8, P11), the desire for continuous training at various levels was emphasised among 11 participants. The participants expressed the need for training that would provide the necessary tools to successfully adapt existing teaching methodologies for online (and distance) learning and how to design methods that would cater to hybrid class environments (P1, P4, P10, P13, P14). Apart from theoretical skills, the participants expressed the need for training on the various learning and most popular applications currently used in online teaching (P5, P6) as well as on the integration of emerging applications into the FLE classroom environment (P2). This particularly speaks to the need not only for subject knowledge and literacy but also for broader digital literacy among teachers and pedagogical content developers who are ultimately responsible for the proper integration of ICT in the FLE classroom.

In this study, we set out to discover how FLE teachers changed their teaching methodologies and if they were adequately trained prior to the COVID-19 pandemic to adapt swiftly and with ease to the new teaching environment and demands.

The shift in delivery mode did not imply the necessary change in methodology as expected, and most teachers depended on ICT for communication purposes only (see Sect. 12.5.4). The lack of in-depth understanding by some of the participants of language teaching methodologies (see Sect. 12.5.1) shows that even the methods used in the classroom before the start of the COVID-19 pandemic are questionable. We could, therefore, also argue that not only was the training offered by institutions during 2020 inadequate to equip language teachers successfully for the online environment but prior training was in some cases not up to standard either. We acknowledge that some ICT training during the 2020–2021 period was successful, as teachers were able to navigate and incorporate ICT (communication mostly) in their endeavours.

The somewhat contradictory findings discussed in this chapter testify to the overall need for further teacher training in ICTs and the importance it will play in the future development of teaching and learning platforms and teaching applications. Teachers

also need to be trained to understand the true nature of their own approaches to language education and how these approaches can be adapted to incorporate the use of ICT without merely thinking that using technology to communicate constitutes a blended learning approach. Overall, and despite some misunderstanding about how to incorporate ICT fully in the teaching and learning experience, the participants were largely in favour of the use of ICT in the FLE classroom. Teachers seem to be aware of the multitude of advantages (and inconveniences) that ICTs could bring to the learning experience. The full use of these technologies should be explored in more depth through well-structured teacher training in an attempt to merge and adapt teaching approaches with the online environment and, in so doing, equip teachers to navigate this space successfully with their learners.

12.6 Recommendations

The study findings allowed us to formulate recommendations for the training of French teachers in Southern Africa, particularly relating to the use and integration of ICTs in their pedagogical approaches and teaching methods. Clearly, the COVID-19 pandemic has brought to the fore a number of teaching aspects that many teachers lack.

In order to enhance teacher training and subsequently teaching (and learning) practices in the (online) classroom in both South Africa and Eswatini, we suggest the following:

- Design and adoption of an adequate framework for skills acquisition and development for the use of ICTs in the classroom within the geocontext of Southern Africa where digital resources can sometimes be scarce;
- Development of new pedagogical approaches that cater to hybrid and fully online environments (not just adaptation or pandemic "crisis management");
- Introduction of digital skills/literacy in teacher training programmes (Biletska et al. 2021);
- Creation of digital spaces for teachers to engage, share and collaboratively develop content;
- Awareness-raising of the benefits of OER and the use, adaptation and contextualisation, of OERs for the FLE classroom;
- Training by language experts on the use of different applications in the language classroom: this training, in particular, should not be theoretical in nature—listing or describing applications, platforms and systems—but practical. The training, both at the initial and in-service level, should practically show how these apply to language teaching and learning.

One of the main aspects of the use of digital tools and working in an online environment in the context of Southern Africa is linked to the cost of data. We recommend that this be dealt with at a national policy-level first and foremost. Policy

development, together with appropriate frameworks for initial and in-service teacher training, is urgent.

Given the multitude of avenues that can be pursued to qualify as a French teacher in South Africa and Eswatini (as can be seen from the data we have collected), in addition to the low number of teachers who have completed a DHE (only four out of 14 in our sample), training by means of the national education system does not seem to be the most effective and reliable avenue for the development of competencies in integrating ICTs in teaching. For this reason, we feel that there is a need to bring teachers together for training purposes through other channels (organised by federations/organisations of French teachers) in order to share knowledge and skills from their "self-learning" experiences. This can be done through online meetings (national conferences, webinars, forum discussions, and websites for the sharing of digital resources).

Further research on teacher education, ICT integration in teaching and learning of foreign languages (e.g., French) in Southern Africa and beyond, before, during and after the COVID-19 pandemic, is required. There are too many questions awaiting answers if we want languages to be taught in such a way that they assist learners to become 21st-century citizens capable of meaningfully contributing to national and regional socio-economic development.

12.7 Conclusion

The brief study on French teachers, COVID-19 and ICT integration examined how Southern African educators fared during the worldwide pandemic which forced us to go online in many aspects of our daily lives, profession included. While our intention was to reach as many French teachers in South Africa and Eswatini as possible, only 14 participants (out of 200 who received the questionnaire) responded to the survey which was administered online in August–September 2021. Nevertheless, the research findings indicate a lack of understanding of pedagogical approaches and teaching methods on the part of the participants, especially when it comes to online teaching and learning. In addition, even though some teachers appreciated the support and resources provided by their work environments, many noted the need for continuous and additional training regarding the integration of ICT in the teaching and learning of foreign languages.

