DURBAN UNIVERSITY OF TECHNOLOGY
INYUVESI YASETHEKWINI YEZOBUCHWEPHESHE

Teachers' Readiness Towards the Integration of Information and Communications Technology into Teaching and Learning:

A case of Engineering Graphics and Design in UMgungundlovu District, Kwazulu-Natal

by

Philani Brian Mlambo

21648090

A dissertation submitted in fulfilment of the requirements for the degree of

Master of Education in Adult and Community Education in the Faculty of Arts and Design

at the

Durban University of Technology

March 2023

Supervisor: Dr M.S.A. Maeko Date: 30 June 2023

Co-supervisor: Dr S.D. Khoza Date: 30 June 2023

ABSTRACT

The infusion of Information and Communications Technology (ICT) into the education system has led to changes in the way teaching and learning are conducted. One of the factors is the migration of the world to the Fourth Industrial Revolution (4IR) and another factor is the recent outbreak of COVID-19. This change has necessitated the need for teachers to have ICT skills that would help them integrate ICT into teaching and learning. Hence, this study was conducted to investigate the state of readiness of Engineering Graphics and Design (EGD) teachers in the integration of ICT in teaching and learning in uMgungundlovu secondary schools.

To carry out the objectives of this study an interpretivism paradigm was employed. The study also employed qualitative approach to collect data. The investigation comprised of 9 teachers and convenience sampling was used to select the participants. Interviews and classroom observations were used as data collection methods. These methods were adapted from the Technological Pedagogical Content Knowledge (TPACK) framework that was used to underpin the study. Data gathered from interviews was subjected to thematic analysis and data gathered from classroom observations was reported descriptively.

The findings of this study discovered that EGD teachers in uMgungundlovu District are ready to infuse ICT into teaching and learning as they indicated that ICT integration in EGD lessons is very essential but there are few challenges like the shortage of ICT resources that are proving to be a stumbling block.

The study recommends that the Department of Basic Education (DBE) should provide teachers with training so that those teachers who are technically disadvantaged can be equipped with relevant ICT skills. The study further recommends that DBE should also provide schools with equipment such as laptops, projectors, whiteboards, AutoCAD, and tablets that EGD teachers would use to incorporate ICT into teaching and learning as it has been proven that abstract concepts are best studied using technology.

Key words: e-learning, Virtual learning, AutoCAD, Abstract concepts, Spatial visualisation.

DECLARATION

I, Philani Brian Mlambo, student number 21648090 hereby declare that the dissertation submitted for the degree M-Ed at the Durban University of Technology titled: "*Teachers' readiness towards the integration of Information and Communications Technology into teaching and learning: A case of Engineering Graphics and Design in uMgungundlovu District, KwaZulu-Natal"* is my own original work and has not previously been submitted to any other institution. All the sources I have used or quoted, have been indicated and acknowledged by means of a comprehensive list of references.

DEDICATION

The study is dedicated to all those who strive to sustain Technology Education without success because of contextual factors. It is also dedicated to all the educators who are trying to infuse ICT into teaching and learning for the purpose of enhancing education.

ACKNOWLEDGEMENT

Firstly, I would like to take this opportunity to thank the Almighty God who afforded me this opportunity to start and complete this work. Without His grace shining upon my life, I would not have been able to get to where I am today.

Secondly, I would like to express my gratitude and appreciation towards my supervisors Dr MSA Maeko and Dr SD Khoza for their guidance throughout the research process. Their patience and willingness to assist has kept me motivated throughout the process. Without their support and assistance, this research would not have been possible.

All thanks to the principals and teachers from schools which participated in this study for allowing me to do interviews and classroom observations. You were so kind and helpful.

To my brother Njabulo Innocent Mbuyazi and my friend Nonkululeko Mdlolo thank you guys for your assistance in transcribing the data from the interviews without your assistance I would not have been able to get where I am today.

Lastly, to Durban University of Technology for yet another opportunity to study. Thank you very much.

TABLE OF CONTENTS

LIST OF ACRONYMS

3D	Three-Dimensional
4IR	Fourth Industrial Revolution
CAD	Computer Aided Design
CAPS	Curriculum and Assessment Policy Statement
CK	Content Knowledge
CMC	Circuit Management Committees
COVID-19	Coronavirus Disease 2019
DBE	Department of Basic Education
DoE	Department of Education
DUT	Durban University of Technology
EGD	Engineering Graphics and Design
FET	Further Education and Training
ICILS	International Computer and Information Literacy Study
ICT	Information and Communications Technology
IWB	Interactive White Board
KZN	KwaZulu-Natal
LT	Learning Tool
MEC	Member of the Executive Council
PAT	Practical Assessment Task
PCK	Pedagogical Content Knowledge
PK	Pedagogical Knowledge
PSVT	Purdue Spatial Visualisation Test
SANS	South African National Standard
TCK	Technological Content Knowledge
TD	Technical Drawing
TK	Technological Knowledge
TPACK	Technological Pedagogical Content Knowledge
TPK	Technological Pedagogical Knowledge
VL	Virtual Learning

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

1.1 INTRODUCTION AND BACKGROUND

The advancement of information and communications technology (ICT) in the 21st century has brought about changes in the style of teaching and learning. Over the past two decades, ICT has been the most important tool for all parts of our lives. Many factors have contributed to this rapid change in the advancement of ICT. The emergence of COVID-19 and the world migrating to digital learning in the form of adapting to the Fourth Industrial Revolution (4IR) are some of the factors that contributed to ICT advancement. Another factor that is contributing to the advancement of using ICT is the COVID-19 outbreak. Indeed, COVID-19 has compelled educational institutions to come up with alternative ways to supplement the traditional teaching approach (Wyk, Mooney, Duma and Faloye 2020). However, according to Mafenya (2022), this sudden transition has undoubtedly caused an incredible amount of damage and disruption to our educational system. One of the ways that can be used to supplement the traditional teaching approach is the integration of ICT in teaching and learning, and Engineering Graphics and Design (EGD) in particular. Hence, this study sought to investigate the level of readiness in EGD teachers to infuse ICT into teaching and learning.

According to the Curriculum and Assessment Policy Statement (CAPS) document, EGD is a subject offered in the Further Education and Training (FET) phase, which is Grades 10–12 in secondary schools (DBE 2011). The subject EGD is one of the technical-practical subjects that mainly focuses on line work, accuracy, and neatness. The concept of understanding line work rests upon understanding the different types of lines that are used in EGD. This notion is echoed by Moolman and Brink (2010), cited by Khoza (2018), as they reported that there are 10 different lines that are used in EGD, and all these 10 different lines have different meanings altogether. Therefore, it is imperative for learners who are doing EGD to understand all these 10 different lines and the impact that these lines can have on drawings. For example, a dotted line to a non-EGD person is just a dotted line, but in EGD it indicates something that is hidden. That is because EGD mainly focuses on teaching principles that have both academic and technical applications (DBE 2011). Within that context, EGD's main emphasis is on basic knowledge and various drawing skills, which might prove to be

very difficult to teach virtually. These various skills in EGD range from spatial skills to the visualisation of abstract concepts to the understanding of different lines used in EGD (Khoza 2013; Sotsaka 2015). The said shift presented multiple challenges to teachers, particularly those with little or no experience with the pedagogy or delivery of what is known as “emergency remote modes” of teaching and learning (Rapanta, Botturi, Goodyear, Guàrdia and Koole 2020).

According to Brink, Gibbons and Theron (2003:164), as cited by Khoza (2013), some chapters in EGD require learners to imagine the part of the object that is removed to reveal hidden detail when nothing has been removed. This part of EGD requires learners to have a spatial-visualisation skill, which can be defined as an EGD cornerstone, in conjunction with knowledge of the different lines that are used in EGD. As attested by Khoza (2013), most learners have poor spatial skills. In the same vein, findings in a study done by Makgato (2016) revealed that learners performed poorly in a Purdue Spatial Visualization Test (PSVT) that he administered. As a result, it has compelled the need to integrate ICT into the teaching and learning of EGD, as abstract concepts can be best studied through technology. This is an indication that ICT integration is very imperative in EGD because it can assist with the development of the most important skill in EGD, which is the spatial visualisation skill. According to Sotsaka (2019), the spatial visualisation skill is essential because it develops the ability to transform abstract concepts into concrete concepts. Spatial visualisation is defined by Pedrosa, Barbero and Miguel (2014) as “the ability to mentally rotate, twist, or invert pictorially presented visual stimuli." Furthermore, spatial visualisation is defined as a mental capability to execute certain graphical tasks (Rodriguez and Rodriguez-Velazquez 2017). It is evident that to understand some concepts in EGD, one must have a spatial visualisation skill, as has been deemed necessary by the above authors. This is an indication that spatial visualisation skill is a solution to understanding abstract concepts in EGD. The EGD subject involves mental rotation, linework, and abstract concepts, and the use of AutoCAD or any other technologies often comes in handy because abstract concepts can be easily manipulated. This assertion is backed by DBE (2011), who reported that AutoCAD, a projector, and a whiteboard are basic requirements in an EGD classroom. All these resources are seen as making EGD more understandable to learners. More of EGD as a subject will be unpacked in Chapter 2.

According to the Department of Education (DOE) (DOE 2004), the infusion of ICT requires teachers to remodel their pedagogical methods in teaching and learning. The importance of ICT integration was alluded to by DoE more than 18 years ago; this is an indication that the concept of ICT integration is not a recent thing. With that being said, it looks like the infusion of ICT into the teaching of EGD has been seen as the tool that can be used to simplify those abstract concepts that are being taught in EGD. This transformation, as expressed by DoE, compels teachers to tweak their pedagogical methods to accommodate the infusion of ICT in their teaching and learning. This is the current situation for EGD teachers, as they are compelled to tweak their teaching styles. However, change is hard, especially if you are changing something that you feel is not broken. As a result, many teachers are sceptical of this transformation because they feel that this change is too great. In support of the above notion, Msila (2015) revealed that teachers claimed that they have been teaching for years without computers or ICT equipment and have been producing great results in the process. In the study by Msila, some of the respondents went on to say, "Why change it when it is not broken?"

However, Maharaj-Sharma and Sharma (2017) posit that ICT infusion in EGD encourages learners to seek knowledge themselves rather than waiting for teachers to be the sole providers of knowledge. Maharaj-Sharma and Sharma (2017) further mentioned that the infusion of ICT helps teachers access teaching and learning materials with ease, which makes the planning of lessons less strenuous. The integration of ICT in teaching and learning will not only benefit the learners but the teachers as well. In addition, the effective adoption of ICT is important for different educational institutions, such as schools and universities (Macharia and Pelser 2014). The importance of integrating ICT in EGD lessons became evident when EGD teachers were left exposed when physical education classes were suspended due to the outbreak of the COVID-19 pandemic. Most EGD teachers did not know how to conduct EGD classes online. As a result, technical teachers claim that the curriculum does not allow them to infuse ICT into teaching and learning, and hence it is very difficult to make use of ICT when teaching (Glasel 2020).

This is an indication that EGD teachers are far behind when it comes to integrating ICT into their lessons. Integration of technology into education has been a prominent topic

for quite some time. As a result, most developed countries like the USA and China are step ahead in the integration of ICT into teaching and learning. According to Hismanoglu (2012), Turkey spent about 11.7 percent of its educational budget on ICT integration. And in China, the government has come up with a plan to invest in ICT integration by ensuring that every class in rural areas has a computer (Bai, Mo, Zhang, Boswell and Rozelle 2016). This shows how committed other countries are to integrating ICT into teaching and learning.

However, in developing countries like South Africa, they are still far behind in the integration of ICT into teaching and learning (Jhurree 2005). In support of what Jhurree said, Van Greunen (2021) reported that a readiness maturity tool was used to test the level of readiness in teachers, and it revealed that schools are aware of the need to integrate ICT but the level of integration is very slow. Furthermore, Mashile (2017) posits that only 26 percent of teachers in South Africa are capable of integrating ICT into teaching and learning. Besides that, it looks like EGD teachers are reluctant to use ICT, fearing that it is going to replace them, and this phenomenon might be shared by most of the EGD teachers around uMgungundlovu District as well. As attested by Tallvid (2016), most teachers fear that the infusion of ICT would take away the control they have in class as the main source of knowledge. However, Jhurree (2005) reported that the integration of ICT should not be seen as a replacement for the face-to-face style of teaching but rather as a tool that would be used in conjunction with the traditional style of teaching to supplement the process of teaching and learning. The integration of ICT into teaching has brought about changes in the style of teaching and learning (Faloye, Ajayi and Raghavjee 2020). This change has compelled the need to investigate the readiness of EGD teachers for the integration of ICT in teaching and learning.

1.2 RATIONALE FOR THE STUDY

Many EGD teachers are still firm believers in using the traditional way of teaching. They still believe that there is no need to change it when it is not broken as they are still producing good results. The literature has revealed that traditional face-to-face classes provide teachers with opportunities to have a more personal interaction with learners, which is something that cannot be achieved through online platforms. The problem started when face-to-face classes were suspended due to the outbreak of

coronavirus, and teaching and learning were disrupted in many schools. Every teacher had to conduct classes online, and that is where most teachers teaching subjects like EGD were left wanting as they could not conduct online classes for the subject. The same can be said about learners, as most of them lack the much-needed basic digital skills (Kumar and Phrommathed 2005). Therefore, the integration of ICT is expected to bring more problems than solutions. As a result, this study investigated the readiness of EGD teachers towards the integration of ICT into teaching and learning.

1.3 SIGNIFICANCE OF THE STUDY

The coronavirus pandemic compelled the adoption of online teaching through the integration of ICT into teaching and learning (Khoza 2021). This study would be beneficial to EGD subject teachers who are having problems integrating ICT into EGD lessons. When the social distance was first introduced, physical classes were suspended and educational institutions had to conduct online classes, which presented multiple challenges for some of the teachers with little or no exposure to virtual engagement. This study is therefore aimed at investigating the teachers' readiness towards the integration of ICTs into the teaching and learning of the EGD subject from Grades 10–12. According to Kumar and Phrommathed (2005), the infusion of ICT into teaching and learning would assist learners in improving their autonomy and also increase their knowledge retention. The findings of this study would shed light for EGD teachers on how to integrate ICT into EGD lessons.

1.4 LITERATURE REVIEW

1.4.1 ICT integration in the classroom

President Cyril Ramaphosa announced that in the next six years, schools will go digital (Matiwane 2019). The writing is on the wall, especially with the rise of COVID-19 cases and perhaps the outbreak of other pandemics to come, but the question is, are teachers ready for these challenges? The integration of ICT into teaching and learning requires teachers with high levels of ICT skills (Mndzebele 2013). In his study, Mndzebele noted that teachers are the ones who would be at the forefront of employing the use of ICT in teaching and learning, so the question is: are teachers equipped with relevant skills and ready? This study aimed at responding to this question.

According to Mashile (2017), teachers are poorly positioned to impart ICT skills into learners. Mashile further mentions that some teachers are feeling that the district is rushing the new process of going digital. However, Msila (2015) argues that teachers have been trained by the district to ensure that they are ICT-efficient. Furthermore, the DoE announced that by 2013, all teachers should be ICT capable. However, according to Naicker (2017), this does not appear to be the case. Msila (2015) further mentioned that in 2015, DoE announced that they would provide teachers and learners with tablets with the aim of replacing the traditional chalkboard. However, there is an outcry from teachers that the introduction of tablets is not impeccable, as they are still trying to understand the newly introduced curriculum and that it would be a strenuous task to integrate ICT into their everyday teaching (Msila 2015). Many people believe that an effort is directly proportional to the results, but Higgins (2014) is not sharing the same sentiment as he posits that ICT may not guarantee good results even though teachers would be putting in a lot of effort in trying to infuse ICT into their everyday teaching.

1.4.2 Factors influencing teacher's resistance in integrating ICT

In spite of the transformation brought about in all aspects of society, the infusion of ICT into education is still in the early stages of development (Mashile 2017). This shows that the integration of ICT into education by teachers is happening more slowly than expected. The slow integration of ICT into teaching can be attributed to many reasons, like the lack of ICT infrastructure in schools and the unwillingness of teachers to use technology in the classroom. Another reason mentioned in a study done by Mashile (2017) is that South Africa has only 26% of teachers who are equipped with ICT skills, which is shocking since technology keeps evolving. On the other hand, Mahdi and Al-Dera (2013) postulate that age is one of the factors that influence teachers' ICT capabilities and willingness to infuse ICT in education. In support of Mahdi and Al-Dera's findings, Msila (2015) posits that older teachers tend to avoid using computers in their lessons. One of the people interviewed by Msila said, *"I feel less professional when I do not know what seems to be the basic computer knowledge,"* and another teacher said, *"I have been teaching for years without these computers."* In addition, teachers' insufficient skills in using the internet discourage them from integrating it into their lessons (Yunus and Wekke 2009). On the other hand, Jegede (2009) argues that

age is not the contributing factor, but attitude is. Copriady (2014) and Badri, Al Rashedi and Mohaidat (2013) concur, as they claim that a teacher's decision to use or not use ICT is associated with their attitude. Copriady (2014) also mentioned that teachers have a nonchalant attitude towards the implementation of ICT; hence, their level of willingness and readiness is very low. In support of the above, literature has shown that EGD teachers do not want to integrate ICT into EGD lessons as they feel that the traditional way is still bearing fruit. In the same vein, Radovi-Markovi (2010) indicate that traditional teaching methods allow teachers to have more personal interaction with the learners, which is in contrast to what online learning can offer. Most teachers seem to not like using the modern method of teaching, which incorporates technology. This assertion is backed by the findings of a study done by Raman and Yamat (2014), as one of the participants said: "My age is 53, and I have been teaching for more than 25 years. I believe in the traditional method, which lets the learners touch, feel, and learn. I could make interactive lessons without using the ICT tools. *"I think this is not the time for ICT integration in my teaching."* This is an indication that most teachers are still stuck in the past in terms of the methods they are using in their lessons.