Our recommendations are multiple: there is a need to develop pedagogical approaches which will allow teachers to integrate ICTs to fully benefit from the opportunities and advantages offered by virtual learning environments, to develop themselves professionally, before they start teaching and also while they teach. The COVID-19 pandemic has clearly demonstrated that change is inevitable, especially in an educational setting and that teachers need to be flexible, motivated and ever-ready to learn new skills. The education system cannot depend on teachers' voluntary and personal updating of skills. Institutions, ministries of education and all stakeholders must offer opportunities for updating teachers' skills and knowledge. This

is in line with what scholars have been requesting since at least the beginning of the 21st-century.

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Chapter 13
Digital Pedagogy for Mathematics and Technology Education: Exploring the Initiatives at One South African Teacher Education Institution

Jayaluxmi Naidoo and Asheena Singh-Pillay

Abstract In the Fourth Industrial Revolution era, globally, the use of digital pedagogy is progressing swiftly. This chapter discusses the findings of a qualitative study that explored mathematics and technology education students' perceptions and experiences of digital pedagogy in a developing country. The chapter focuses on one teacher education institution's initiatives to empower mathematics and technology education students to prepare them for teaching and learning in the digital age. The study was framed by connectivism, a network learning theory guided by the view that learning is a lifelong process that continuously acquires new information. For this study, postgraduate mathematics and technology education students who are also practising school teachers were invited to interactive online workshops and interviews focusing on teaching and learning using digital tools. Apart from showcasing the effects of the digital age on the teaching and learning process, this study's findings indicated the challenges of using digital pedagogy in a developing country. The advantages of virtual collaboration inspired by digital pedagogy are also discussed in this chapter. These findings have relevance globally and nationally when considering the perceptions, experiences, and implications of digital pedagogy in a developing country.

Keywords Connectivism · Digital pedagogy · Online learning · Mathematics · Technology · Students

13.1 Introduction

The digital world has entered education environments, with technology progressively being used to deliver education innovatively. Technology is increasingly used by society for various activities daily (Qurat-ul et al. 2019). Also, in the Fourth Industrial Revolution (4IR) era, there are mixed debates on how existing education

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environments should be transformed to support and incorporate digital pedagogy. Moreover, digital pedagogy developments have provided lecturers access to various digital tools and interactive digital platforms to change their 4IR education environment. Globally, institutions are introducing remote and online learning within their curricula, and digital pedagogy is essential to facilitate remote and online learning. In mathematics and technology education contexts, coupled with embracing online learning, are issues of what it means to incorporate digital pedagogy in a developing country.

In this study, digital pedagogy provided students and lecturers with various digital tools and platforms to discuss knowledge, content, perspectives, solutions to problems, assessments, skills and attitudes that aimed to encourage and guide online teaching and learning via the Internet.[1] Also, in this study, digital platforms and digital tools were aided by digital devices, for example, computers, document cameras and mobile devices that support digital pedagogy through video, audio, images and text (Peachey 2017). Digital tools in this study included, for example, websites, software programmes, PowerPoint presentations and online resources. Thus, digital pedagogy endorses digital platforms to effectively integrate digital tools and devices during teaching and learning (Buzzard et al. 2011). Consequently, digital platforms assist lecturers in using digital resources and tools to upload learning materials online. For example, the digital platforms Learn 2021,[2] Zoom[3] and Microsoft Teams[4] are combined software solutions that support online teaching and learning.

This study sought to respond to the main research question: What are postgraduate students' perceptions and experiences of initiatives used at their university to empower and prepare them for teaching and learning in the digital age. Moreover, this study was conducted during the COVID-19 pandemic era. The COVID-19 pandemic has transformed life, resulting in lockdowns globally. Globally, in the 4IR era, and contemplating the novel COVID-19 pandemic conditions, higher education institutions (HEIs) favour digital tools, digital devices and digital platforms to support digital pedagogy. Digital pedagogy, an approach for using digital platforms to teach and learn, is therefore seen as a means of avoiding the spread of the transmittable COVID-19 virus (Murgatrotd 2020).

[1] The Internet is a global system of connected computer networks that comprise government, public, business, private, academic and business systems linked by wireless, electronic and optical networking technologies.

[2] The Learning Management System (LMS) that is being used at the participating university is Learn 2021. This LMS is an open-source e-learning/online/digital platform.

[3] Zoom is a software application (app). This app allows one to network virtually with colleagues, family, friends and students when communication through face-to-face means is impossible. Zoom is used as an official digital platform for meetings, lectures, tutorials, consultations and practical sessions at the participating university.

[4] Microsoft Teams is an online platform developed by Microsoft. This digital platform is used by the participating university for chats, tutorials, sharing documents, meetings, lectures, videoconferencing and communication for students and lecturers.

13.2 The Fourth Industrial Revolution

In the Fourth Industrial Revolution (4IR) era, digital tools, digital devices and digital platforms transform the way we go about our daily lives. Moreover, the 4IR encompasses diverse approaches to integrating technology within society and the human body (Schwab 2016). In higher education environments, lecturers and students may be at different readiness levels for success in the 4IR; they may be digital immigrants or digital natives. Digital immigrants may obtain information on how to use digital tools. Rather than working online, they may initially examine their printed notes before going to the Internet for assistance (Helsper and Enyon 2009). In contrast, digital natives are acquainted with digital tools, devices and platforms, for example, the Internet, computers, smartphones and other digital tools, devices or platforms (Helsper and Enyon 2009). Digital natives would most probably thrive when using digital tools, devices and platforms when learning. However, digital immigrants may need additional support when using digital tools, devices and platforms. Thus, lecturers need to be aware of their students' abilities concerning their familiarity with digital tools, devices and platforms. This awareness would assist the lecturer when preparing and presenting the philosophies of the 4IR within the higher education environment.

Also, educational institutions need to change to adequately prepare their students for success in these situations (Butler-Adam 2018), and the 4IR influences the role of higher education in successfully preparing students for the digitally advanced society. To be successful, lecturers should take advantage of 4IR prospects. We need to change our pedagogy to include the effective use of digital tools, devices and platforms. Moreover, there has been criticism of the effect of the 4IR on developing and underdeveloped countries. Some countries do not have access to digital devices, stable Internet services, effective digital platforms, or adequate infrastructure to ensure that all members of society can access the essential digital devices to equally participate within a digitally progressive community (Zervoudi 2020). Apart from access to necessary digital tools, devices and platforms, to be successful in the 4IR, a vital requirement is training in the effective use of technology (Oprea 2014; Zervoudi 2020). Students and lecturers need to be adequately prepared to use technology within education environments, and they need to have the necessary exposure to digital pedagogy. However, in most underdeveloped and developing countries, for example, South Africa, preparing students and lecturers for digital pedagogy has only just commenced, and we now find ourselves amid the global COVID-19 pandemic.

13.3 Digital Pedagogy in Developing Countries

Its economic contribution often defines a country, and a developing country is a country with a "lower gross domestic product (GDP) per person" (Kuepper 2021, p. 1–3). The use of digital pedagogy has consequences for students in HEIs who live in a developing country, for example, South Africa. This is particularly valid for students living in contexts that are not conducive to online learning and teaching. For example, using a generic digital teaching and learning approach at HEIs can affect learning outcomes and the level of student performance (Sánchez and Singh 2018). In addition, a student's social background may influence achievement (Panthi 2016) due to the unequal educational opportunities available to students at HEIs (Ndimande 2016). In most South African HEIs, students are from rural contexts. They have limited access to essential services, such as housing, sanitation, internet connectivity and electrification (The World Bank 2018). In addition, all South African students do not have access to digital tools, digital devices, the Internet, data and other resources required to participate equally on digital platforms. Consequently, higher education students who live in rural contexts are limited from participating equally in higher education environments that favour digital pedagogy.

Thus, one of the significant concerns in higher education is ensuring equal access for all students, especially in developing countries (Gegel et al. 2015). At the same time, research has been conducted on using technology in mathematics higher education (Naidoo 2015; Schuck 2016). However, not much research has been conducted focusing on the implications of digital pedagogy for mathematics and technology higher education students living in unequal social contexts. The introduction of new technologies has changed pedagogy for HEIs globally. The physical presence of students is not necessary; however, this has implications for students from lower socio-economic backgrounds (Kromydas 2017). Students in developing countries may not participate actively and equally in online/digital higher education environments, resulting in unequal outcomes (Sánchez and Singh 2018). This is of particular concern, since mathematics and technology teacher education in the 4IR era requires that lecturers are prepared to include digital tools, devices and resources effectively within their contexts (Adom and Aravind 2019; Naidoo and Singh-Pillay 2020).

13.4 Digital Pedagogy for Mathematics and Technology Education

To prepare teachers for the twenty-first century, they must use digital pedagogy in their teaching (Pongsakdi et al. 2021). The use of technology by society has changed the way we network, think and conduct our day-day activities (De Wet et al. 2016). Digital tools, devices, platforms and resources advance novel approaches for thinking, collaborating and communicating (Klopfer et al. 2006). Pope and Mayorga

(2019) emphasise that many online platforms guide students' learning and achievement through education-based teaching and learning applications. The advantages of using digital tools, devices and platforms in mathematics, science and technology education have been reinforced by researchers (Cheung and Slavin 2013; Guzey and Roehrig 2009; Persson 2011). Also, digital tools, devices and resources can provide different problem-solving methods (Yang and Kwok 2017) and promote student collaboration in mathematics and technology educational environments (Naidoo and Singh-Pillay 2020).