1.4.3 Virtual Learning as a tool to infuse ICT

Integrating ICT into education is a very difficult task; hence, teachers need to be thoroughly trained (Adams 2020). In addition, Adams (2020) noted that teachers need weeks or months of in-depth preparation to be ready for Virtual Learning (VL). They should not be thrown into the deep end without proper training. In the entire universe, VL is defined as a broader concept that has to do with conducting classes through virtual or online platforms. According to Schlosser and Simonson (2006), "virtual learning" refers to a classroom environment that functions effectively without or with little traditional teaching. For the classroom to function effectively without traditional teaching, it requires teachers to have special skills. This has often been a hindrance to other teachers, as not all teachers possess these "special" skills. As a result, several studies have shown that teachers need to be exposed to training so that they can acquire these special skills. For example, a study by Msila (2015) showed that teachers believe that if training can be provided, the challenges of introducing ICT into teaching and learning would be curbed. In the same vein, Barbour (2014) posits that the majority of teachers use teacher development programmes to receive proper

training to implement VL. Most of the teachers, especially those who have more than 20 years of teaching experience, need to be trained, as they know very little about the ICT integration. A decision to implement ICT rests entirely on teachers' willingness (Howard and Mozejko 2015). Howard and Mozejko (2015) further cite that ICT can lead to improved teaching and learning outcomes. As much as ICT promises all kinds of improvement, there are some teachers who are still reluctant to infuse it. For example, Howard and Mozejko (2015) posit that one of the reasons teachers are reluctant to integrate technology is that they feel less confident. Howard and Mozejko (2015) further cite that not being able to solve computer errors or access files or web pages makes teachers feel embarrassed and that their professional competence is compromised. The authors concluded by outlining that these minor issues make teachers feel out of control and unwilling to integrate ICT into education. These developments are worrying considering how ICT has revolutionised the education system. Some of the schools around uMgungundlovu district only have access to the photocopy machine, which could prove difficult to integrate ICT in their lessons.

1.5 THEORETICAL FRAMEWORK

This study revolves around the adoption and usage of technology in teaching and learning. The primary objective of this study was to investigate the level of readiness among EGD teachers towards the integration of ICT into teaching and learning. Therefore, this study adopted the Technological Pedagogical and Content Knowledge (TPACK) framework by Koehler and Mishra (2009). This framework is derived from the Pedagogical Content Knowledge (PCK) of Lee Shulman, who introduced it in 1986 and explains how teachers understand technology education. According to Koehler and Mishra (2009), TPACK consists of three main components, namely: technological knowledge (TK), content knowledge (CK), and pedagogical knowledge (PK), which give rise to other four components, which are: technological content knowledge (TCK), pedagogical content knowledge (PCK), and technological pedagogical content knowledge (TPACK). The development of TPACK is critical to the effective integration of technology in teaching and learning (Koehler, Mishra and Cain 2013). For this reason, this study employed the TPACK framework, as shown below in Figure 1.1, developed by Koehler and Mishra.

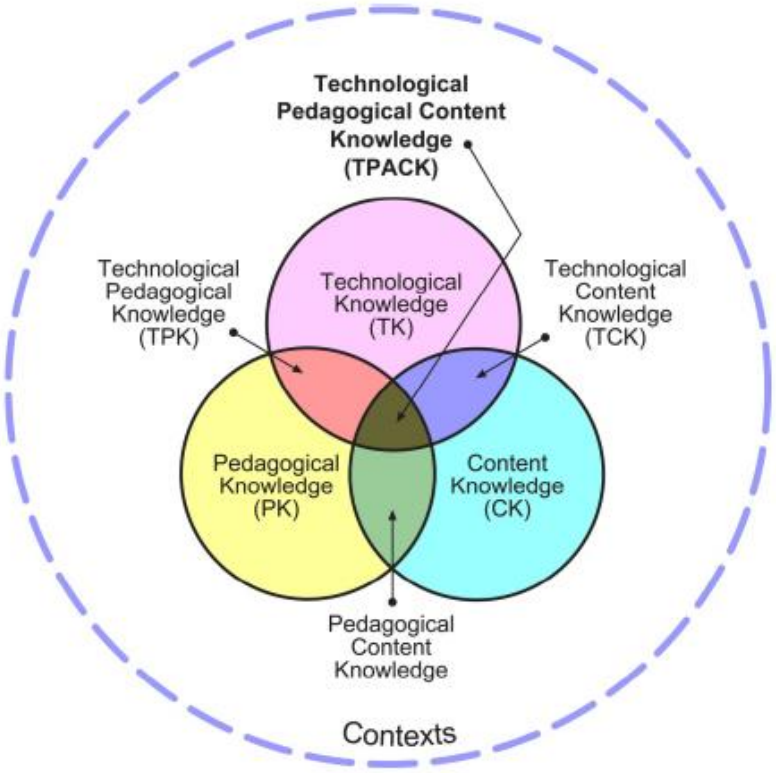

Figure 1.1: The TPACK Framework (Koehler and Mishra 2009)

Figure 1.1 above is the TPACK framework that underlies this study. It is worth mentioning that not all components of TPACK were used, but only three were, as they were relevant to the scope of the study. More of the TPACK framework and which components were adopted will be detailed in Chapter 2.

1.6 RESEARCH PROBLEM

I have been an EGD teacher for 3 years and did my teaching practical for 3 years, which equates to 6 years of experience teaching EGD. In these 6 years of dealing with EGD, I have seen EGD teachers struggling with the infusion of technology in EGD classes. The traditional way of teaching has always been the method of choice, and it produced good results. In support of a study conducted by Msila (2015), one of the interviewed teachers claimed that they had been teaching for years without these computers and producing great results in the process. So, indeed, the traditional way of teaching has been doing wonders. In the same vein, I also attended some content workshops, and all teachers were using the traditional approach, which worked wonders, such that most of us achieved 100% pass rates. This was evident in the EGD

matric results analysis for 2019, as most schools in the uMgungundlovu District achieved 100% pass rates in the EGD. The problem started when COVID-19 broke out in 2020 and physical classes were no longer possible. According to Khoza (2021), COVID-19 compelled the adoption of ICT into teaching and learning. Consequently, EGD teachers were found wanting, as they did not know how to conduct EGD classes online. The Department of Basic Education (DBE) minister Angie Motshekga reported that the 2020 matric pass rate in EGD dropped by 5% (Magubane 2021). This is an indication that COVID-19 had a dire effect on EGD results, and this could relate to the way teachers taught during COVID-19, as the traditional way of teaching was no longer possible. Furthermore, the 2021 diagnostic report for technical subjects revealed that learners performed poorly in EGD in both paper 1 and paper 2, which was the lowest compared to other years (DBE 2021).

The emergence of COVID-19 has led to changes in the way teaching and learning is conducted in academic institutions. One of those changes is the shift from the traditional way of teaching to the modern way of teaching, which includes the integration of ICT into teaching and learning. According to Wyk et al. (2020), this shift has necessitated the need for EGD teachers to have ICT skills to be able to integrate ICT into their teaching and learning. In addition, the use of technology in education brings about interest in learners' pedagogical activities (Radovi-Markovi 2010). However, the current experience on the ground, where the study was conducted, shows that EGD teachers are reluctant to integrate ICT into their teaching and learning, citing many reasons as contributing factors (Copriady 2014). If the status quo remains the same, learners would be at a disadvantage when they get to universities, and teachers would become irrelevant as the world is moving to 4IR. Consequently, this issue has compelled the need to investigate the level of readiness among EGD teachers towards the integration of ICT into teaching and learning. This study also looked at the possible effects the post-COVID-19 era would have on the teaching and learning of EGD. A study done by Chirinda, Ndlovu and Spangenberg (2021) revealed that digital learning would forever be with us, so it is best for every teacher to be equipped with relevant ICT skills. Put simply, it means that practises adopted during COVID-19 are likely to be carried over to the post-COVID-19 era. Therefore, this study also looked at the effects COVID-19 had on the teaching and learning of EGD. This

study also recommended ways that EGD teachers could adopt for infusing ICT into teaching and learning.

1.7 AIMS OF THE STUDY

The purpose of this study was to investigate EGD teachers' level of readiness towards the integration of ICT into teaching and learning and recommend ways they can adopt toward integrating ICT into teaching and learning. This would help them stay relevant in the educational system since everything is migrating to digital. Second, to assist EGD teachers in smoothly transitioning from the COVID-19 era to the post-COVID-19 era.

1.8 OBJECTIVES OF THE STUDY

The main objectives of this study were as follows:

1 To investigate challenges faced by EGD teachers in the adoption of ICT in EGD classrooms.
2 To understand EGD teacher's technological knowledge towards the use of technologies in teaching and learning.
3 To recommend different ways EGD teachers could use to infuse ICT into teaching and learning.

1.9 RESEARCH QUESTIONS

This study used the following main research question:

What is the readiness of EGD teachers in the integration of ICT in teaching and learning in uMgungundlovu secondary schools?

Based on the main research question above, the following key research questions were identified:

RQ1: What are the challenges faced by EGD teachers in the adoption of ICT in EGD classrooms?

RQ2: What are the EGD teachers' technological knowledge in teaching and learning?

RQ3: What are different ways that EGD teachers can use to infuse ICT into teaching and learning?

1.10 RESEARCH METHODOLOGY

1.10.1 Research design

A research design is a blueprint for how a researcher would collect data and analyse it to provide valid answers (Faloye et al., 2020). Furthermore, a research design is defined as the researcher's general plans that would provide answers to the research questions that underpin the research study (Faloye et al., 2020). Since a descriptive design is a research design used to gather information on social issues, it addresses questions like "what, who, where, why, and how." This study employed a descriptive research design to obtain information to describe the phenomenon.

1.10.2 Research approach

According to Creswell (2014), research approaches are plans and procedures for research that span the steps from broad assumptions to detailed methods of data collection, analysis, and interpretation. Furthermore, Creswell (2014) asserted that there are three research methodologies: the qualitative, quantitative, and mixed method approaches. The quantitative approach looks at the data that can be analysed and expressed numerically, whereas the qualitative approach is concerned with the data that can be analysed and expressed in words (Saul 2019). As a result, this study employed a qualitative research approach.

1.10.3 Research paradigm

According to Kivunja and Kuyini (2017:30), there are three main research paradigms that can be used in educational research, which are positivism, interpretivism, and critical theory. Positivism is usually used in a quantitative study where data can be obtained through questionnaires and experiments, while interpretivism is used in a qualitative study where interviews and observations are used to collect data. Thus, I see paradigms as a guide that the researcher can use to ground their research. This study seeks to investigate the level of readiness in EGD teachers towards the

integration of ICT into teaching and learning using a qualitative approach; hence, this study embraces the interpretivism paradigm.

1.10.4 Population

According to Fricker (2012), the target population is the group of elements from which the researcher wants to gather data. The researcher approached 11 schools to partake in this study, but only nine responded positively. Consequently, the population of the study consisted of 9 EGD teachers from 9 different secondary schools situated around uMgungundlovu District under uMsunduzi CMC.

1.10.5 Sampling

Sampling is a procedure used by a researcher to select a smaller number of people from a larger group of people to serve as subjects for an experiment of observation (Sharma 2017). There are two sampling techniques that are normally used in research: probability sampling and non-probability sampling. In the context of this study, a non-probability sampling was employed. According to McCombes (2019), non-probability sampling is when individuals are selected without following a random criterion and not every member of the population has a chance of being selected for the study. This study used a convenience sampling technique as one of the non-probability sampling methods to select nine EGD teachers that were available. Through convenience sampling, this study used nine grade 10 and 11 EGD teachers, one from each of the nine schools, who were conveniently available as EGD is not a popular subject, hence not every school offers EGD.

1.10.6 Data collection techniques

This study employed a qualitative approach. Faloye et al. (2020) allude that there are three commonly used data collection techniques in research, which are: interviews, observations, and questionnaires. A qualitative study normally uses interviews, observations, focus groups, and case studies as methods of collecting data (Bhandari 2020; Bhat 2020). This study used semi-structured interviews and classroom observations. Semi-structured interviews were used to respond to RQ1, RQ2, and RQ3. On the other hand, classroom observations were used to respond to RQ1 and RQ2.

1.10.7 Data analysis

Data collected through interviews was transcribed and typed after each interview, showing respondents' quotes as they were responding to the questions asked. The data was then coded, analysed, and discussed thematically. Themes were derived from the data obtained to answer the sub-research questions that guided the study, which were RQ 1, RQ 2, and RQ 3. The presentation and analysis of the data took the form of a narrative and detailed description with quotations from respondents to capture their real views. Verbatim quotations were used in thematic discussions of interview data to support the results. As for the classroom observations, field notes were made and reported descriptively. Furthermore, data from observations was then analysed according to the observation protocol or schedule. The observation schedule, containing the criteria that the researcher used to obtain information and the analysis thereof, was done in sequence as per the observation schedule.

1.11 ETHICAL CONSIDERATIONS

According to Yip, Han and Sng (2016:648), "the main role of human participants in research is to serve as sources of data, and researchers have a duty to protect the dignity, integrity, right to privacy, and confidentiality of the participants". As such, consent and protection of privacy are still considered paramount practises in research (Favaretto, De Clercq, Gaab and Elger 2020:30). Respondents need to know that their privacy and sensitivity will be protected and what will happen to their information. Ethical approval for this study was obtained from the Durban University of Technology (DUT) Ethics Committee. Permission to conduct a study in schools in uMgungundlovu district (Msunduzi CMC) was also sought from the DoE and informed consent was issued. In addition, a written letter was to be sent to the principals of all selected schools requesting permission to use their schools as study sites. To ensure the integrity of the study, the researcher obtained informed consent from the respondents assuring them that participation in the study was voluntary and that if they felt uncomfortable during the study, they could discontinue the study at any time without negative consequences.

1.12 OUTLINE OF THE CHAPTERS

This dissertation consists of five chapters. These chapters are listed in the order in which the study was conducted. A brief explanation of each chapter follows.

Chapter 1 introduces the study. It provides a brief background on the integration of ICT in EGD teaching and learning and the factors involved. The chapter also introduces the problem statement, research questions, and objectives. The methodology used is also briefly explained.

Chapter 2 provides a literature review on the integration of ICT into the teaching and learning of EGD. It then discusses the theoretical framework that was used to support the analysis and arguments made to answer the research questions.

Chapter 3 explains the methodology used to conduct the research. Explanations of the nature of the research design, research approach, sampling, and data collection techniques are also provided.

Chapter 4 presents the results of the data analysed, as well as the interpretations and detailed discussions of the findings of this study.

Chapter 5 presents the recommendations of this study, future recommendations, and a conclusion.

1.13 CONCLUSION

This introductory chapter provided an introduction and the background of the study insofar as the integration of ICT into teaching the EGD subject is concerned. The chapter also presented equally the statement of the problem, the theoretical framework of the study, the main research questions, and the research design. The methodology used to collect data was also discussed in this chapter, which concluded by examining the ethical considerations of the study. The next chapter focuses on the in-depth literature review and the theoretical framework on which the study was based.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

In the previous chapter, an introduction to the study was given. It also presented the research questions and the objectives and significance of the study. This chapter reviews the existing literature on ICT integration and discusses the factors that influence teachers' resistance to ICT adoption. Furthermore, the chapter presents a review of the literature on virtual learning, the importance of ICT training for teachers, and the availability of resources in schools.

2.2 BACKGROUND ON EGD AS A SUBJECT

According to Sotsaka (2015), EGD is a technical subject that was once called Technical Drawing (TD). Furthermore, Sotsaka (2015) asserts that this was more than just a name change, as many things changed. Some notable changes were the context of the subject, the assessments carried out, and the methods used to teach. This is an indication that change has always been there in EGD; the change of subjects also necessitated the need to use different teaching strategies to teach the subject matter, as mentioned above. The change with regards to the teaching strategies speaks directly to infusing technology more into the teaching and learning of EGD. In support of this notion, according to DBE (2011), one of the goals of EGD is to introduce computer aided design (CAD) as a drawing method and to solve graphical problems by drawing. And that can be achieved through the integration of ICT into EGD lessons, as most concepts in EGD are abstract. Abstract concepts are things that cannot be seen with the naked eye, and ICT integration would assist in making these abstract concepts clearer. Making abstract concepts clear would assist EGD learners to be able to interpret and produce drawings with ease.

Findings in a study done by Khoza (2013) shows that learners have poor spatial skills, which results in learners failing to understand some concepts that are taught in EGD. The study further revealed that some learners are poor in spatial skills, especially in the rotations of objects. The same was echoed by Makgato (2016), as his study revealed that most learners performed poorly in a PSVT he administered. According to Rodriguez and Rodriguez-Velazquez (2017), PSVT is one of the most commonly used tests for the rotation of three-dimensional (3D) objects. So, the implementation

of AutoCAD in EGD would assist in improving learners' spatial skills. In support of this notion, Pedrosa et al. (2014) argue that spatial visualisation can be developed using ICT learning tools because they allow the manipulation of 3D objects. Rodriguez and Rodriguez-Velazquez (2017) and Pedrosa et al. (2014) are in agreement that ICT integration can be beneficial in developing spatial visualisation skills and the manipulation of abstract concepts. This is an indication that ICT integration in EGD is imperative and cannot be overlooked. Hence, this study sought to investigate the readiness of EGD to use technology when teaching EGD.

In EGD, spatial ability is not only a challenge for learners, but also for some teachers who face the same challenge. This assertion is backed by the findings in the Khoza (2013) study, which revealed that EGD teachers are finding it difficult to facilitate some sections effectively because both the learners and the EGD teachers do not have proper learning and teaching resources. According to DBE (2011), there are requirements for EGD classrooms that every school should meet in order to offer EGD to the learners in an effective and efficient manner. These requirements are as follows:

- Sufficient artificial fluorescent lighting
- All computer hardware and software required for CAD
- A large chalkboard and/or whiteboard, with eraser and chalk/pens
- Overhead projector and projection screen

The above-mentioned requirements are a clear definition of what ICT is all about, as articulated in 2.2 above. This simply means that all means utilised by teachers with the purpose of infusing technology are said to be ICT. This is an indication that EGD and ICT go hand in hand and cannot be separated. Put simply, it means that to teach EGD efficiently and ensure that all abstract concepts are clearly understood by learners, ICT must be integrated into all EGD lessons. The same assertion was echoed by Pedrosa et al. (2014), that the use of virtual on-screen models can assist in understanding abstract concepts and improve spatial visualisation skills.

2.3 INFORMATION AND COMMUNICATIONS TECHNOLOGY

“The advent of the COVID-19 pandemic and the resultant worldwide uptake of remote forms of teaching and learning are heralded as the much-needed catalyst to radically transform the ways in which teaching and learning are understood, designed, enacted,

and evaluated”(Mafenya 2022). As a result, many educational institutions are now infusing ICT as part of their daily teaching and learning, and in doing so, they are moving away from the traditional way of teaching and learning. Changes are evident, showing that ICT is proving to be a force to be reckoned with in trying to shape a new era in teaching and learning. Nowadays, educational institutions use devices such as computers and tablets to improve the process of teaching and learning (Faloye et al., 2020). To understand this concept of ICT that has become integral all over the world, a definition must be attached to it. According to DoE (2004), ICT is “the combination of networks, hardware, and software as well as the means of communication, collaboration, and engagement that enable the processing, management, and exchange of data, information, and knowledge." The above definition of ICT was given by the DoE more than 18 years ago, which is an indication that ICT has always been there and has slowly gained momentum. In recent years, ICT has gained prominence; hence, Bornman (2016) postulates that ICT includes all technological tools such as computers and tablets that enable individuals to access, create, and modify information. In the same vein, Cardullo, Wilson and Zygouris-Coe (2018) describe ICT as network devices, computers, and all other wide ranges of telecommunication technologies that can assist in interactive communication and are also capable of performing data communication. Another definition of ICT is given by Linden (2013) as devices used for communication such as cell phones, computers, and other applications used to pass information. Furthermore, ICT refers to both scientific and technological processes used to transmit information (Das 2019). According to Crittenden (2009), ICT is the process of transmitting, storing, creating, sharing, or exchanging information through various technologies such as computers and tablets. In addition, JT and Mbachu (2015) further define ICT as a set of technologies and technological tools used to communicate, disseminate, store, and manage information. In EGD, such could be used to draw on a computer using a CAD programme and save them for later usage. The concept of ICT simply means that all the means utilised by teachers with the purpose of infusing technology are said to be ICT. The concept of “ICT” revolves around the usage of technological tools such as computers, among other things. This means that educators need to be fully equipped with ICT skills so that they can infuse ICT effectively. Such could be beneficial for teaching concepts such as solid geometry and isometric drawing, to name a few in which EGD can be effectively taught through ICT. However, to infuse ICT in the teaching and learning of

EGD, teachers should have ICT skills; these skills refer to an ability to use a wide range of technological devices and their application in teaching and learning (Rastogi and Malhotra 2013). This shows how crucial this component is to infusing ICT into teaching and learning. A study done by Rastogi and Malhotra (2013) to explore the process of ICT integration into pedagogy, reported that 28% of teachers were at the first stage of ICT integration. First-level refers to those who are at a familiarity level. This is the shocking statistic as the world is taking a more digital approach. Technology has indeed compelled the educational system to adopt new ways, and those ways include integrating ICT into teaching and learning. This is an indication that 4IR is upon us, and teachers need to tweak their pedagogical methods so that they can embrace the change that has been enforced upon the educational system by the outbreak of the coronavirus.

2.4 ICT INTEGRATION IN THE CLASSROOM

The integration of ICT is not something that is new; it is something that has been talked about on many media platforms as well. In one of the media platforms that South Africa has, the president, Cyril Ramaphosa, announced that in the next six years, schools are going digital (Matiwane 2019). The writing is on the wall, especially since the outbreak of COVID-19, but the question is, are teachers ready for this challenge? The unprecedented outbreak of COVID-19 has accelerated the need to infuse ICT into teaching and learning. Furthermore, COVID-19 came with a lot of changes in the educational sector, like moving from physical classes to online classes and the adoption of ICT as a tool to supplement the traditional teaching approach. This sentiment is shared by Van der Spoel, Noroozi, Schuurink and van Ginkel (2020), who assert that COVID-19 has indeed compelled teachers to transform their styles of teaching from the traditional to the modern, which entails the integration of ICT. The effects of COVID-19 in education were further articulated by Khoza (2021), who said that COVID-19 compelled the Member of the Executive Council (MEC) of education to introduce the paperless classroom initiative as a way of salvaging education from the pandemic. The paperless classroom, also known as the "virtual classroom," is a platform that teachers can use to integrate ICT into teaching and learning without being physically present in the classroom. As much as this is a great idea in an attempt to move with the times, the integration of ICT into the teaching and learning of EGD

subjects is a concept that requires teachers to have a high level of ICT skills (Mndzebele 2013). However, it seems that because of their practical nature, teaching subjects like EGD, which require the ability to visualise or perceive a graphic, may be difficult to teach online. Unlike other academic subjects, those requiring practical, hands-on learning appear to have several obstacles to overcome in online settings. As articulated by UNESCO (2020), the shift in the delivery of lessons with a strong practical component such as EGD raises fundamental questions about teachers' abilities to deliver practical-based teaching. Mndzebele (2013) posits that teachers are the ones who should be at the forefront of employing the use of ICT in teaching and learning, so the question is whether teachers are equipped with relevant skills and ready to infuse ICT in EGD lessons. This is more like driving a car, and to be able to do so, you must have relevant driving skills. This notion is the same as the integration of ICT into teaching and learning, especially for subjects like EGD, which will require teachers to be capacitated with relevant ICT skills. Consequently, this study aimed at responding to this phenomenon.

A study by Mashile (2017) indicates that teachers are poorly positioned to impart ICT skills into learners. Mashile (2017) further mentions that some teachers are feeling that the district is rushing the new process of going digital. Findings on Mashile can be challenged on the basis that this study was not conducted in uMgungundlovu district, so it can be a different case in uMgungundlovu district. However, Msila (2015) brings another dimension to this narrative as he argues that teachers are ready to infuse ICT into teaching and learning as they have been trained by the district to ensure that they are ICT efficient. Msila (2015) further mentioned that in 2015, DoE announced that they would provide teachers and learners with tablets with the aim of replacing the traditional chalkboard. If the announcement by DoE in 2015 is anything to go by, it means that teachers are ready to infuse ICT, as they have been trained by DoE. However, there is an outcry from teachers as they are saying the introduction of tablets is not impeccable as they are still trying to understand the newly introduced curriculum and that it would be a strenuous task to integrate ICT into their everyday teaching (Msila 2015). This was before the outbreak of COVID-19, which means that the view of the teachers might have changed now that the outbreak of COVID-19 has imposed the need to integrate ICT into teaching and learning. As a result, this study sought to investigate the readiness of EGD teachers to integrate ICT into teaching and learning.

Many people believe that an effort is directly proportional to the results, but Higgins (2014) is not sharing the same sentiment as he posits that ICT may not guarantee good results even though teachers would be putting in a lot of effort in trying to infuse ICT into their everyday teaching. It is worth noting that the successful infusion of ICT in teaching and learning EGD subjects depends on many aspects, like the classrooms, which should be fully equipped with relevant ICT equipment like an overhead projector and computers that are installed with AutoCAD. If one of the aspects mentioned above is lacking, ICT integration cannot be successfully integrated, especially because of the abstract nature of EGD. This assertion is further articulated by Skhephe, Caga and Boadzo (2020), who state that most classrooms in secondary schools in the Eastern Cape province are not in a good state to infuse ICT in general. Skhephe et al. (2020) further mention that other teachers are not ready to integrate e-learning into teaching and learning. However, a contrasting idea was voiced by Msila (2015), who said that DoE has provided some schools with ICT tools to ensure that classrooms are in good condition to infuse ICT. In reality, the availability of resources doesn't necessarily mean that the infusion of ICT in all subjects would be without challenges.

2.5 FACTORS INFLUENCING TEACHER'S RESISTANCE IN INTEGRATING ICT

In spite of the transformation brought about in all aspects of society, the infusion of ICT into education is still in the early stages of development (Mashile 2017). This shows that the integration of ICT into education by teachers is happening more slowly than expected. The slow integration of ICT might be due to many factors, like the lack of training of teachers and the unwillingness of teachers, which can be associated with attitude and a lack of confidence in using ICT tools. A study done by Mashile (2017) indicated that the slow integration of ICT is because South Africa has only 26% of teachers who are equipped with ICT skills, which is a shocking statistic since technology keeps evolving. According to Mahdi and Al-Dera (2013), age is one of the factors that influence teachers' ICT capabilities and willingness to infuse ICT in education. In support of Mahdi and Al-Dera's findings, Msila (2015) posits that older teachers tend to avoid using computers in their lessons. One of the people interviewed by Msila said, *"I feel less professional when I do not know what seems to be the basic computer knowledge,"* and another teacher said, *"I have been teaching for years without these computers."* Based on Msila's (2015) findings, it can be deduced that

older teachers are resistant to using technology, which is one of the factors that this section is trying to look at. But also, it doesn't mean that younger teachers are willing to infuse ICT. There is a wide range of factors that contribute to teachers' resistance to infusing ICT. Another is teachers' shortage of skills to use technology. A study done by Raman and Yamat (2014) further revealed that there are many factors that hinder teachers from integrating ICT, and one of those factors is the age and experience of the teachers. In support of this notion, a participant in a study conducted in Malaysia by Raman and Yamat (2014) said, *"I have 10 years of teaching experience. So, I'm very convenient using my manual ways, and I did not grow up in a technological environment. "I prefer reality experiences rather than looking at monitors."* Another participant said, *"My age is 53, and I have been teaching for more than 25 years."* I believe in the traditional method, which lets the learners touch, feel, and learn. I could make interactive lessons without using the ICT tools. *"I think this is not the time for ICT integration in my teaching."* This resistance to using ICT may be due to many reasons, like not being trained or a lack of facilities at schools. These forms of resistance from teachers were also evident in Zimbabwe, as a study done by Matongo (2022) revealed that teachers are not infusing ICT into teaching because they lack ICT skills, which can be acquired through training. Matongo (2022) further states that not being trained results in teachers not being confident in using technology in classes full of ICT-capable learners and often suffering from technology phobia. Another factor that influences the resistance of teachers is that they were not trained or taught how to use ICT while they were in universities. To validate the above (Matongo 2022, Quaye, Ametepe and Annan 2015), we assert that teachers are not infusing ICT in their lessons because they were not trained in the colleges where they obtained their teaching qualifications, which influences their attitudes when turning professional.

In addition, literature has shown that teachers' insufficient skills in using the internet discourage them from integrating ICT in their lessons (Yunus and Wekke 2009). On the other hand, Jegede (2009) argues that age is not the contributing factor, but attitude is. This notion by Jegede (2014) shows that age doesn't influence the usage of ICT, which is in contrast to claims made by Msila (2015) and Mahdi and Al-Dera (2013). Copriady (2014) and Badri et al. (2013) concur, as they claim that a teacher's decision to use or not use ICT is merely associated with their attitude. Copriady (2014) also mentioned that teachers have a nonchalant attitude towards the implementation

of ICT; hence, their level of willingness and readiness is very low. In support of the above, the literature has shown that generally, teachers do not want to integrate ICT in their EGD lessons as they feel that the traditional way is still bearing good fruit and EGD might not be an exception. Interestingly, Radovi-Markovi (2010) indicate that traditional teaching allows teachers to have more personal interaction with the learners, which is in contrast to what online learning can offer. Since EGD needs lots of practice, the teaching of the subject has always been synonymous with personal interaction with learners through demonstration teaching methods.

Another factor that can contribute to teachers' resistance to infusing ICT is a lack of confidence. Rastogi and Malhotra (2013) reported that some teachers had the basic knowledge of using computers but lacked the confidence to use them in the teaching and learning process. Rastogi and Malhotra (2013) further mentioned that they knew the basics of many software programmes but were too sceptical to use them for teaching and learning purposes. For example, in EGD, a teacher might feel confident when using AutoCAD without the presence of learners, but it becomes a challenge for them to operate it in front of them. This comes down to a question of teachers' attitudes towards ICT, as Rastogi and Malhotra cite in the study they conducted. In a study, they also reported that the success of implementing the new curriculum with ICT in education depends greatly upon the attitudes of the teachers and their willingness to embrace such technology and ICT knowledge and skills (Rastogi and Malhotra 2013). Rastogi and Malhotra (2013) further explained that teachers should not only have ICT skills, but also the right attitude toward ICT use. In a study by Mustafina (2016), findings show that teachers display a positive attitude toward ICT integration. The study further revealed that gender, age, knowledge, and confidence play a crucial role in shaping teachers' attitudes toward ICT. On the contrary, Raman and Yamat (2014) postulate that age, gender, and attitude are some factors influencing teachers' resistance to infusing ICT. Raman and Yamat (2014) further revealed that one of the interviewed teachers said: *"My age is 53 and I have been teaching for more than 25 years. I believe in traditional method which let the learners touch, feel, and learn. I could make interactive lesson without using the ICT tools. I think this is not the time for ICT integration in my teaching."* Another teacher said: *"I prefer reality experiences rather than looking at monitors. So, applying ICT tools in my classrooms is not effective. However, traditional forms are more effective."* The issue of attitude towards the

integration of technology seems to be a common problem among teachers, translating to a poor attitude towards the usage of technology in teaching and learning. This assertion is further expressed by Erişti, Kurt and Dindar (2012), who cited that one of the barriers that affects teachers' ability to infuse ICT is their attitude. Attitude is one of the factors that influences teachers' resistance to infusing ICT into EGD classes. Mustafina (2016) came up with factors other than attitude that contribute to teachers' resistance to the integration of ICT into teaching and learning. Figure 2.1 below shows some other factors that influence teachers' attitudes toward technology integration.

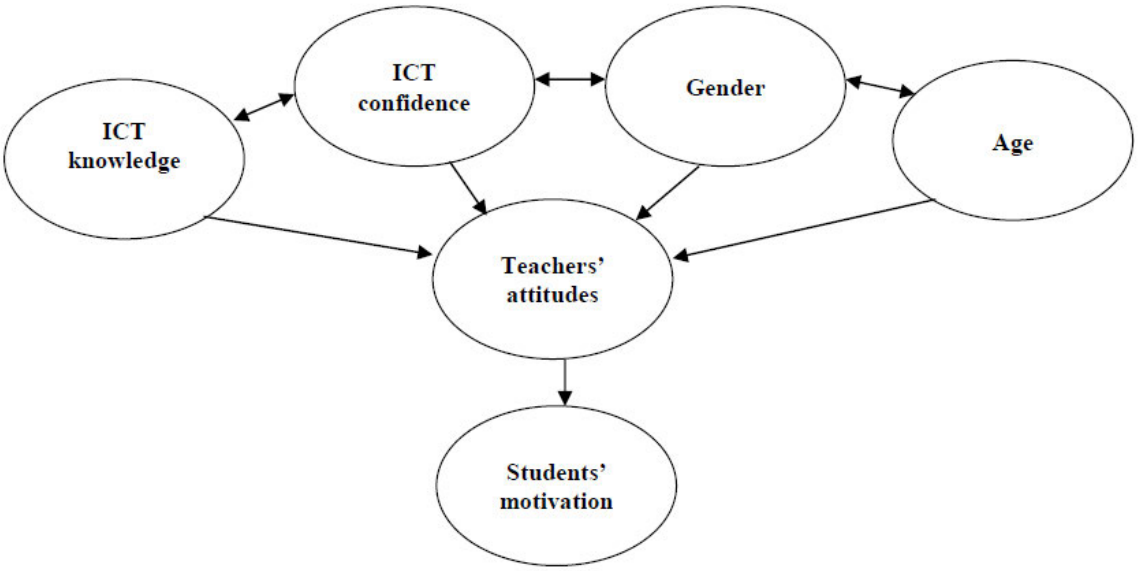

Figure 2.1: Factors that influence teachers' attitudes toward technology integration (Mustafina 2016)

Figure 2.1 above shows different factors that contribute to teachers' attitudes towards the infusion of ICT in teaching and learning. In addition, Al-Zaidiyeen, Mei and Fook (2010) state that a teacher who possesses a positive attitude toward ICT is more inclined to infuse it into his teaching and learning. This is also evident in a study done by Raman and Yamat (2014), which found that teachers' attitudes toward the use of technology in teaching and learning is one of the most important factors in the meaningful use of computer technology in education. If this attitude continues unabated in practical subjects like EGD, learners will be put at a disadvantage when getting into institutions of higher education and also when competing for jobs.