In the 4IR, globally, education institutions are inclined to use digital tools for teaching and learning. So, too, in the study under focus, digital tools, devices, platforms and resources were used to teach and learn mathematics and technology education within a higher education context. Consequently, if digital pedagogy is going to be embraced, lecturers' knowledge of using digital pedagogy is essential to guarantee that digital tools, devices and platforms are used successfully (Qing 2003). Therefore, the lecturer must select suitable digital tools and resources to support students' learning when using digital tools, devices and platforms. Hence, designing digitally integrated lectures needs to be in harmony with the digital tools, devices and resources to provide maximum support for students' understanding (Drijvers 2013). Moreover, research (Adom and Aravind 2019; Cheung and Slavin 2013; Guzey and Roehrig 2009) has shown that using digital pedagogy for learning has advanced students' performance in mathematics, science, and technology education.

Research has been conducted on digital pedagogy, for example, dynamic software programmes in mathematics (Segal et al. 2021). Research (Dogruer and Akyuz 2020; Yeung and Ng 2021; Zhang 2021) has shown that using dynamic geometry environments enhances students' reasoning and conceptual understanding of the area and volume of three-dimensional (3D) shapes. Thus, the use of geometry software programmes was necessary for the study under focus. The mathematics workshop activities focused on using digital tools and a geometry software programme (Geometer's Sketchpad) to teach and learn the area and volume of 3D shapes.

For the technology education workshop activities, it was essential to raise awareness about the use of indigenous technologies for extending the lifespan of materials and the recycling of plastics. Globally, plastic waste has become a considerable challenge and endangers the environment (Awoyera and Adesina 2020). The recycling of plastics reduces the release of carbon dioxide into the air, which impacts global warming; in addition, recycling diminishes the use of oil and reduces the amount of waste produced (Hopewell et al. 2009). Moreover, it is important to consider ICT when teaching and learning about food preservation and extending the lifespan of materials. Using indigenous and new technologies to teach about the processes and skills involved in food preservation can enhance food security, ensure safe and sustainable food products, and reduce global warming (Raheem et al. 2019).

Although technology contributes to advancements in society, many students are still not competent technology users (Bennett et al. 2008) or do not have the digital devices required to effectively participate in a digital environment. South Africa is a developing country and, as such, students' access to digital devices is diverse. Challenges persist as students continually learn new skills in a digitally advanced

society (Ng'ambi et al. 2016). Educational environments need to be improved to prepare students to succeed in these environments (Butler-Adam 2018; Wahyuni 2018).

13.5 Exploring the Theory of Connectivism

The development of the theory of connectivism has been encouraged by advances in digital pedagogy and technology. Within the ambits of connectivism, students engage with digital pedagogies and interact on digital platforms to reflect on, share and improve their current knowledge and understanding.

Connectivism is a theory of learning proposed by George Siemens and is pertinent in our current digital era (Downes 2019). Siemens (2005) suggested that connectivism as a theory of learning is strengthened by existing digital tools and is founded on the view that the ever-present ICT impacts students' lives, learning and communication. Similarly, technology is necessary to develop digital pedagogy (Yang and Kwok 2017). Technology has transformed pedagogy such that digital pedagogy can develop successful teaching and learning by promoting online collaborations among students and lecturers (Vululleh 2018). While digital tools, devices and resources can support teaching and learning success, within the ambits of connectivism, digital devices and resources need to be readily accessible to all students, since accessibility has important consequences for student achievement and collaboration (Gilbert 2015).

Siemens (2005) maintained that connectivism could be regarded as a restructured form of constructivism appropriate for the technological era. Connectivism is a network system of information that emphasises using digital tools and resources to improve and extend online communication (Downes 2019). Integrating digital tools within education environments has been beneficial, as they have contributed to inspiring and developing higher-order thinking skills among students (Murphy 2016). Also, the valuable impact of integrating digital tools for teaching and learning can provide students with varied methods to complete their tasks independently (Ahmad 2015).

Connectivism supports students as they collaborate, communicate knowledge, solve and complete tasks (Downes 2019). Connecting students online with digital tools and resources does not essentially occur in a particular education environment; this is ubiquitous due to access to the Internet (Bell 2011). Thus, connectivism offers the lecturer a way of demonstrating aspects of teaching and learning that may not be directly observed or experienced (Duke et al. 2013). Connectivism suggests that knowledge, understanding and information advance in a system due to the collaborations within the group (Downes 2019). Thus, collaboration is reinforced within the ambits of connectivism, and opportunities for individual student learning are supported (Kizito 2016).

In this study, digital pedagogy enhanced the participants' understanding of using digital tools when teaching mathematics and technology education. The notions of connectivism were evident in this study as participants interacted via the digital

platforms to complete each workshop task. Thus, the tasks were completed after participants had engaged via digital platforms (Zoom, Microsoft Teams, Learn 2021, and WhatsApp) with the researchers and other students. In this study, the theory of connectivism was also helpful in illustrating how the participants adapted to using digital pedagogy. It was apparent that the participants made connections with current and new knowledge. Subsequently, after actively participating in the interactive digital-based workshops, the participants were invited to semi-structured virtual individual interviews. The interviews aimed to identify the participants' perceptions of using digital pedagogy for teaching and learning mathematics and technology education within the ambits of connectivism. The connections between current and new knowledge made by the participants were discussed further during the interviews.

13.6 Research Methodology

13.6.1 General Background

This qualitative, interpretive study explored digital pedagogy for mathematics and technology education and the initiatives used at one teacher education institution during the 2020 academic year. This institution is located in KwaZulu-Natal, South Africa. Gatekeeper approval, access and ethical clearance were obtained from the participating institution's research office. Participants were given an informed consent letter that outlined the purpose and various phases/stages of the study. Data were generated through interactive online workshops and online interviews via digital platforms. The participants' right to withdraw from the research should they wish to and request for permission to record the interactive online workshops and individual online interviews were also stated in the consent form. Moreover, the confidentiality and anonymity of all participants were guaranteed by using pseudonyms instead of the participants' names. Pseudonyms were created in the order the participant was interviewed. For example, Participant 2 refers to the second interviewee, and Participant 15 refers to the fifteenth interviewee.

13.6.2 Sampling

The study population comprised of Bachelor of Education Honours (B.Ed. Hons) in mathematics and technology education students registered at the participating university. All students enrolled for an honours degree in mathematics and technology education at the participating university were invited to participate. A total of 64 B.Ed. Hons students were invited to participate in the study. Of the 64 B.Ed. Hons students who were invited to participate, 43 responded positively. Participation in the data generation phase for this study was voluntary (Šorgo and Špernjak 2020).

Participants who did not agree or volunteer to participate in this study were excluded from the pilot and main study selection. All study participants were also mathematics or technology school teachers, the cases under investigation.

13.6.3 Pilot Study

A sample of 10 participants was selected at random for the pilot study. The pilot study was conducted to ensure the reliability and validity of the research instruments and the research process. As a result, the research instruments were modified. For example, the interview schedule was revised so that the questions were clearly defined, well-structured and easy to understand. In addition, probing questions were rephrased to eliminate vagueness. The language used during the workshops and the interviews was specific and straightforward to increase dependability. The remaining 33 participants participated in the main study. Data were generated by conducting two interactive online workshops and individual semi-structured online interviews.

13.6.4 Interactive Online Workshops

For the main study, two workshops were conducted. Thirty-three participants participated in these workshops. The researchers facilitated these workshops held on two Saturdays during the second semester (July–December) of the 2020 academic year. One workshop was conducted using the Microsoft Teams platform, and the second workshop was conducted using the Zoom platform. The workshops lasted approximately six hours per Saturday, with two breaks between the online workshop activities (one 30 min tea break, and a one-hour lunch break). The workshops were focused on exploring digital pedagogy for mathematics and technology education. Activities focused on exploring the initiatives of the one institution under focus. These initiatives empowered mathematics and technology education students to prepare them for teaching and learning in the digital age. The workshops' content included teaching and learning surface area and volume of 3D objects, as well as teaching and learning processes involving indigenous technologies. The mathematics workshop activities focused on enhancing students' conceptual understanding of calculating the volume and area of 3D shapes. Students were given the opportunity to manipulate and drag shapes on their screens during the workshops while using the Geometer's Sketchpad programme. Consequently, students could see the effects of these hands-on manipulations on the final solution for the area and volume of the 3D shapes under focus.

The learning activities for mathematics and technology education were not linked, since the mathematics activities were conducted with participants who taught mathematics at schools. The technology education activities were undertaken only with participants who taught technology education at schools. The learning outcomes for

the mathematics activities focused on the participants' ability to use formulae for measuring area, surface area, perimeter, the volume of 3D objects, and select and convert between suitable units of measurement. The learning outcomes for the technology activities focused on the participants' ability to apply technological processes and skills to extend the lifespan of materials using indigenous technologies. Additionally, recycling plastics to provide the raw material for manufacturing new plastic products was also discussed during the interactive online workshops. This topic was specifically selected due to the global concern on the use of fossil fuels in the making of plastics and the effects of this process on global warming (Awoyera and Adesina 2020; Gervet 2007). Fossil fuels are a limited resource (Cui et al. 2010). Discussing the recycling of plastics in the workshops provided critical awareness of the need to conserve fossil fuels and thereby reducing global warming.

Participants were provided with video clips and presentations at each workshop, focusing on teaching notes, examples of lesson plans, demonstrations, concrete manipulatives, models of assessments and demonstrations of how digital pedagogy could be embedded effectively within mathematics and technology education classrooms. Next, participants were invited to participate in online individual semi-structured interviews at the end of Semester 2 (December) of the 2020 academic year. This meant that all participants would have the chance to reflect on what they had learnt from the workshops. Their learnings would possibly advance their knowledge and use of digital pedagogy in their future teaching practice.