In Figure 2.1 above, gender was mentioned as one of the factors that contributes to teachers' resistance to infusing ICT. Gebhardt, Thomson, Ainley and Hillman (2019) posit that female teachers are seen as being less likely to use technology as opposed to male teachers. In the same vein, as reported by the International Computer and Information Literacy Study (ICILS) 2013, a study done by Fraillon, Ainley, Schulz, Duckworth and Friedman (2019) reveal that when asked about using technology in the classroom, female teachers responded negatively. This is an indication that female teachers are mostly shy or not inclined to infuse technology into teaching and learning as compared to male teachers. In support of a study done by Mukhari (2016), one of the interviewed people's responses was *"women made excuses when asked to go for computer training and if they did, left the course early. In comparison, their male counterparts were keen to be trained on various computer programmes."* It was further revealed that female teachers exhibit low levels of ICT usage, and this is due to a lack of ICT skills (Du Toit 2015). Du Toit (2015) further mentions that females do not want to use technology despite having all technologies available to them in schools. In contrast to Du Toit's (2015) assertion, Aslan and Zhu (2016) found that gender is not a contributing factor as both male and female teachers were infusing ICT into their lessons. Aslan and Zhu (2016) further mentioned that *"teachers are integrating technology in their practises regardless of their gender."* In uMgungundlovu District, there is a balance in terms of gender that was evident in the EGD workshops attended, and EGD teachers included both old and young, but the majority are younger teachers. Even though EGD is dominated by younger educators, the level of ICT integration seems to be very low in comparison to the preference given to the traditional method of teaching. As discussed in chapter 1, EGD is a subject that deals with abstract concepts, and the usage of ICT tools can help teachers deliver content to the learners in a better way. It is presumed that this could also help learners make sense of the abstract concepts that are being taught in EGD. This assertion was echoed in Chapter 1 by Khoza (2013) and Makgato (2016) that learners are usually poor at spatial visualisation. Integrating technology into the classroom can be seen as the main reason for improving spatial skills (Akkuş and Arslan 2022). It is contended that ICT integration in the teaching and learning of EGD is essential, and for that to be possible, teachers must be ready to infuse ICT. Consequently, this study is investigating the readiness of teachers so that they can infuse ICT into the teaching of EGD. The readiness of teachers will be of benefit to those learners who are poor in spatial

visualization, as technology will be used to manipulate abstract concepts that are found in EGD.

2.6 VIRTUAL LEARNING AS A TOOL OF INFUSING ICT

Social distancing has become the norm since lockdown was implemented more than a year ago (Nordling 2020). Schools were no exception as they were also expected to practise social distancing, so virtual learning (VL) came into the picture, and for the VL to be implemented successfully, teachers needed to have technological skills. According to Schlosser and Simonson (2006), "virtual learning" refers to a classroom environment that functions effectively without or with little traditional teaching. Another definition for VL or e-learning is that it comes in many forms, such as using WhatsApp, Zoom, or Microsoft Teams for the purpose of teaching and learning. A study by Li and Lalani (2020) reveals that e-learning has changed education dramatically in the sense that the level of retention for learners has increased, but Higgins (2014) claims that ICT combined with VL would not guarantee good results. However, Bernardes and Oliveira (2021) argue that the process of adapting and implementing remote teaching for EGD has changed the idea that it is not possible to deal with a subject of this nature online. But it looks like most teachers, inclusive of EGD are still resistant to integrating ICT in their classrooms. However, Li and Lalani (2020) further argue that it is not all rosy about VL, as teachers are frustrated about the fact that some learners have unreliable internet access while others are struggling with the actual virtual learning and electricity outages.

In these trying times, teachers can adopt VL as a way of replacing traditional teaching pedagogy (Bloom, Reid and Cassady 2020). However, for them to utilise VL, they must be ICT-capable. This means that teachers must be equipped with ICT skills so that they can integrate ICT into the classroom via VL. A study by Mashile (2017) shows that many educators are having problems keeping up with the technology and digital demands of the school environment, which brings concerns as the time we are living in forces us to go digital. In contrast, Yuen, Law and Wong (2003) posit that the use of ICT in the past decade has increased enormously. Generally, in schools around uMgungundlovu district, the integration of ICT in other subjects is increasing, but it remains unclear as to whether the same principle applies in the teaching of EGD considering its complexities. Since most youths are digitally savvy and own a gadget

or two, the adoption of VL would bring excitement into learning, and maybe even classroom attendance would grow. Prieto and Velasco (2010) conducted a study to investigate how to improve spatial skills in drawing classes and showed that learners performed better in drawing subjects supported with visual and virtual materials rather than printed materials. Trucano (2005) posits that the integration of ICT in teaching and learning can increase learners' autonomy and the retention rate since they would be learning with things, they are familiar with. For example, in the cams section and the assemble drawings section, most of the things their learners are not familiar with are technological, so using technology can work to their advantage. This is an indication that ICT integration in the teaching and learning of EGD leaves much to be desired by both teachers and learners.

In the entire universe, VL is a broader subject that has to do with conducting classes through virtual or online platforms. This term became prevalent in the education sector during the nationwide lockdown that came due to the outbreak of COVID 19, as educational sectors tried to come up with alternative ways to supplement physical classes. Physical teaching and learning became impossible, and educational institutions resorted to distance learning platforms (Li and Lalani 2020). According to Li and Lalani (2020), teachers used WhatsApp, Zoom, and Microsoft Teams to conduct online classes as physical classes were no longer possible. Li and Lalani (2020) further mentioned that other teachers had opted for Google Classroom. "WhatsApp is a free messenger application that works across multiple platforms like iPhone and Android phones, and this application is being widely used among learners to send multimedia messages like photos, videos, and audios along with simple text messages" (Gon and Rawekar 2017). According to Asmara (2020), this is the tool some teachers used to send videos and documents to their learners for the purpose of learning. This is an indication that WhatsApp is playing an important role in teaching virtually. In support of this assertion, Gon and Rawekar (2017) came up with a list of advantages of using WhatsApp as a learning tool (LT) in the study they conducted. These advantages included: easy use, a teacher who is always available to respond to queries, and the ability to receive learning documents very easily. These advantages are an indication of why many teachers prefer to use WhatsApp for teaching. In EGD, teachers can easily use WhatsApp to send videos to learners that expand on what was taught in class. WhatsApp has been proven to be very important in facilitating classes online,

and it gained prominence during the COVID-19 lockdown. It has been of great benefit to the educational sector ever since. According to Bere (2012), below are the benefits of using WhatsApp as a LT:

- Multimedia: Allows users to share videos, text messages, images, and voice memos.
- Group chat: It supports interaction of up to 50 group members.
- Unlimited messaging: there is no limit to the number of messages you can exchange on WhatsApp.
- Offline messaging: Messages are automatically saved when the device is offline.

However, Gon and Rawekar (2017) further mentioned that not all is rosy with WhatsApp, as some teachers did experience problems while using the app. This is the sentiment that was echoed by Asmara (2020) and Li and Lalani (2020), that slow internet connections or no internet connections at all, electricity outages, and not having phones at all were the obstacles teachers were faced with. Table 2.1 below, by Gon and Rawekar (2017), highlights other challenges that teachers and learners were faced with in using WhatsApp as a LT.

Table 2.1: Challenges of using WhatsApp as teaching learning tool.

S.No	Advantages/ Subcategories	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
TECHNICAL						
1	No smart phone	38 (59.23%)	14 (27.98%)	-	6 (8.20%)	2 (4.59%)
	Message flooding	36 (57.16%)	9 (16.07%)	5 (10.16%)	3 (4.92%)	7 (11.69%)
	Time consuming	29 (54.54%)	14 (15.74%)	-	5 (11.26%)	12 (18.47%)
	Group maintenance	23 (34.15%)	8 (14.37%)	14 (23.66%)	1 (2.73%)	14 (25.08%)
	Eye strain	31 (52.79%)	11 (15.74%)	5 (5.68%)	5 (14.37%)	8 (11.42%)
EDUCATIONAL						
2	High expectation of teacher's availability	31 (43.11%)	9 (17.98%)	5 (10.93%)	4 (8.96%)	11 (19.02%)
	Huge amount of learning material makes it confusing	20 (40.87%)	18 (24.97%)	7 (11.04%)	7 (7.38%)	8 (15.74%)
	Use of inappropriate language	3 (4.64%)	4 (9.18%)	2 (1.80%)	4 (6.45%)	47 (77.92%)
INSTRUCTIONAL						
3	No efforts by some students	35 (63.17%)	8 (11.80%)	3 (5.30%)	7 (9.67%)	7 (10.05%)
	Some students share material to impress facilitator without actually learning about it	34 (57.65%)	14 (21.97%)	4 (7.43%)	2 (2.73%)	6 (10.22%)

Source: Gon and Rawekar (2017)

Table 2.1 above shows the findings based on the study conducted by Gon and Rawekar (2017) about the challenges most learners and teachers encountered when using WhatsApp during the COVID-19 lockdown. Being on lockdown meant that physical classes were no longer possible, and as a result, virtual classes were the only way to go. This presented teachers with an opportunity to try other modes of conducting classes, and some discovered WhatsApp as a great platform to conduct classes away from school premises. However, such an idea did not work out for the best for some other teachers, as they experienced problems related to WhatsApp. Based on findings by Gon and Rawekar (2017), as expressed in Table 2.1 above, some learners had no smartphones that supported WhatsApp, while other teachers reported that some learners did not put much effort into engaging in the lesson, and another challenge was that it consumed much time. As much as WhatsApp promised to be the best way teachers could conduct virtual classes, that was not the case. Another challenge that was faced by many teachers was load shedding. According to Malik, Memon, Ali, Mallah, Bux and Haq (2022), load shedding is the temporary interruption of electricity for a certain period of time due to a greater demand for

electricity than supply. The interruption of electric power also affects the network, which leads to teachers and learners not being able to use WhatsApp as it needs the internet (network) to operate. The issue of load shedding is further attested to by Siddiquah and Salim (2017), who report that most teachers reported load shedding as some of the challenges they encountered during COVID-19 lockdown that hindered the process of teaching and learning. Furthermore, Siddiquah and Salim (2017) cite that the second-largest challenge faced by teachers and learners was the non-availability of ICT resources at home. This is because not even a single person was expecting COVID-19; as a result, it took everyone by surprise, hence no provisions were put in place to conduct lessons away from home. All the above-mentioned challenges, which hindered EGD teachers from successfully conducting classes during lockdown, have necessitated the need to investigate the level of readiness of EGD teachers towards the integration of ICT into teaching and learning.

2.7 IMPORTANCE OF ICT TRAINING FOR TEACHERS

Integration of ICT into teaching and learning is something that has gained prominence over the years more especially as the world is moving to the 4IR. However recently the need to integrate ICT into teaching and learning more especially of EGD has gained momentum as it is on every person's lips due to the recent outbreak of COVID-19. COVID-19 compelled every education institution to migrate to virtual learning. This has become a problem as some of the schools around uMgungundlovu district only have access to the photocopying machine this shows that integrating ICT is something that is hard for them, hence they feel out controlling and stick to the traditional method. As much as going virtual is a good idea given the current state, we are living in but some teachers are not in a position to conduct lessons virtually as they are not trained to carry out such activities. This is attested to by Msila (2015) that teachers are firm believers that training is very important for them so that they can be able to integrate ICT into EGD lessons. During COVID-19 lockdown teachers around uMgungundlovu could not conduct classes from home as they cited that they did not know how to conduct classes online, they feel less confident of using technology in front of learners, another reason was that they also did not have ICT materials to help them carry out lessons from home. The issue of being less confident by teachers is alluded to by Howard and Mozejko (2015) that teachers are feeling less confident because they lack

training. According to Adams (2020), this is an indication that without proper ICT training teachers are doomed. Furthermore, Barbour (2014) cited that teachers should be subjected to development programmes and workshops where they will be equipped with ICT skills.

Training of teachers is a crucial component to infusing ICT into teaching and learning. For teachers to be effective in implementing ICT in education, they require training. Many countries across the world have realised the importance of ICT; hence, they have started to provide ICT training to teachers in various forms and degrees (Jung, 2005). These various degrees include the following:

- Training teachers on how to use ICT in the classroom
- Training teachers via ICT
- Training also equips teachers with skills to be able to select appropriate ICT tools

However, in South Africa, there are still teachers who claim that they have not been trained thoroughly to use technology effectively in teaching and learning. In his contract, Jung (2005) posits that several efforts have been made to ensure that teachers receive training that would help equip them with tools to enhance teaching and learning. Furthermore, Alazam, Bakar, Hamzah and Asmiran (2013) postulate that ICT can prove to be a very crucial component in a classroom if used wisely by a well-trained teacher. This simply means that teachers need to be thoroughly trained so that they can infuse ICT into teaching and learning effectively. Alazam et al. (2013) discovered that the level of teachers' ICT skill and usage was moderate in a study that examined the levels of ICT skills and ICT use in classrooms. In addition, teachers who possess ICT skills are found to be more useful than those who do not (Rastogi and Malhotra 2013). This shows how important it is for teachers to be thoroughly trained so that they can have relevant skills for infusing ICT. The importance of training teachers is being seen as a very important step in ensuring that teachers are in a better position to infuse ICT. This is attested to by Tasir, Abour, Halim and Harun (2012). There’s an increase in the number of countries that are undertaking the programme of training teachers for ICT integration. Hence, the explosion of ICT all over the world has compelled the need for individuals to have ICT skills, which are deemed paramount in the present time. Training is a very essential component in ensuring that teachers are

ready to infuse ICT into teaching and learning. The importance of ICT training was alluded to in Chapter 2.4 by Matongo (2022), who said that most teachers are not confident enough to use technology in the classroom because they don't have relevant ICT skills. Matongo (2022) further mentioned that without training, teachers develop a phobia of technology as they are less motivated to use it due to a lack of ICT skills. This simply means that ICT training plays a significant role in ensuring that teachers integrate ICT into teaching and learning. However, most authors have stressed that teachers must be willing to integrate ICT, or the training will have no effect and be just a futile exercise. Willingness forms part of the attitude that was mentioned in Chapter 2.4 that contributes to the resistance of teachers in infusing ICT into the teaching and learning of EGD. The aforementioned statement is echoed in a study conducted in Malaysia by Raman and Yamat (2014), who found that one of the factors that influences the infusion of ICT is the hesitancy of teachers to use technology in the classroom. This is an indication that a teacher needs to be willing to use technology in the classroom, which is what Figure 2.1 above alludes to. The hesitancy and unwillingness exhibited by the teachers might be an indication that teachers are not ready to infuse ICT, and as a result, this study sought to investigate the readiness of EGD teachers to infuse technology in the teaching and learning of EGD. However, a study conducted in Zimbabwe by Matongo (2022) indicated that teachers ended up enrolling in ICT courses from their own pockets so that they could receive ICT skills. This shows that teachers understand the importance of having ICT skills and are willing to integrate ICT into teaching and learning. But the study further revealed that not many teachers enrolled for these courses because of financial constraints, as they had to fund themselves from their own pockets. The lack of ICT training is seen as a major challenge in ensuring that ICT is integrated into EGD lessons. As a result, this study sought to investigate the readiness of EGD teachers in integrating ICT by looking at the challenges EGD teachers are faced with in the adoption of ICT as per RQ 1.

2.8 AVAILABILITY OF RESOURCES IN SCHOOLS TO INTEGRATE ICT

For EGD teachers to be able to integrate ICT into the teaching and learning of EGD, they need to have access to ICT resources. Classrooms must be in a good state to support the integration of ICT. This notion is voiced by Mathevula and Uwizeyimana (2014), who argue that ICT equipment must first be available in schools before

teachers can start integrating ICT into their teaching and learning. In the schools where this study was conducted, teachers had access to basic ICT tools such as the projector, IWB, photocopiers, and computers. Others even had access to AutoCAD, which assists in the teaching of abstract concepts. Being able to teach abstract concepts with ease is a very important step toward improving learners' spatial visualization, which has been proven to be a big problem. The above assertion is corroborated by Khoza (2013), Makgato (2016), and Khoza (2016) that most learners are poor when it comes to spatial visualisation. On the contrary, this is only a dream in developing countries like South Africa, as most schools do not even have a computer or access to the internet (Mathevula and Uwizeyimana 2014). Consequently, the lack of ICT resources has always been a cause of outcry for many teachers around the world, especially in developing countries like South Africa. The contrast is because the study by Mathevula was conducted in Limpopo, which is why the findings contradict the experience in uMgungundlovu District. The same sentiment was echoed by Mathevula and Uwizeyimana (2014), who reported that there is a lack of ICT resources for ICT integration in schools. Photocopiers, TVs, and laptop or desktop computers are the only ICT resources available to teachers in schools (Mathevula and Uwizeyimana 2014). Figure 2.2 below shows the availability of ICT resources in schools.