13.6.5 Online Interviews

Participants were interviewed via digital platforms. These interviews centred on participants' perceptions and experiences of digital pedagogy. Although 33 BEd Hons mathematics and technology education students participated in the two interactive online workshops for the main study, only 22 participants were available for individual online interviews due to personal reasons. The participants were interviewed using the Zoom, WhatsApp,[5] Skype, and Microsoft Teams digital platforms. Participants chose the digital platform they were most comfortable using, ensuring that each participant felt at ease during the interviews. Participants also selected the day and time of the interviews; this ensured that they were available for the online interview. The reason for choosing semi-structured interviews was that each interview item's responses could be probed to acquire accuracy. Participants could also openly ask for interview questions to be explained further. This type of interview also allowed the researchers to clarify replies. The interviews were used to clarify each participant's perception and experiences of digital pedagogy for mathematics and technology education.

[5] WhatsApp is a free messenger application (app) that uses the Internet to receive and send calls and messages. WhatsApp was used as a digital platform unofficially at the university under study.

The online interviews focused on the following key questions:

- What were the participant's perceptions and experiences of digital pedagogy for mathematics and technology education?
- What were the strengths or challenges of using digital pedagogy within mathematics and technology education classrooms?
- Were the two workshops beneficial to the participants, as they integrated digital pedagogy within their lessons at school?
- Did the initiatives employed at the university empower and prepare the participants for teaching and learning in the digital age within the ambits of connectivism?

These interviews were recorded and then transcribed. Transcripts were sent to each participant to ensure the accuracy of what was stated during the interview. Subsequently, all the data that were generated during the main study were analysed.

13.6.6 Data Analysis

Data analysis for this study entailed coding and categorising themes and was based on the conceptual framework of the research, i.e., the theory of connectivism. As a result of the data analysis process, codes for describing participants' replies to each interview question were developed. Data generated from the workshops and interviews were analysed qualitatively. After each interview transcription was completed, the interview data were scrutinised and segmented into essential codes. This type of coding revealed the participants' perceptions and experiences of using digital pedagogy for mathematics and technology education. These codes were carefully reviewed and summarised as themes. Thematic coding was used to create themes inductively. The identified themes provided a clear picture of the participants' perceptions and experiences of digital pedagogy for mathematics and technology education. Four main themes emerged from the qualitative content analysis of the interview transcripts. Participants' perceptions and experiences of digital pedagogy for mathematics and technology education were as follows: Digital pedagogy has strengths for teaching and learning; digital pedagogy can empower and motivate teachers; digital pedagogy inspires virtual collaboration among the connected online community; and digital pedagogy exposes challenges in a developing country.

13.7 Findings

While, in general, the participants appreciated the use of digital pedagogy for mathematics and technology education, they did indicate that, apart from strengths, there are also challenges when using digital pedagogy in a developing country. The participants' responses concerning the initiatives employed by the participating university are described next.

13.7.1 Digital Pedagogy Has Strengths for Teaching and Learning

The interview responses showed that the participants valued digital pedagogy for mathematics and technology education. The participants mentioned the strengths of using digital pedagogy for teaching and learning. The interview transcript excerpts that follow support this view.

> P3: …technology tools help as we view the different indigenous design processes…seeing these processes in the video makes learning about them easier…
>
> P4: …seeing and moving the diagrams using Sketchpad[6] made it easier to calculate the volume of the cone…using technology made a difference…
>
> P6: …Sketchpad helped to calculate dimensions and also helped us know what we were working with…we could see the diagrams and identify them quickly…
>
> P9: …we saw how to calculate and solve the volume and area it made it easier…we saw…step by step process as we viewed the screen…the hovercam[7] displayed each step and each key that was used on the calculator…we could follow and solve easily…
>
> P14: …we could identify each real-world shape that was displayed in the video…much better to see the video than just hear about it…the step by step solution process in the presentation was easy to follow…we could also rewind the video if we did not understand or if we missed something…
>
> P18: …hovercam displayed all the steps…real-time…could ask for clarification as we worked…the solution could be explained again in real-time with the hovercam…later we could view the recording to understand better when we were working on our own…

Various digital tools and online resources, such as videos, PowerPoint presentations, the hovercam, Geometer's Sketchpad, and visually enriched demonstrations, were integrated into the interactive workshops to succeed with digital pedagogy. This is aligned with the theory of connectivism. Technology is a crucial part of the teaching and learning process and offers opportunities to choose our teaching and learning strategies. As is evident from the preceding excerpts, these digital tools and resources strengthened the teaching and learning of mathematics and technology education in this study.

13.7.2 Digital Pedagogy Can Empower and Motivate Teachers

The participants indicated that using digital tools and resources increased their confidence levels, and they noted that using digital pedagogy would benefit their

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[6] The Geometer's Sketchpad programme is a software programme for teaching mathematics.

[7] The hovercam is a mobile document camera which links to one's computer so that one can teach in real time and display on one's computer as one teaches. One can use the hovercam to magnify images and manipulatives to make them easier to see. In addition, one can record lessons/lectures using the hovercam.

learners. The participants believed that using different websites, videos and software programmes would make their lessons more interesting and save time in the class. This created a sense of empowerment, and the participants felt motivated to teach their future lessons in this manner. The interview transcript excerpts that follow exhibit these notions.

> P1: …using different technology tools makes me more confident… I can always use other websites to ensure I am on the right track…
>
> P4: …feel better that I can use videos and software to help me as I teach…some 3D shapes… challenging to explain and draw…I can use the different websites to show examples with correct drawings…and videos of how to solve area and volume…
>
> P7: …more confident…know more now using the Internet and the different maths sites…feel better, and my learners will benefit more…
>
> P12: …using technology makes me want to teach differently…it is exciting to me…we can see how different cultures designed the different cultural objects…better to watch and learn using the video…takes less time than using the board to draw…I can teach more concepts using videos and presentations…
>
> P16: …I feel comfortable now using the Internet and the online resources…I want to show my learners more examples of different designs…I am eager to teach more now…
>
> P21: …we only used the textbook…my learners don't focus much…they do not talk much…now with the different tools and websites…so many examples…I know my learners will be excited…I am eager to teach…I have all these resources from all over the world to use…
>
> P22: …technology makes it easier to teach…teach more concepts in less time…any questions…by using the different websites and videos as we did in the workshop…more interesting lessons…step by step design with pictures…

The use of digital pedagogy during the workshops created a transformation in teaching, learning and assessing, which changed how the participants viewed their current teaching practice. Instead of using traditional paper-based assessments, the assessments were conducted online using the Learn 2021[8] digital platform. Students were required to complete their assessments electronically and submit their responses on the Learn 2021 platform. As was evident, within the domains of connectivism, digital tools and devices are an important part of teaching, learning and assessing and allow for the transformation in traditional teaching, learning and assessment processes. This study showed that digital pedagogy stimulated the participants' interests and promoted self-confidence in planning and teaching their future lessons. The participants were empowered and motivated by what they had learnt during the interactive workshops. Based on the preceding interview transcripts, it was evident that the participants now knew a wide range of digital tools and resources to use in their future teaching.

[8] The Learn 2021 platform is the digital Learning Management System (LMS) that is being used at the participating university.

13.7.3 Digital Pedagogy Inspires Virtual Collaboration Among the Connected Online Community

The participants indicated that using digital pedagogy increased virtual collaboration in the online community. Based on the findings of this study, digital pedagogy encouraged the participants to collaborate online. This online collaboration was supported by the use of digital platforms, for example, WhatsApp. This is supported by the following interview transcript excerpts.

> P2: …easy to get help online from my class…share resources… problem-solving ideas and tips online…quicker this way…
>
> P3: …we help each other online…discuss using WhatsApp…share our practice online…-more help this way…
>
> P8: …convenient to use WhatsApp…share our ideas and resources…more help online…all work together, and give ideas on how to solve problems…even share worksheets on WhatsApp…
>
> P13: …can always ask for help online…someone always responds…we can discuss our challenges with the group online…more efficient sharing online…
>
> P15: …class works well online…someone is always available to help…share the problems in a topic…class posts activities and worksheets that I can use…
>
> P20: …better way to work now…always get ideas from the class…have a problem we can discuss solutions quickly online…class is available to assist me online…

Participants were encouraged to discuss their challenges and share their ideas, problem-solving strategies, resources, and activities online to achieve virtual collaboration. As was evident, through the use of digital platforms, the participants collaborated extensively. The most common digital platform used for this virtual collaboration was WhatsApp. This is aligned with the theory of connectivism in that digital platforms, devices and resources are essential for encouraging a connected and collaborative teaching and learning process.

13.7.4 Digital Pedagogy Exposes Challenges in a Developing Country

From the responses in the online interview, it was apparent that some participants had reservations about the use of digital pedagogy in their contexts. These participants mentioned the challenges associated with unstable internet connections, the high cost of purchasing data, the numerous power cuts resulting from load shedding,[9] and not

[9] Load shedding is a planned interruption in electricity supply by the Department of Electricity in South Africa. Load shedding refers to the disturbance of electricity supply to avoid unnecessary overload when there is a high request for electricity. All consumers are informed in advance of load shedding times within their areas through the use of a comprehensive schedule. However, these timetables are not always adhered to.

having access to the necessary digital devices. The following excerpts support this view.

> P5: …sometimes it is difficult when internet connectivity is bad…I have the online resources and videos…difficult to load when the Internet is bad…

> P8: using WhatsApp on my phone is great…no internet then it is a problem…very unstable connections in my area…this is the downside of using technology…also I don't have all the gadgets…

> P10: I am all for using technology and the Internet when I teach…difficult for me…live and teach in a rural area… no good infrastructure for the Internet…connectivity is always breaking…also our electricity is always cutting off…especially with load shedding…not predictable…so it is hard for me to use the Internet and technology when I teach…also it is expensive to buy all these devices…

> P11: …I need to have plan A and plan B for my lessons…plan A I prepare using the textbook and the board, and plan B I prepare with videos and online resources…stressful when I want to use the Internet and then it is down in my area because the Internet is not good in rural areas or if there is no electricity because of load shedding…load shedding timetable is not always correct…