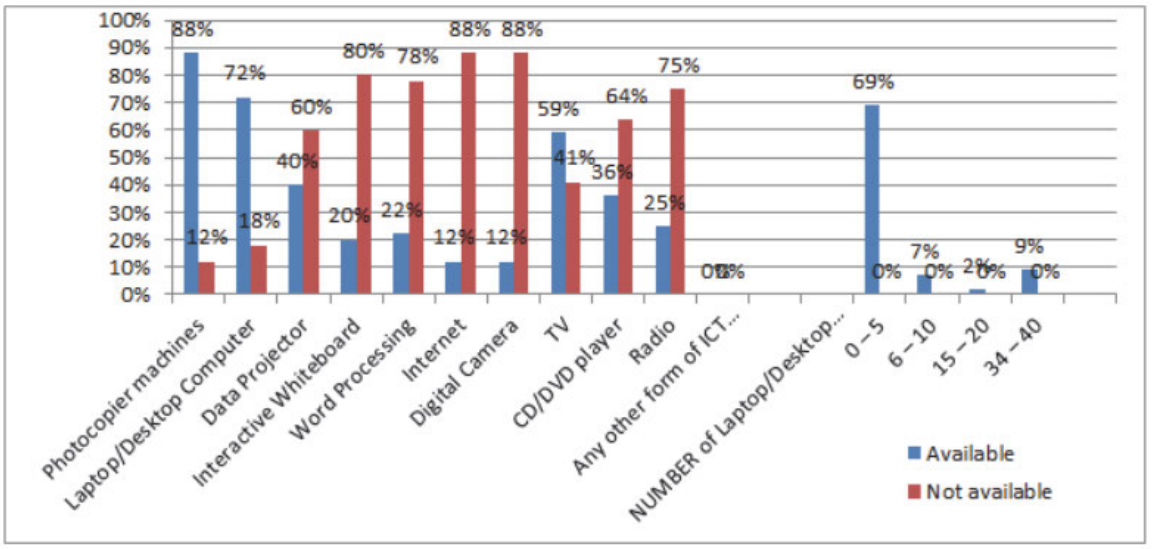

Figure 2.2: Availability of ICT resources in schools Mathevula and Uwizeyimana (2014)

Figure 2.2 above shows that there was a shortage of ICT resources in schools in a study that was conducted in 2014. Much as the data presented in the above figure is 8 years old, the possibility that little has changed due to the ailing economy of the country in the past 10 years is evident. According to DBE (2011), some ICT resources are regarded as the minimum requirement for any school that wants to integrate ICT into the teaching and learning of EGD. These resources are an IWB, AutoCAD, and a projector. The lack of ICT infrastructure in schools is further revealed in the findings of the study conducted by Alharbi (2021), which revealed that one of the barriers teachers are faced with in integrating ICT is a lack of resources. The issue of a lack of ICT resources is not only experienced by teachers in South Africa but all over the globe. This assertion is backed by Addandani (2011), as he cites that schools in Saudi Arabia also experience a lack of ICT resources, which hinder the successful integration of ICT. So this is the global challenge when it comes to integrating ICT into teaching and learning. The same can be said for the schools around uMgungundlovu district that offer EGD, as the lack of ICT resources has been found to be inadequate. Alharbi (2021) further cites that the lack of resources also includes a lack of educational software. Put simply, it means that teachers are put at a disadvantage when there is no educational software at their disposal. This is to say computers might be available, but the lack of educational software and the internet can hinder teachers greatly (Alharbi 2021). This further raises the role played by the educational software. The most used software in EGD for the purpose of simplifying abstract concepts is AutoCAD.

For computers to function efficiently and be able to assist teachers in integrating ICT into EGD lessons, those computers must be installed with relevant educational software. In contrast to Mathevula and Uwizeyimana (2014), what is displayed in Figure 2.2 about the lack of availability of interactive white boards (IWB) in schools Bakadam and Asiri's (2012) findings show that most teachers believe that IWB is an effective and convenient method of delivering learning and that it increases classroom interaction, which in turn increases learning success. Furthermore, Bakadam and Asiri (2012) revealed that other teachers go as far as using the IWB as a background sheet for the projector to project on. This is further attested to by Karsenti (2016), who reported that many studies have shown that teachers are using IWB exceptionally well in teaching and learning. Karsenti (2016) further postulates that in the last 5 years,

IWB has been massively introduced in schools for the purpose of teaching and learning. As a result, most teachers have access to the IWB in schools, and they are using it very well. This assertion is articulated clearly in Figure 2.3 below:

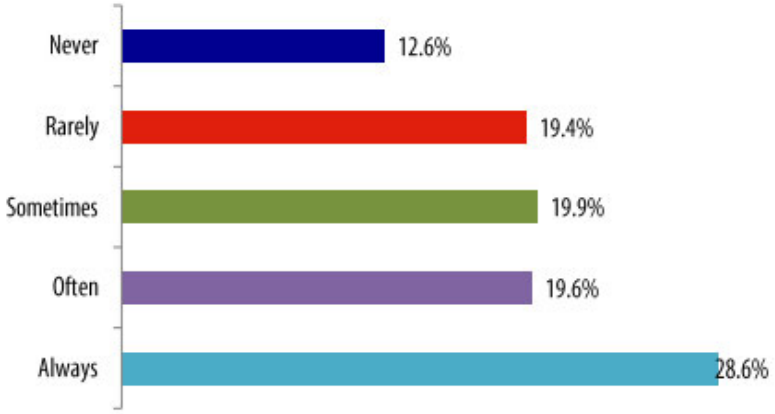

Figure 2.3: Use frequency of the IWB by teachers (Karsenti 2016)

Figure 2.3 above shows the results of the findings from the study done by Karsenti (2016) about the use of the IWB by the teachers. This is an indication that most EGD teachers are relying heavily on using AWB as part of integrating ICT into the teaching and learning of EGD. Most schools around uMgungundlovu do have an IWB, and teachers are using it. This sentiment is echoed in studies conducted by Bakadam and Asiri (2012) and Karsenti (2016). This sentiment was further alluded to by DBE (2011), which listed AWB as one of the requirements an EGD classroom should have in order to offer EGD to learners in an effective manner.

2.9 THEORETICAL FRAMEWORK

The primary objective of this study was to investigate the level of readiness among EGD teachers towards the integration of ICT into teaching and learning. Therefore, this study adopted the Technological Pedagogical and Content Knowledge (TPACK) framework by Koehler and Mishra (2009) as its underpinning. This framework was derived from the Pedagogical Content Knowledge (PCK) of Lee Shulman, who introduced it in 1986 and explains how teachers understand technology education. According to Koehler and Mishra (2009), TPACK consists of three main components, namely: technological knowledge (TK), content knowledge (CK), and pedagogical knowledge (PK), which give rise to other four components, which are: technological

content knowledge (TCK), pedagogical content knowledge (PCK), and technological pedagogical content knowledge (TPACK). The development of TPACK is critical to the effective integration of technology in teaching and learning (Koehler et al., 2013). For this reason, this study employed the TPACK framework, as shown in Figure 2.4 below, that was developed by Koehler and Mishra.

In the context of this study, three TPACK components were deemed relevant as they deal with the technological aspect of teaching and learning. These three components are TK, TCK, and TPK. These components were used to develop research questions and derive the research objectives that underpinned this study. These three components are relevant because they fit the scope of this study, which is to investigate the level of readiness among EGD teachers towards the integration of ICT into teaching and learning. Following is a detailed breakdown of how each of these three constructs is deemed relevant and how they fit into the scope of the study. In addition, the construct of the framework was employed for the development of the interview questions and classroom observation schedule used in the study.

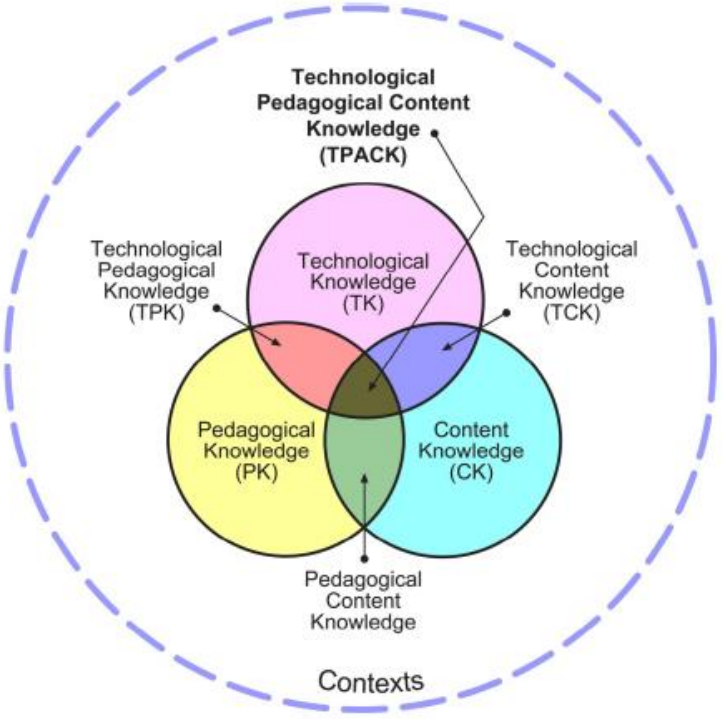

Figure 2.4: The TPACK Framework (Koehler and Mishra 2009)

2.9.1 Technological Knowledge

According to Kurt (2018), "TK" refers to teachers' knowledge and ability to use a wide range of technologies to enhance teaching and learning. It also has to do with teachers' understanding of using technology in their everyday teaching. In addition, Koehler et al. (2013) define TK as the “fluency of information technology,” which translates to having an immense understanding and knowledge about integrating technology into teaching and learning. According to Koehler and Mishra (2009), TK “refers to knowledge about various technologies, ranging from low-tech ones such as pencil and paper to digital ones such as the Internet of Things, digital video, interactive whiteboards, and software programs, robotics, artificial intelligence, and big data”. This assertion is echoed by DBE (2011), as they reported in the EGD CAPS document that a projector, IWB, and AutoCAD are basic requirements that an EGD class should have so that learners can immensely benefit. Knowledge of certain ways of thinking and working with technological resources can be applied to all technological tools and resources. This includes understanding information technology to the extent that it can be used productively at work and in everyday life, recognising when information technology can help or hinder the achievement of a goal, and being able to continually adapt to changes in information technology (Koehler and Mishra 2009). The concept of TK was verified through lesson observations and semi-structured interviews on how teachers utilise technology in teaching and learning of EGD. In the context of this study, this component was used to investigate teachers’ technological knowledge towards the use of technology in their EGD classes. This component was crucial in shedding light on how well EGD teachers knew how to integrate technology into their instructional practices.

2.9.2 Technological Content Knowledge

Technological Content Knowledge looks at the relationship between technology and content knowledge about the subject matter (Kurt 2018). It's about how technology and content affect each other. Teachers need to understand which technologies are best suited to address topics (Koehler and Mishra 2009). The TCK component is further defined as the knowledge of how technology can create new representations for specific content (Koehler and Mishra 2009). The TCK component is important to understand because, if better understood, an EGD teacher would develop appropriate

technological tools to present tools and equipment in both the theoretical and practical constituencies. Findings in the Khoza (2013) study revealed that EGD teachers are finding it difficult to facilitate some sections effectively because both the learners and the teachers do not have proper learning and teaching resources. This is an indication that if teachers were to infuse ICT into their lessons, much would be achieved. Teachers must not only be proficient in the content they teach, but also have a comprehensive knowledge of how the subject matter can be modified through the use of technology. TCK was verified through the lesson observations and the interviews. In this study, this component was used to investigate teachers' level of competency with the use of technology and how well they manage to showcase a newer teaching style when teaching EGD.

2.9.3 Technological Pedagogical Knowledge

"An understanding of how teaching and learning can change when technologies are used in particular ways. This includes knowing the pedagogical affordances and constraints of a range of technological tools as they relate to disciplinarily and developmentally appropriate pedagogical designs and strategies" (Koehler and Mishra 2009). Technological pedagogical knowledge refers to the knowledge of how various technologies can be used in the classroom and the understanding that the use of technology can change the way teachers teach (Koehler and Mishra 2009). Technological pedagogical knowledge was verified through the lesson observations, where teachers were observed on how they utilise technology to teach EGD. According to Khoza (2013), most learners are poor at spatial skills, and utilising technology in an EGD lesson would assist learners in understanding some abstract concepts in EGD very well. Similar assertions are further echoed by Makgato (2016), who reported that most learners performed poorly in a spatial visualisation test that he administered. This observation is aimed at verifying if, indeed, EGD can be taught with technology in this era of the 4IR. This component was used to investigate teachers' understanding of using a variety of technologies at their disposal in a manner that would enhance teaching and learning.

2.10 CONCLUSION

In this chapter, I examined the literature review of various theories in terms of the necessary knowledge teachers must have in order to successfully integrate ICT into teaching and learning. The literature review also addressed the factors that influence teachers' resistance to integrating ICT and the importance of teacher training for ICT. The theoretical framework underlying this study was explained. The EGD concept and its complexity that justifies the use of technology was also discussed. The next chapter addresses the methodology used in this study.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

The previous chapter addressed the study's literature review on the incorporation of ICT in EGD teaching and learning and considered the theoretical framework underlying this study. The topic of EGD and all of its concepts were also discussed. This chapter presents the research method used in this study and explains why a qualitative approach was adopted in this study. It also describes the research site and the data collection methods. The data collection instruments and sampling procedure used in the study are also outlined. This is followed by a description of the data collection procedures and the method of data analysis. The chapter ends with a justification of the validity of the instruments and analysis procedures to promote the credibility of the research findings.

3.2 RESEARCH DESIGN

A research design is a blueprint for how a researcher collects data and analyses it to provide valid answers (Faloye et al., 2020). Furthermore, a research design is defined as the researcher’s general plans that would provide answers to the research questions that underpin the research study (Faloye et al., 2020). Since a descriptive design is a research design used to gather information on social issues, it addresses questions like "what, who, where, why, and how." This study employed a descriptive research design to obtain information to describe the phenomenon. The descriptive research was used because of its strength to gather an in-depth view of any phenomenon that is under study (Sumeracki 2018). This aspect of getting an in-depth view of the matter at hand was evident as the researcher needed to establish the readiness of EGD teachers, and the best way to do that was to get an in-depth view on the readiness of teachers. The choice of data collection techniques was specifically chosen because of their ability to get in-depth information from the participants. The methods of data collection used in this study are discussed in Section 3.7. Sumeracki (2018) further mentions that a descriptive research design can work best if a study adopts a qualitative research approach.

3.3 RESEARCH PARADIGM

According to Becker, Bryman and Ferguson (2012), a research paradigm is a set of beliefs and precepts that, for scientists in a particular discipline, influence what should be studied, how the research should be conducted, and how the results should be interpreted . Furthermore, as attested by Favaretto et al. (2020:38), the choice of a paradigm implies a near certainty about particular methodologies, pointing to a very important relationship between a paradigm and methodological implications, which permeate the choice of research question(s), participant selection, data collection instruments and collection procedures, as well as data analysis. Therefore, choosing the right paradigm is crucial when conducting research because it points your work in the right direction.

In a study done by Kivunja and Kuyini (2017:30), three research paradigms that are used in educational research were articulated: positivism, interpretivism, and critical theory. Furthermore, Rehman and Alharthi (2016) posit that positivism is usually used in a quantitative study where data can be obtained through questionnaires and experiments, whereas interpretivism is used in a qualitative study where interviews and observations are used to collect data. Thus, I see paradigms as a guide that the researcher can use to ground their research. This study sought to investigate the level of readiness in EGD teachers towards the integration of ICT into teaching and learning using a qualitative approach; hence, this study embraced the interpretivism paradigm. The interpretivist paradigm was necessary for this qualitative study because the aim of the study was to understand the EGD teachers' phenomena of their readiness in integrating ICT in their classrooms through face-to-face interview and classroom observation. As Rehman and Alharthi (2016) alluded, interpretivism research relies mostly on verbal data; hence, this study used semi-structured interviews to exploit the advantages of interpretivism research.

3.4 RESEARCH APPROACH

The research approach is a detailed layout of how a researcher can structure their methods as far as collecting data is concerned. According to Creswell (2014), "research approaches are plans and procedures for research that span the steps from broad assumptions to detailed methods of data collection, analysis, and interpretation".

Furthermore, Creswell (2014) asserted that there are three research methodologies: the qualitative, quantitative, and mixed method approaches. Qualitative research is the process of collecting, analysing, and interpreting non-numerical data, whereas quantitative research has to do with data collected and expressed numerically (Saul 2019). A mixed-methods approach can also use both qualitative and quantitative approaches in the same study. However, this study employed a qualitative research approach. According to Bhandari (2020), qualitative research involves the collection and analysis of non-numerical data. This approach is mainly used because of its ability to gather in-depth insights into a problem. This study investigated the level of readiness of EGD teachers in integrating ICT into teaching and learning, and a qualitative approach was deemed relevant because of its ability to gain greater and more in-depth insight about the issue at hand.