> P16: …enjoy using online videos and resources when I teach…problem when there is no internet…this often happens in my place…connections not dependable in my area…this wastes a lot of time when I am teaching…

> P17: …so much to do with technology for maths lessons…can't always use the online methods…internet connectivity is not stable in my rural area…I don't have many tools to use…

> P19: …I don't use much technology or online resources in my teaching…pointless since internet connectivity is very poor where I teach…can't always buy data to use in my lessons…expensive…some videos take lots of time to upload…lots of data is used…also I do not have all the devices…

> P22: …lessons…more interesting…using online websites and resources…problem with my internet connection…not very good where I teach…sometimes I can't load the website…can't access the Internet…not good…

The preceding transcript excerpts indicate that, despite the challenges the participants mentioned, they valued the use of digital pedagogy. Within the ambits of connectivism, digital platforms allow participants to collaborate and make informed choices about teaching and learning. However, unstable internet connections, numerous disconnections of electricity, the expenses incurred for purchasing data, and limited access to digital tools affected the participants' ability to use digital pedagogy within their educational environments. This is common in a developing country like South Africa. Thus, the relevant role players within the education sector need to collaborate to ensure that classrooms are equipped with the necessary resources and requirements to embrace digital pedagogy in the era of the 4IR.

13.8 Discussion and Conclusion

The aim of this study was to explore participants' perceptions and experiences of digital pedagogy at one university in KwaZulu-Natal, South Africa. Participants were invited to two interactive online workshops and were consequently interviewed using digital platforms. Four main themes emerged from the qualitative analysis of the interview transcripts, namely digital pedagogy has strengths for teaching and learning; digital pedagogy can empower and motivate teachers; digital pedagogy inspires virtual collaboration among the connected online community; and digital pedagogy exposes challenges in a developing country.

The participants valued the use of various digital tools, devices, platforms and resources and maintained that exposure to digital pedagogy allowed them to envisage a transformed pedagogy. Digital pedagogy in this study encouraged active online collaborations among students and lecturers, leading to successful teaching and learning (Vululleh 2018). These ideas are supported within the ambits of connectivism, as students collaborate and solve tasks online (Downes 2019). The participants viewed the initiatives at the participating university as empowering and motivational. They were exposed to different digital tools, devices, platforms and resources. These experiences encouraged participants to have the confidence to transform their perceptions of teaching their future lessons. Within the ambits of connectivism, opportunities for individual learning are supported (Kizito 2016), and existing knowledge and understanding progress due to the online collaborations within a virtual group (Downes 2019).

Furthermore, the participants indicated that the use of digital pedagogy encouraged active virtual collaboration. This result resonates with research (Downes 2019; Kizito 2016), whereby collaboration promotes learning and is reinforced within the ambits of connectivism. As was evident in this study, the participants were encouraged to virtually share their ideas, resources, challenges and problem-solving techniques. They were encouraged to communicate and collaborate online using various digital platforms at any time. Connecting students online with digital tools, devices and resources is ubiquitous due to access to the Internet (Bell 2011). As was evident in this study, the participants collaborated online and discussed mathematics and technology education problems using digital pedagogy. Participants constructed knowledge and meaning in their connected online group. Similarly, connectivism can be regarded as a restructured form of constructivism (Siemans 2005). This learning theory requires digital tools and resources to expand and extend online communication, collaboration and knowledge construction (Downes 2019).

The participants in this study mentioned the challenges of digital pedagogy in a developing country like South Africa. These challenges included unstable internet connections, the high expenses associated with using digital pedagogy, the lack of electricity due to load shedding, and limited access to the necessary digital devices. The findings of this study reveal that these challenges shaped the participants' experiences and perceptions of integrating digital pedagogy within their classrooms (Klopfer et al. 2006). Similarly, in connectivism, digital tools, devices, platforms

and resources can support teaching and learning success. However, digital tools, devices, platforms and resources must be easily accessible, since accessibility has significant consequences for achievement and collaboration (Gilbert 2015).

This study has provided interesting perceptions and experiences concerning the initiatives used at the participating university. The findings of this study showed that, within contemporary mathematics and technology education contexts, digital tools, devices and resources are important. If the notions of connectivism are embraced, teachers would seek to integrate digital pedagogy in their educational contexts to amplify the benefits to student learning. However, for the successful integration of digital pedagogy in the 4IR era, easy access to digital tools, devices, platforms and resources are essential. In the 4IR era, access to digital tools, devices, platforms and resources would benefit teachers in developing countries, for example, South Africa, and other developing countries globally.

More studies on a larger scale to explore mathematics and technology teachers' perceptions of using digital pedagogy are necessary. Opportunities for future studies could include qualitative studies conducted at different South African universities. Comparable studies could also be conducted at universities globally. Large-scale data may provide greater dependability and prospects for further qualitative analysis and clarification. Opportunities for national and global quantitative studies to explore teachers' perceptions of using digital pedagogy when teaching mathematics and technology education could also be explored. This would be useful for increasing the knowledge base in the field nationally and globally.

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