3.5 POPULATION AND SAMPLING

3.5.1 Population

According to Taherdoost (2016), "population" is the set of cases that a researcher would use to draw a sample from. Furthermore, all members who meet a special criterion for a research project are referred to as the "target population" (Alvi 2016). The target population for this study was Grade 10 and 11 teachers from the nine selected schools who were selected for the study. This study was based in the uMgungundlovu District, which has 141 public secondary schools across several circuit management committees (CMC), which range from quintile 1 to quintile 5. This study focused on schools under Umsunduzi CMC, which has 11 secondary schools that offer EGD.

3.5.2 Sampling

Over the years, various definitions of sampling have been given, and they all have one thing in common: taking a certain portion of a population from a larger population. Sampling is a procedure used by a researcher to select a smaller number of people from a larger group of people to serve as subjects for an experiment of observation (Sharma 2017). Sharma asserts that researchers usually use sampling because it is impossible to test every single person in a chosen population. For example, when a chosen population is 1500 and you cannot source data from all 1,500 people, take a

subset of 100. Sharma (2017) further states that even though it is a subset, it represents a larger population, hence they have similar characteristics. In addition, Taherdoost (2016) posits that sampling is a technique used to take a subset of people from a chosen larger population. While taking a subset, it is imperative that it represent the population, and that can be achieved by having similar qualities (Sharma 2017). In the same vein, Alvi (2016) posits that sampling is the process of extracting members from a larger group of members known as a population.

In other words, sampling is the process of selecting individual members or a subset of the population to source data from them and estimate the characteristics of the whole population. Sharma (2017) and Taherdoost (2016) posit that there are two different types of sampling techniques: probability and non-probability sampling, and it is very important for a researcher to decide on a broad sampling technique. From the above assertion, a sampling technique is a very important part of the research and should be chosen wisely. The importance of sampling in research was further echoed by Alvi (2016), who asserts that sampling is paramount in research because it is not possible to assess every single member of the population. Figure 3.1 below shows the various types of sampling techniques that a researcher could use.

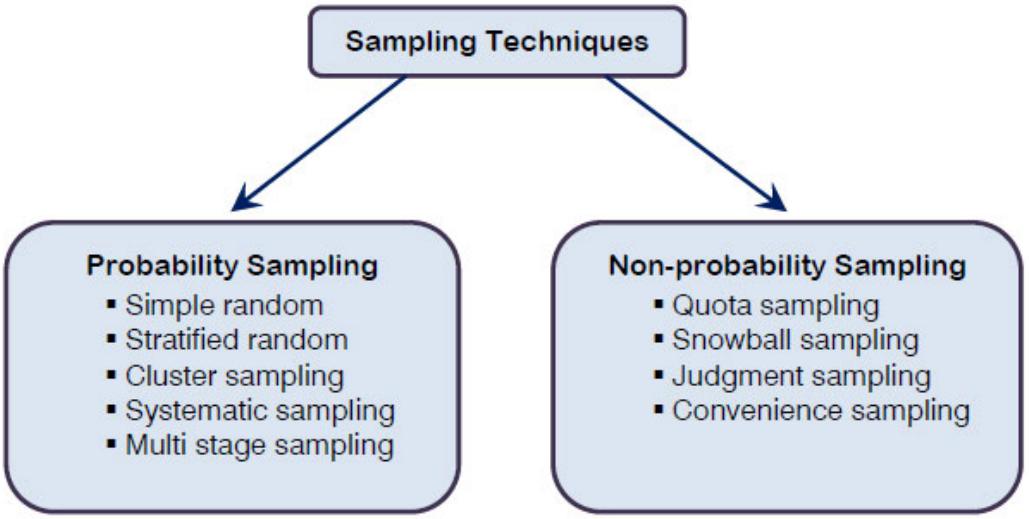

Figure 3.1: Sampling techniques (Taherdoost 2016)

According to Taherdoost (2016), probability sampling means that every individual in the chosen population has an equal chance of being selected for the study. As shown

in Figure 3.1 above, a researcher employing probability sampling can use simple random, stratified random, and cluster sampling, among other probability sampling techniques. A nonprobability sampling, on the other hand, each unit is selected such that the probability of selecting each unit in the population is unknown. Probability sampling is preferred because it has the greatest freedom from bias and saves time. However, in the context of this study, non-probability sampling was employed. According to McCombes (2019), non-probability sampling is when individuals are selected without following a random criterion and not every member of the population has a chance of being selected for the study. As a result, this study used the convenience sampling technique as one of the non-probability sampling methods to select all Grades 10 and 11 EGD teachers that were available as participants.

Out of 11 schools offering EGD as a subject, this study used 9 EGD teachers from 9 different schools who were conveniently sampled. It is worth noting that EGD is a very scarce subject that not every school has; hence, this study used the available EGD teachers as the sample for this study. And that explains why other schools were not selected for the study. Besides, the schools were also chosen because of their accessibility and proximity to the researcher. It is worth noting that the researchers had intended to use all 11 schools in the uMgungundlovu district offering the subject EGD, but only 9 schools responded positively to participating in the study. Hence, only 9 teachers from 9 schools were selected as respondents.

According to Taherdoost (2016), convenience sampling involves selecting participants because they are readily and easily available. This sampling method was used because it is very cheap and helps overcome many limitations that a researcher can stumble upon. In the same vein, the advantages of using convenience sampling are that it consumes the least time and is the most convenient and least expensive (Taherdoost 2016). Convenience sampling was employed because there were no other criteria in place beyond the willingness and availability of respondents. With convenience, you do not struggle to get participants because the nature of this sampling is to take those who are readily available, which makes it easier to use than other sampling techniques. Another reason behind employing convenience sampling is the geographical proximity of EGD teachers, so using convenience narrowed it down to teachers who are close to the researcher, which again saves time and proves to be

more economical (Etikan, Musa and Alkassim 2016). To protect the true identities of teachers and schools, pseudonyms were used. All teachers were referred to as Teacher A from School A and Teacher B from School B.

3.6 INCLUSION AND EXCLUSION CRITERIA

Inclusion and exclusion criteria are crucial components for selecting participants for the study. According to Garg (2016), inclusion and exclusion criteria are used to determine who can be included or excluded from the study sample. Inclusion criteria is a key aspect that a researcher uses to select a target population, while exclusion criteria refer to participants who meet the inclusion criteria but possess some external characteristics that could interfere with the success of the study (Patino and Ferreira 2018). The inclusion criteria for this study included EGD teachers who were teaching in the pre- and post-COVID-19 era. Furthermore, this study only considered EGD teachers from uMgungundlovu District. Exclusion criteria included EGD teachers who were hired after the COVID-19 era, as they would not be able to share their experiences of teaching during the COVID-19 pandemic. Other exclusion criteria involved those teachers who were not able to sign the informed consent form, as signing a consent form is a big part of research ethics that should be observed all the time. In the context of this study, all nine selected teachers were able to sign the consent form.

3.7 DATA COLLECTION

Faloye et al. (2020) allude that there are three commonly used data collection techniques in research, which are: interviews, observations, and questionnaires. A qualitative study normally uses interviews, observations, focus groups, and case studies as methods of collecting data (Bhandari 2020; Bhat 2020). This study used semi-structured interviews and classroom observations to gather data. The aforementioned instruments were used because they were appropriate for the collection of qualitative data, as per the research design. The other reason for using multiple techniques to collect data was triangulation.

3.7.1 Semi-structured interviews

According to Bhat (2020), interviews are the most commonly used method of collecting data in a qualitative study. Bhat (2020), further mentions that interviews are used to gather first-hand information through one-on-one discussion with the participants and invite the opportunity to draw in-depth information from the participants. In the context of this study, interviews were used to gain a deeper insight into the matter at hand through one-on-one sessions with the participants. Semi-structured lessons were used because of their ability to get first-hand information from the teachers. According to Creswell (2007), as cited by Raman and Yamat (2014), semi-structured interviews are preferred because of their ability to elicit insights toward understanding a phenomenon. The interviews were conducted with the aim of responding to the main research question and the sub-research questions, which are RQ 1, RQ 2, and RQ 3. As part of the interview schedule (see Appendix C), the first three questions were dedicated to the teachers' biographies. The biography questions included gender, majors, and teaching experience. The interviews with the nine EGDs took place in their EGD classrooms. The interviews with each teacher lasted about 12-15 minutes. 9 EGD teachers were interviewed, and they were all saying similar things, and that is when the researcher realised that he would no longer get new information, and in research, that stage is called the "data saturation point." A data saturation is a way of estimating a sample size in a qualitative study (Guest, Namey and Chen 2020). Furthermore, data saturation means that there is no additional data from the respondents.

3.7.2 Classroom observation

In a study by Somekh (2011), as cited by Sotsaka (2015), classroom observation involves being present in the classroom and observing what is happening, then interpreting what transpired. This would give a researcher an opportunity to gather some things that he could not get from the interviews. Classroom observations were used to get a sense of the reality of the teaching methods teachers use to infuse ICT into their teaching and learning. The observations were conducted after the interviews as a way of getting the information that a researcher could not get in the interviews. Observation in qualitative research is one of the oldest and most fundamental research approaches, which involves collecting data systematically and in a meaningful way using one's own senses, especially looking and listening. Observations offer a chance

for researchers to directly study behaviour in a natural setting. In addition, Sotsaka (2015) postulates that observations take place in a real-life setting, and researchers are in direct contact with the setting and the people they are observing. The observations responded to RQ 1 and RQ 2 of this study. The classroom observation schedule (see Appendix D) was adapted from the TPACK framework by Koehler and Mishra (2009). The observations were 60 minutes each, as most lessons in uMgungundlovu District are 60 minutes long. The researcher observed nine lessons from nine different schools. The observation schedule was observing against the three components of TPACK, which are TK, TCK, and TPK, as they all speak to the technological aspect of teaching.

3.8 RESEARCH RIGOUR

3.8.1 Validity

Validity, according to Sotsaka (2015), is defined as a tool in a qualitative study that is used to ensure that a research project is carried out as proposed. Sotsaka and Singh-Pillay (2020) further mentioned that validity in research is concerned with the authenticity of the research. "Establishing validity would help your evaluation be more credible and provide you with information that you can stand behind with confidence" (Guion, Diehl and McDonald 2011). The same idea was echoed by McMillan and Schumacher (2010), as cited by Mukhari (2016), that validity refers to the degree of congruence between the explanation of the phenomenon and the realities of the world. Instruments used need to be verified to be trustworthy. The classroom observation schedule was adapted from the TPACK framework by Koehler and Mishra (2009). This schedule has been applied before and used in a published journal, so it is valid and trustworthy. For the interview, the schedule was given to experts in related technology fields to proofread and validate its contents. And the experts deemed the schedule to be valid and trustworthy.

3.8.2 Credibility

According to Solutions (2017), credibility is the first important aspect to be established in research. This is because credibility means that the researcher tries to relate the results to reality in order to prove the validity or truth of the results. To ensure the credibility of the results of this study, the researcher used several methods to generate

data, had members review the interview transcripts, and triangulated the data obtained. The term "triangulation" is unpacked in Section 3.8.3. To increase credibility of this study, the researcher implemented prolonged engagement with the participants; again, the researcher implemented persistence observation of teachers' while teaching EGD; and lastly, after the data was collected and interpreted, the final report was shared with participants for checking of findings and interpretation to allow participants to clarify what their intentions were, correct errors, and offer supplementary information if necessary. According to Solutions (2017), this process of sharing findings with the participants is referred to as "member checking," which is one of the two ways a researcher can use to establish credibility in a qualitative study. Solutions (2017) further asserts that member checking is when the findings of the study are shared with the participants to clarify what their intentions were and correct errors.

3.8.3 Triangulation

To ensure reliability and validity of the collected data, a triangulation method was employed. Triangulation is another important term in research that is used to ensure the reliability, credibility, and trustworthiness of the data collected. The term "data triangulation" refers to the process in research of using different sources to gather data (Guion et al., 2011). In addition, a study that uses two or more methods of data collection is displaying triangulation (Check and Schutt 2011; Punch and Oancea 2014). In the same vein, Cohen (2018), cited by Sotsaka and Singh-Pillay (2020), claims that a study that uses two or more methods to collect data is triangulation. To avoid bias and improve trustworthiness and credibility in this study, data were collected through semi-structured interviews and classroom observations. Triangulation in this study was important to test, verify, compare, and corroborate the research findings obtained through each data collection method.

3.9 DATA ANALYSIS

According to Bhatia (2018), data analysis is the tool used by researchers to move from a mass of collected data to more simplified and meaningful insights. One of the goals of data analysis is to integrate statistical procedures into the collected data.

3.9.1 Semi-structured interviews

For the interviews, English was used as the medium of communication with the EGD teachers. A tape recorder was used for this purpose, and the data was transcribed thereafter. The researcher listened to the transcripts, focusing on each item repeatedly. Data collected through interviews was then subjected to a process called transcription after each interview and typed, showing respondents' quotes as they were responding to the questions asked. The data was then coded, analysed, and discussed thematically. According to Caulfield (2019), creating themes is a way of analysing qualitative data. Caulfield (2019) further mentions that, when creating themes, a researcher examines the data to identify common trends and patterns. Themes were derived from the data obtained to answer the sub-research questions that guided the study, that is, RQ 1, RQ 2, and RQ 3. The presentation and analysis of the data took the form of narratives and detailed descriptions with quotes from the respondents to capture their actual views. Verbatim quotations were used in thematic discussions of interview data to support the results. Semi-structured interviews were used because of their ability to get first-hand information from the teachers. According to Creswell (2014), semi-structured interviews are preferred because of their ability to elicit insights toward understanding a phenomenon. Caulfield (2019) indicated that if a researcher has decided on using a thematic analysis, they should follow the six steps developed by Braun and Clarke (2006).

Step 1: Data familiarisation

The first step is to get to know your data. Once the data has been collected, you need to get an overview of the data. This involves transcribing audio data by listening over and over so that the data can be understood (Braun and Clarke 2006). In the context of this study, the researcher listened to the recordings repeatedly until he was familiar with the data. This was done to ensure that the researcher was familiar with the raw data from the interviewees.

Step 2: Coding

This second step is called "coding." A researcher goes through the transcript repeatedly to identify codes. According to Braun and Clarke (2006), identifying codes is done by coming up with shorthand labels, or "codes," to describe their content. The

researcher started to read the data in detail to identify preliminary codes, which are the features that seem to be meaningful. Codes that emerged were noted down.

Step 3: Generating themes

This step comes after codes have been identified. From the codes created, recognise patterns among them, and begin to develop themes. Themes are generally more comprehensive than codes. Most often, you will combine several codes into a single theme (Braun and Clarke 2006). The researcher looked at the responses after transcription and came up with patterns that emerged from the responses. Those patterns are referred to as themes.

Step 4: Reviewing themes

After themes have been identified, the next step is to review the themes. The next step is to ensure that themes are useful and accurate and that they are a true representation of the data. Return to the data set and compare our themes against it. According to Braun and Clarke (2006), researchers should ask themselves these questions. Is there something missing? Are these topics really present in the data? What can be changed to make the themes work better? The researcher went back and reread the transcription to check if the themes really emerged from those transcriptions.

Step 5: Defining and naming themes

Now that the list of topics has been determined, the next step is to name and define each topic. Defining the themes is about articulating exactly what is meant by each theme and figuring out how they help us understand the data (Braun and Clarke 2006). The researcher provided the themes' names and clear working definitions that captured the core of each theme in a brief and effective manner.

Step 6: Writing up

According to Braun and Clarke (2006), the final step is writing up this step is where the researcher transforms the analysis into an interpretable text by using rich and convincing examples that relate to the themes. Analysis and findings are deliberated in the next chapter of this study.

3.9.2 Classroom observation

For the classroom observations, field notes were made and reported descriptively. The observation data was then analysed according to the observation schedule. The observation schedule, containing the criteria that the researcher used to obtain information and the analysis thereof, was done in sequence as per the observation schedule. Classroom observations were administered for the purpose of responding to RQ 1 and RQ 2.

3.10 ETHICAL CONSIDERATIONS

Ethics in research plays an important role in ensuring a smooth data collection process and protecting participant privacy. In this study, ethical approval was obtained from the Durban University of Technology (DUT) Ethics Committee. Approval to conduct a study in schools in uMgungundlovu district (Msunduzi CMC) was obtained from the DoE. The gatekeeper letter requested by the DoE stated that teaching and learning should not be disrupted in any way during data collection. As a result, teaching and learning were not disrupted during the interviews, as teachers were interviewed during their free periods in their EGD labs. The observations took place during class, but there was no interaction with the teachers or learners as the researcher conducted a non-participant observation. The researcher was assigned a place in the back of the room to sit and observe without making any comments. The principals of all selected schools were asked in writing for permission to use their schools as the study site. To ensure the integrity of the study, the researcher sent consent forms to respondents ensuring that participation in the study was voluntary and that if respondents felt uncomfortable during the study, they could stop the study at any time without negative consequences.

3.11 CONCLUSION

This chapter deals with the empirical investigations and research methodology used in this study. In addition, the chapter expanded more on the identified population and the sampling methods used in the study. The methods and procedures, namely, semi-structured interviews and classroom observation instruments, used in the data collection for the study were also clarified in this chapter. This chapter further explained

the presentation and the analysis of the data. The findings of the study are presented, interpreted, and discussed in the next chapter.

CHAPTER 4: DATA PRESENTATIONS, INTERPRETATION AND DISCUSSIONS OF THE RESULTS

4.1 INTRODUCTION

The previous chapter focused on the methodology used in the study. The methods and procedures used to collect and present the data collected were also discussed. The previous chapter also determined the population of the study and discussed the sampling technique used in this regard.

Therefore, this chapter presents the results of the study as well as the discussions on the results of the study. It must be reiterated that the main objective of this study was to determine the level of readiness for the integration of ICT in teaching and learning by EGD teachers of grades 10-11 in 11 selected schools in uMgungundlovu district. However, the researcher was only able to reach nine schools as the other two schools did not respond to the invitation to participate in the study. To achieve this goal, interviews and classroom observations were conducted with the teachers. All 9 EGD teachers were interviewed and observed to obtain their responses to the central research question: What is the state of readiness of EGD teachers for integrating ICT into teaching and learning in uMgungundlovu secondary schools?

As explained in Chapter 1, this study focuses on investigating EGD teachers' readiness for integrating ICT into teaching and learning and developing possible means by which EGD teachers can integrate ICT into their teaching and learning. To achieve this goal, the following main research questions were asked:

1. What are the challenges faced by EGD teachers in the adoption of ICT in EGD classrooms?
2. What are teachers' technological knowledge towards the use of technologies in teaching and learning of the subject?
3. What are different ways that EGD teachers can use to infuse ICT into teaching and learning?

4.2 PARTICIPANTS' BIOGRAPHY

The study included nine participants. Table 4.1 below shows the summary of the teachers' biographies from the nine schools.

Table 4.1: Participants Biography

Name of Teachers	Gender	Majors	Teaching Experience
Teacher A	Male	EGD and Motor Mechanics	18 years
Teacher B	Female	EGD and Technology	11 years
Teacher C	Female	EGD and Mechanical Technology	9 years
Teacher D	Male	EGD and Technology	14 years
Teacher E	Female	Technical Drawing and Woodworking	25 years
Teacher F	Female	Technical Drawing, Mathematics and Woodworking	20 years
Teacher G	Male	EGD and Mechanical Technology	4 years
Teacher H	Male	EGD	19 years
Teacher I	Female	Technical Drawing and Civil Technology	25 years

The table above shows all the teachers who took part in the study. These teachers are professionally trained to teach EGD, as they are all in possession of EGD as a major subject in their qualifications, which means they are sufficiently qualified to teach EGD. In terms of age, there is a mix of teachers who were born before technology and those who were born after technology, who are referred to as "digital natives." In terms of gender, females dominate slightly with 56% of the sample and males constituting only 44% of the sample size. This will be interesting to see, as a study by Gebhardt et al. (2019) revealed that female teachers are less inclined to infuse technology as opposed to male teachers. To protect the true identity of the teachers and their schools, pseudonyms were used. All teachers were referred to as Teacher A of School A and Teacher B of School B.

4.3 FINDINGS

4.3.1 Presentation of data from the interviews

The use of open-ended, semi-structured interviews allowed the interviewees an opportunity to speak freely, allowing for a dialogue with the researcher rather than a straightforward question and answer session. The results of the interviews were transcribed to obtain the themes or patterns of all the results about what the teachers said. The interviews with the nine EGDs took place in their EGD classrooms. The interview questions used were aimed at answering the main question: What is the state of readiness of EGD teachers for integrating ICT into teaching and learning in uMgungundlovu secondary schools? And the sub-research questions are as follows:

RQ1: What are the challenges faced by EGD teachers in the adoption of ICT in EGD classrooms?

RQ2: What are the EGD teachers' technological knowledge in teaching and learning?

RQ3: What are different ways that EGD teachers can use to infuse ICT into teaching and learning?

Themes were then created from the teachers' responses for better discussion. Below are the responses of the participants based on the posed question.

The first question that was posed was about the EGD teachers' background in being exposed to ICT during their university time. Below is how they responded:

Teacher A said:

> "*While I was still in university, we were taught about how to integrate technology when teaching EGD we were mainly taught in using CAD and PowerPoint to teach EGD."*

Teacher I from School I had this to say:

> "*Yes, we did Auto AutoCAD which was taught mainly on our final year of study even during the course of other years we had AutoCAD classes."*

Teacher C said this when asked:

"*We did. We had a module called life skills where they taught on how to use Excel, PowerPoint and how to generate a report. It was more structured on the report side and marks entering not on the teacher's side of it. We also did AliCAD until they phased it out to AutoCAD."*

In the same vein, Teacher D said the following:

"*There wasn't much of Technology it was more of the standard media that we use, the chalkboard, the whiteboard. I do not remember myself seeing anything other than that. There was AliCAD, which we were using during our last year. We were introduced to AliCAD. For personal use not to use in class. It was for personal use just in case you wanted to create a question."*

Teacher E replied and said:

"*During that time there was only an overhead projector. That was the only technology that we used in our undergraduate studies."*

Teacher H had the following to say:

"*Technology back then was not as sophisticated as it is these days. Mainly it was just the use of the overhead projector. And the use of AutoCAD those were the only technology things we can talk of back then."*

From the above responses, only one theme emerged. Theme: Teachers were or were not exposed to technology at the university level.

4.3.1.1 THEME 1: Teachers were not exposed to technology at university level

Many researchers have found that teachers ICT background from university does influence the willingness of infusing ICT when they turn professional. Put simply, it means that if teachers were taught how to use ICT in the classroom while they were trained it has a greatest effect when they turn professional. This assertion is corroborated by Quaye et al. (2015), who postulate that "there is a positively high impact of ICT on teaching and learning in tertiary institutions in the sense that, broadband is a major factor in increasing collaboration between teachers". Based on the above statements it shows that they did get the background of ICT in university.

This means that changes of infusing ICT into their teaching and learning are great. The literature in chapter 2 by Quaye et al. (2015), indicated that being exposed to ICT in higher institutions of education does influence using it when they turn professional. In the same vein the literature in chapter 2 by Matongo (2022), revealed that teachers are not integrating ICT because of not being trained in colleges where they did their teaching qualifications.

The second question was about whether or not schools have the resources they need to integrate ICT. Below is how they responded:

Teacher I from School I said:

> "*We have a centre, an EGD centre which has 20 computers. We also have a printer there, a projector, a white board, and we also have an interactive board that also assists us in teaching EGD. There are also have laptops which the school provided for the EGD and Technical department. They are just for EGD, they are installed with AutoCAD. It's for EGD only not other subjects. We do have other labs for other subjects. But that one is just strictly for EGD.*"

Teacher H said the following when asked:

> "*Now that technology is evolving very fast, there are several ways of doing it. You can project on the whiteboard using a projector overhead using a computer you show them demonstrations on the board from different websites it is possible. With the nature of EGD, it's a subject that is practical it needs constant interaction with the learners you cannot rely too much on the gadgets. They need to see you on the board with the similar instruments. Technologies that are available here at school are computers, projector, and whiteboard. I generate worksheets using a computer using a software called AutoCAD."*

In a same vein, Teacher A from School A said:

> "*Since EGD is a practical, so we do lots of copies we do not have many technologies we only use the chalkboard instruments as well as the worksheets. So, I generate worksheets for the learners. I use a photocopier to generate*

worksheets. We also have access to computers and internet if we want to research."

Similarly, Teacher C said:

"*We have internet, computers, and overhead projectors. And few models. We have machines to print and make copies."*

Same assertion was echoed by Teacher G:

"Yeah, there is a photocopying machine for A3 and A4 they assist us to teach and learn. There's also a school computer and a school laptop."

In the same vein, Teacher E said:

"*We have an overhead projector; we also got a computer lab. That's all."*

This is how Teacher B from School B responded when asked about the resources that are available:

"*We only have a laptop."*

Teacher D continued and said:

"*We do have access to AutoCAD*. *We also have projectors and laptops."*

From the above responses, only one theme emerged. Theme: Schools have resources available to infuse ICT.

4.3.1.2 THEME 2: Schools have basic resources available

The researcher wanted to identify the availability of resources in schools for the purpose of ICT integration in EGD teaching. It is no secret that teachers who want to successfully integrate ICT into teaching and learning must have the appropriate resources. Based on the above statements, it is a clear indication that teachers in schools have some technologies at their disposal. They have access to the basic technologies that are sufficient to kick-start the infusion of ICT into the teaching and learning of EGD. However, based on the literature presented in Chapter 2, this is contrary to the findings of this study. According to Mathevula and Uwizeyimana (2014),

a lack of resources in schools has been proven to be a hindrance to the success of ICT integration. This was further asserted by Alharbi (2021), who revealed that a lack of ICT resources has been found to be inadequate in schools, which makes it hard to infuse ICT effectively.

Another question posed was about teachers' level of competency in using the technologies that are available at their schools. Below is how they responded to the question:

This is how Teacher I from School I responded:

> *"Projector: I can give myself an 8 because I use it almost every day. The interactive board: I can give myself a 7, we do not use it mainly because that one is not just for me or EGD. It's for the whole school. The white board: it's ours. I can give myself a 9 or an 8. Not 10."*

Teacher A said:

> *"For the photocopier I'd say maybe 9 out of 10 because I can google something, make copies than change A4 to A3 because we normally use A3 paper in EGD. We do have computers and I'd say 9 out of 10."*

Furthermore, Teacher H said:

> *"In terms of rating, using AutoCAD to draw or prepare worksheets, I'm comfortable. I can do almost everything. So, I can say I'm good with operating these technologies and with AutoCAD I'm home and dry."*

When Teacher E was asked about her level of competency in using technologies, she said:

> *"With the use of a projector I will say 50%, with the computer 80%, printer and photocopying machine that is 9 out 10."*

The same sentiment was shared by teacher F.

> *"I will say 5 out of 10 for a projector, 10 for a whiteboard, 8 for a laptop and 10 for a photocopier."*

Teacher B from School B said this when asked about her competency levels in using technologies:

> *"I would say 6 out of 10. Printing you do not need much work you just click print. Maybe its 6 or 7 because I do not know how to change toners and cartridge there are people who work with that and change them. I will stick to 7."*

Teacher C had the following to say:

> *"A computer I'm quite good, very good but I normally use it for the lower grades (Technology) not EGD. For the photocopying machine it's a 10."*

Teacher D from School D had the following to say about his level of competency in using technology:

> *"For the computer I will give myself a 7 out of 10 in terms of creating a question. For a printer that would be 10, A photocopier 10, a projector 10. I am good with the Whiteboard I do have the whiteboard in fact in class we've got the whiteboard and a chalkboard."*

From the above responses, one theme emerged. Theme: Teachers know how to use ICT resources.

4.3.1.3 THEME 3: Teachers know how to use ICT resources

When teachers were asked about their competence in using the technologies available at their school, the majority of teachers demonstrated a high level of competenceThese assertions show that EGD teachers are all good or well-equipped at using the technologies that are available to them. If they had all the required technologies, surely, they would have utilised them effectively and efficiently in the process of teaching and learning. But from the above statements, it shows that they know how to use the ICT resources that are at their disposal. A study that examines the level of ICT skills in teachers, conducted by Alazam et al. (2013), revealed that teachers' levels of using ICT were moderate. which is contrary to the findings from the statements of the teachers above. Furthermore, Alazam et al. (2013) postulate that ICT integration can prove to be a very crucial tool if technologies are used wisely by teachers. This is

exactly what was demonstrated by the teachers when asked about their level of competency.

Another question posed was about the teachers' view of using technology in the teaching and learning of EGD. Below is how they responded:

Teacher B from School B stated that:

> "*It is necessary. In fact, we all need to use technology when teaching EGD because there are a lot of things like graphics and drawings which learners must be able to see. I think the use of technology is very important.*"

When asked for her view about the integration of technology into teaching and learning, Teacher I from School I had this to say:

> *"Teaching needs technology, without technology teaching is impaired, because technology moves with time, so if we are training or raising a generation that must be competitive globally, they need ICT they need technology we just cannot divorce the two (technology and education)".*

In a similar vein, teacher H from School H had this to say:

> *"One thing for sure you cannot run away from is technology because the world is evolving fast in terms of technology*. *And we are moving far away from the traditional way of doing things. Things have evolved so we also need to adapt to change. So, I like to believe, and I believe that technology needs to be incorporated in learning and teaching processes because without it you would not survive. Technology is an integral part of teaching and learning."*

Teacher E had the following to say:

> *"I think it is very important to use technology in teaching so that even leaners when they are exposed to new technologies in tertiary education they would not be disadvantaged. Technology also enhances teaching; learners understand better if teachers use technology."*

Teacher C when asked, she gave similar answers as the other teachers:

"I think it is something we as educators need to educate ourselves more on because these kids carry smartphones most of the times. In terms of that I think it is really something that we need to educate ourselves especially as the world is moving to the fourth industrial revolution. Everything is on the internet, so it is great idea to use technology in teaching and learning".

In a similar vein, Teacher G had the following to say:

"It is important to use technology in this case of Engineering Graphics and Design because you cannot draw an assembly using a chalkboard. You need to project it."

Teacher A also echoed the same sentiment:

"Yeah, it is important to use technology when teaching more especially when teaching EGD."

Teacher D, when asked, said:

"It is a good idea to infuse technology. Just that our Department of Education maybe they are out of funds because they have to fund every school because in order to infuse ICT, we need to have computer labs in every school."

From the above responses, one theme emerged. Theme: Technology is very essential in the teaching and learning of EGD.

4.3.1.4 THEME 4: Technology is very essential in teaching and learning of EGD

All teachers responded positively to the idea of using technology when teaching. They are all of the same view that technology is important and should be incorporated into teaching and learning. They highlighted that teaching and technology can never be divorced; others said technology changes with time, so this should also be the case in teaching and learning. This is an indication that EGD teachers do understand the importance of incorporating technology into EGD lessons. They claim that introducing technology doesn't only enhance the process of teaching and learning but also assists learners in preparing them for the life that lies ahead. These assertions are further confirmed by Erişti et al. (2012), who reported that teachers are willing to infuse

technology into their lessons. Erişti et al. (2012) further mentioned that teachers saw the integration of technology into teaching and learning as a good thing, so they reacted willingly. In addition to that, Mustafina (2016) reported that teachers had a positive attitude toward integrating ICT into teaching and learning.

Another question that was posed was about the challenges teachers experienced when using technology. Below is how they responded:

Teacher B responded like this:

> *"It's important and I cannot say I have a challenge in using them, it's just that I do not have the correct equipment for example a projector. Here in school, we do not have a projector, I have to buy it and a projector is very expensive".*

In addition to what is said above, Teacher F had the following to say:

> *"As I have been saying in our school, we have got lot of subjects that are being offered so sometimes if I prepare a lesson and I wish to use a particular type of technology and the other teacher wants to use it as well. In this school, it is a big school but there are only two projectors for the whole school. Only a photocopier that I have access to anytime."*

Teacher G, when asked, said:

> *"The computer that we have here at school doesn't have AutoCAD. We do not have smartboards; we do not have a whiteboard we only have a chalkboard."*

Teacher F said:

> *"The laptop I use is mine. I use my own because here in school there were break ins and the laptops that were provided by DoE were stolen."*
>
> "*The main challenge. The thing that poses as a challenge is the electricity, when you find that there is load shedding, so your lesson is ruined because you cannot use things such as the generator because everyone is using the same school so the generator will make noise. But if the school had funds, we would use solar panels to provide for electricity so that our lessons would not be impaired. We do have material but without electricity we cannot use them."*

Teacher A said:

> "*The challenge we have in this school is that we do not have a computer lab where we can use AutoCAD and learners can also AutoCAD for PAT purposes".*

Teacher G had the following to say:

> *"In terms of AutoCAD, it is still a challenge because we know how to use AutoCAD, but you cannot put it in any computer. The computer that we have here at school does not support AutoCAD."*

Similarity, Teacher E said:

> *"With AutoCAD it is still a challenge for me. I need the be trained because I do not know how to draw using a computer, so it is a big challenge for me."*

In a same vein, Teacher D said:

> "*We do have a computer lab, the only thing we do not have is a license for the AutoCAD."*

From the above responses, only one theme emerged. Theme: Lack of availability of ICT resources in schools.

4.3.1.5 THEME 5: Lack of availability of ICT resources in schools

Several teachers indicated that the challenge they are most facing is the lack of availability of ICT resources in schools. They claim that they understand the importance of infusing technology, but they do not have the resources to use for the purpose of teaching and learning. This sentiment is shared by Munje and Jita (2020), as the findings of their study revealed that schools do not have adequate resources to infuse ICT. This was further echoed by Ghavifekr, Kunjappan, Ramasamy and Anthony (2016), who said that the greatest challenge in schools is the insufficient provision of computer resources, which prevents the integration of technology in the classroom. According to Alharbi (2021), there are a host of challenges that teachers come across every day when trying to infuse ICT into teaching and learning. One of those challenges is the lack of provision for educational software. On the contrary, some teachers mentioned that the department did provide the school with resources,

but there were other challenges that proved to hinder them. This is echoed by one of the participants in the Munje and Jita (2020) study, who said, *"The DBE had provided the school with computers, but due to theft, these were no longer available."* This is an indication that DBE is making provisions so that teachers can infuse ICT into teaching and learning. Teachers and learners encountered many challenges when trying to utilise video as a tool to infuse ICT. According to Li and Lalani (2020), those challenges included but were not limited to slow internet connections and electricity outages, to mention a few. These statements from the teachers are indicating that in schools there is a lack of availability of resources.

Another question posed was about the different ways teachers were using to conduct lessons during the COVID-19 lockdown. Below is how they responded:

Teacher I said:

> *"We used WhatsApp, we created a WhatsApp group. So, I communicate with them via WhatsApp. We have been using it before COVID-19, so when COVID-19 came it gave us more time to communicate using technology. I recorded the lessons and sent them on WhatsApp".*

In addition to what is indicated above, Teacher H from School H said:

> "*We tried to give them work over WhatsApp where you can just send videos or pictures so that they can see what you are trying to teach them.*"

Teacher B from School B also confirmed that WhatsApp was the only way she used to conduct classes during lockdown:

> "*I created a WhatsApp group and I was sending information like maybe this week can you read your books from this page to that page and try to do those activities that are there. I remember isometric drawing in grade 12 2020 I asked them to draw it and take a picture and send it back to me.*"

Teacher G said the following after he had been asked how he was conducting classes during lockdown:

> "*We used video calls through WhatsApp and I also recorded myself and send it to them".*

Similarly, teacher A from School A said:

> "*With the Grade 12's we had a WhatsApp group that we used. WhatsApp group assisted us especially with the PAT, as it had to be done at home because learners weren't allowed to come to school so that how we managed to have some lessons. Only WhatsApp."*

Teacher F said this when asked about conducting classes during the COVID-19 lockdown:

> "*There was no communication except using WhatsApp.*"

The same sentiment was echoed by Teacher F:

> "*We used WhatsApp. It was basically voice recordings on WhatsApp*".

Teacher G said:

> "*We used video calls through WhatsApp and then I also recorded myself and send it to the children but the problem with that, was that some children did not have smartphones*".

Similarity, Teacher E from School E said:

> "*I did not conduct any classes because leaners did not have cell phones and others did not have data. In a class of 40 leaners maybe two leaners had cellphones and they did not have data so we could not do anything*"

The same sentiment was echoed by Teacher F:

> "*There was no communication except using WhatsApp and other did not have phones".*

Teacher I had the following to say:

"*For learners that had problems with data I requested them that they must use their parent's phones so that they can access, or they can go to one place as a group in one home that had access to WIFI so that they can all get the lesson".*

From the above responses, only two themes emerged. Theme 1: Classes were conducted through WhatsApp. Theme 2: No classes were conducted during COVID-19 lockdown.

4.3.1.6 THEME 6: Classes were conducted through WhatsApp

In terms of conducting classes during the COVID-19 lockdown, most teachers indicated that they relied heavily on using WhatsApp to ensure that the process of teaching and learning was kept alive. Reliance on WhatsApp during the COVID-19 lockdown was mentioned by EGD teachers. This is an indication that EGD teachers did conduct classes during the lockdown, and they did that through social platforms such as WhatsApp. And it proved useful in ensuring that the process of teaching and learning was continued even in times of trying in the educational sector as physical classes were suspended. WhatsApp proved to be a crucial tool in conducting classes. This is backed up by Alenazi (2018), who reported that integrating WhatsApp into education produced desired learning and social benefits. The same sentiment was echoed by Asmara (2020), who said WhatsApp is a tool that was used by teachers to support the process of teaching and learning during the COVID-19 pandemic. However, not all teachers had the luxury of using WhatsApp, as others encountered problems in trying to use WhatsApp as a tool to keep classes alive during COVID-19 lockdown. The majority of teachers indicated that they did conduct classes during the COVID-19 lockdown, and they did that through WhatsApp.

4.3.1.7 THEME 7: No classes were conducted during COVID-19 lockdown

This shows that as much as most teachers managed to successfully conduct classes through WhatsApp, the same cannot be said for other teachers, as they encountered challenges when trying to use WhatsApp. The challenges of using WhatsApp for educational purposes are common. In support of this notion, Gon and Rawekar (2017) posit that there were many challenges that arose from using WhatsApp in teaching and learning. Asmara (2020) further mentioned that learners experienced problems such as not having a good internet connection and supported headphones. Those

challenges include the availability of smartphones, being inundated with messages, not having a data or internet connection, and constantly focusing on the phone screen, which causes eye muscle fatigue. Challenges associated with VL were further mentioned by Li and Lalani (2020), who cited that slow internet connections, electricity outages, and not having phones or laptops were considered challenges by teachers and learners.

Another question posed was about the influence COVID-19 has had on the way they are conducting class or if they are still teaching the same way they did before COVID-19. Below is how they responded:

Teacher A from School A said the following when asked about the influence COVID-19 had:

> "*I would say after COVID-19 everything changed. It is no longer like before. As of now we are still using that WhatsApp we created during lockdown. COVID-19 did influence the way I'm teaching now."*

Teacher B had the following to say:

> "*Yes. It influenced a lot because there were learners who were doing grade 11 grade 10 in 2020, they were affected by COVID-19 and there were so many things they did not do, so many chapters they did not do. So, we are now trying to cover all the gaps in a short period of time".*

In a same vein, Teacher G said:

> "*Yeah, COVID-19 changed the way we teach, because we saw that WhatsApp can make things easier for children when they are at home. So, we continued to use video calls and voice recordings even after school hours. COVID-19 did influence the way I'm teaching now."*

Teacher I said:

> "*I think COVID-19 opened the window of using technology and the importance of knowing more and of learning more using technology. Before COVID-19 we thought that everything was ok the absence of classes and the absence of*

learners made us to realise that we need to use something. A tool that which we can use to convey information to learners and continue with teaching and learning. So, it did, it was like an eye opener. It taught us that we are in a technological world."

Similarly, Teacher H said the following:

"*Changes are there. We had to think of ways of preparing worksheets way in advance for the entire year in a form of a booklet. We are now proactive we prepare work way in advance so that whatever happens they have something. It opened our eyes that we need to prepare worksheets in advance. Yes, it did we are proactive now."*

Teacher D, in answering the question that was asked, said:

"*The only challenge is time because some chapters were not done, and we are now trying to fill those gaps. COVID-19 did change the way we are teaching now."*

From the above responses, only one theme emerged. Theme: COVID-19 has changed the way teachers are teaching now.

4.3.1.8 THEME 8: COVID-19 changed the way teachers are teaching now

With the above assertions from the teachers, it shows that COVID-19 really changed how things are done. The changes brought by COVID-19 to the educational system were echoed by Van der Spoel et al. (2020), who posit that COVID-19 compelled teachers to transform their teaching methods from traditional to online lessons. Furthermore, according to Khoza (2021), the effect COVID-19 had on our educational system compelled the MEC of education to introduce what is called the "paperless classroom" to ensure that technology was integrated into teaching and learning. This was seen as a major measure being put in place to counter changes that were enforced upon us by the COVID-19 pandemic. In a nutshell, COVID-19 did influence the way teachers are teaching now.

The last question posed was about the ways teachers think technologically disadvantaged teachers can be assisted. Below is how they responded:

Teacher A said:

> *"Like in rural schools, I think the Department needs to step up because the school on its own cannot manage. So, it is through the Department of Education if they know that the certain school offers that subject, they need to step up and assist".*

Teacher B responded like this when asked about the way technologically disadvantaged teachers can be assisted:

> *"I think there must be workshops. They must be taught on how to use computers. Like be taught how to create worksheets, how to project them. The Department of Education and the subject advisors must assist teachers through workshops on how to infuse technology into teaching".*

On the same regard, Teacher C said:

> *"The Department of Education could assist in terms conducting workshops to get the teachers to be taught on how to use these technologies."*

Teacher D, Teacher E and Teacher F all shared the same sentiment on how technologically disadvantaged teachers can be assisted, stating respectively:

> *"I think to help those teachers there's only one way. The Department of Education needs to run workshops maybe during the holidays they can have them for four days and that is the only way they can help those teachers."*

> *"I think the Department of Education can assist them by providing workshops that is meant to equip them with ICT skills so that they can be on the same level as other teachers"*

> *"I think workshops, if the Department of Education can create workshops and develop teachers because at the end the day, they must use technology".*

The same sentiment was shared by Teachers G, H, and I. And they made the following statements:

"*Department of Education can use workshops. And those workshops should be conducted on weekends so that they will not disturb the process of teaching and learning*" (Teacher G)

"*I think people need to embrace technology. It must be an initiation that must be kick started by the Department of Education. The Department of Education must kick start the whole process of making sure that all educators are technologically equipped beside equipping the teachers' schools themselves must be well equipped to embrace technology. So, the must be a programme where the Department of Education must spear head so that teachers can go there may be over some few days over the holidays so that they can learn how to use technology.*" (Teacher H)

"*Things that assist like programmes. They can take classes or attend workshops. Department of Education does conduct workshops, like this year we were offered with a CAD workshop early this year. We will also be attending another workshop before the end of September. Such workshops are free they are offered by the Department of Education just for EGD. These workshops are mainly for CAD, they are sharpening our skills since CAD is always changing so we always need to be sharpened.*" (Teacher I)

From the above assertions, only one theme emerged. Theme: The DoE should conduct workshops.

4.3.1.9 THEME 9: Department of Education should conduct workshops

This theme looks at the importance of workshops in helping teachers acquire ICT skills. According to the teachers' responses, all 9 teachers agree about how technologically disadvantaged teachers can be assisted. All the teachers are saying the DoE should take the initiative in training EGD teachers so that they would be in a better position to infuse ICT into teaching and learning. They all believe that training teachers for ICT through workshops can be very helpful, as illustrated by their responses above. All the above responses from the teachers share the same sentiment about the importance of workshops to equip teachers. The sentiments expressed by these teachers echo Msila's (2015) argument that the district should train teachers so that they would be ICT efficient. This view is further attested to by Barbour's (2014) emphasis that

teachers use teacher development programmes to receive proper training so that they can infuse ICT. Further emphasis is being put forward by Tasir et al. (2012), who posit that there's an increase in the number of countries that are now undertaking the programme of skill development for teachers in ICT integration. Through all the questions that were posed and responses that were given by the teachers, it is clear that EGD teachers from uMgungundlovu district are ready to infuse ICT into teaching and learning, but there are a few challenges that pose a thread, but they are ready.

In addition to interviews, the researcher also did something called non-participant observation, which is discussed in the next section.

4.3.2 Presentation of data from the classroom observation

The classroom observations were done with nine EGD teachers in the uMgungundlovu District. All the observations were done in the teachers' classrooms, and they lasted for an hour, as most periods here in the uMgungundlovu district have a duration of an hour. The researcher arranged the classroom observations with the intention of discovering teachers' technological knowledge and observing the challenges they face when infusing ICT into their lessons. Observations were chosen because they give a researcher a chance to directly study behaviour in a natural setting. The purpose of these observations was to respond to the main research question: What is the state of EGD teachers' readiness for the integration of ICT in teaching and learning in uMgungundlovu District secondary schools? Secondly, observations also assisted in responding to the sub-research questions, which are RQ 1 and RQ 2, which are:

RQ1: What are the challenges faced by EGD teachers in the adoption of ICT in EGD classrooms?

RQ2: What are the EGD teachers' technological knowledge in teaching and learning?

The observation schedule (see APPENDIX D) was adapted from the TPACK framework by Koehler and Mishra (2009). Observations were done against the three components of TPACK, which are TK, TCK, and TPK, with an aim to observe teachers' technological knowledge in using technologies while they were teaching EGD. These three components are discussed below together because they are interrelated. If someone's TK is weak, the entire TPACK collapses, as these other two concepts, TCK

and TPK, can only be strong if TK is strong. They basically depend on TK; as a result, a researcher discussed them together below.

4.3.2.1 Observations based on TK, TCK and TPK

Technological knowledge refers to the knowledge of various technologies, ranging from low-tech technologies such as pencil and paper to digital technologies such as the Internet of Things, digital video, interactive whiteboards, and software programs, robotics, artificial intelligence, and big data (Koehler and Mishra 2009). In this regard, we are observing the knowledgeable part of using technologies. Technological Content Knowledge looks at the relationship between technology and content knowledge about the subject matter (Kurt 2018). TCK also looks at how technology and content influence each other. Teachers need to understand which technologies are best suited for addressing subject matter (Koehler and Mishra 2009).

Technological pedagogical knowledge refers to the knowledge of how various technologies can be used in teaching and to the understanding that using technology may change the way teachers teach (Koehler and Mishra 2009).

Below are the observations from different teachers with respect to the components of TPACK, which are TK, TCK, and TPK.

Teacher A on TK: Component TK was observed through the usage of whiteboard and the computer, and he taught using the whiteboard very well. The researcher observed that teacher A was very much knowledgeable in using certain technologies that were at his disposal. He did not exhibit any kind of struggles when using the likes of whiteboard, a computer to prepare worksheets and printing them out. The researcher does also believe that the teacher A is also knowledgeable when it comes to using a printer and the prepared worksheets needed to be printed out from the computer. The researcher can conclude that teacher A displayed a high level of TK in using technologies that were at his disposal.

Teacher A on TCK: Teacher A exhibited a high level of understanding as far as choosing relevant technologies for the lesson he was conducting. He chose to use a whiteboard instead of a chalkboard, which was his choice of relevant technology for a certain lesson. The researcher presumes that teacher A also used AutoCAD to prepare

the worksheets that were used as classwork by the learners. So far as the TCK is concerned, teacher A exhibited a high level of it.

Teacher A on TPK: Teacher A drew a sketch on the white board using the set squares and a marker. The sketch was done to clarify the hatching. While drawing, he demonstrated a high level of accuracy and competency in using a whiteboard and the set squares. After that, learners proceeded to draw while he moved around the class, assisting those who were struggling a bit. He went to his desk, opened his computer, and called out some learners who had outstanding marks on his marksheet on the computer, and this showed the level of understanding in as far as a computer is used. The class progressed without any disruptions. After 60 minutes, the bell rang, and the class was dismissed. With the task being given to go and complete at home as they could not finish it in class,

Teacher C on TK: The researcher observed that in teacher C's classroom there was a projector hanging on the ceiling and a whiteboard as well. Teachers C demonstrated a high level of understanding of these two technologies that were at their disposal. Both of these technologies were used in conjunction with the computer. No sign of struggle whatsoever was shown by teacher A. Teacher A showed a clear understanding and was knowledgeable about using the above-mentioned technologies. As a result, the researcher believes that teacher C's TK was strong.

Teacher C on TCK: The researcher observed that all the technologies that were used by teacher C were relevant to teaching the content of the day. It is also worth mentioning that in teacher C's class there was no chalkboard, only two white boards that were used for drawing and as a background for the projector. Teacher C was teaching interpenetration, so at some point during the lesson, teacher A projected a video explaining how the interpenetration occurs, which assisted learners in visualising the drawing much better. And also, the fold lines and turning points were clearly articulated in the video that was projected by teacher C. The worksheets given to learners were prepared prior using AutoCAD, which showed that teacher C's choice of choosing technologies relevant to the content being taught is exceptional. Based on the observation, the researcher believes that teacher C's TCK was exceptional as long as the technologies used assisted the learners in understanding the topic better.

Teacher C's TPK: With teacher C’s TCK being strong, it meant that his TPK would be strong as well, as the researcher observed that teacher C merged technologies well with the content being taught to the learners. The video that was projected using a projector was very important for the learners in understanding some abstract concepts related to the interpenetration, and after the video, you could see that they had a better understanding of fold lines and turning points. Teacher C was observed pausing the video from time to time to further emphasise some points from the video. All of this can be done by someone who understands technology well enough to successfully integrate it into the lesson. Teacher C demonstrated on the white board using the set squares as most learners were confused with some aspects of the drawing. Teacher C had the knowledge of using a whiteboard to draw, as she was drawing comfortably and moving the set squares very well. The topic she covered very well; it showed that she knew what she was doing.

Teacher D on TK: The researcher observed that Teacher D had access to a whiteboard and a projector, and he demonstrated being knowledgeable about these technologies. Teacher C also had a computer, which he used in conjunction with the projector as well as the printer. All the above technologies were present in Teacher D’s classroom, and the researcher observed him using them effectively throughout his lesson. Teacher D knew exactly how to operate these technologies, and as a result, Teacher D’s TK was observed and it was strong.

Teacher D on TCK: Teacher D was teaching Cams, which was the first lesson of the chapter, and most of the work was done by him. The first thing he did was project PowerPoint slides that showed a cam and crank moving right around the cam. That painted a vivid picture for the learners, as computers also require a high level of spatial visualization, so projecting the slides did the trick. After the slides were finished, Teacher D instructed the learners to look at the worksheets, which contained a drawing of the day, and he used his AutoCAD to take them step by step. All the technologies used by Teacher D were spot-on and all assisted in the process of teaching and learning about computers. The researcher observed that Teacher D is highly skilled in using technologies for their intended purposes at the right time.

Teacher D on TPK: The researcher observed that Teacher D knew exactly how to operate the technologies that were at his disposal, and they assisted in making

learners understand the concept that was taught. When projecting slides, he played them in slideshow mode, which shows how comfortable he is using a computer to project slides. The worksheets that were used were prepared by him, and he used a printer in his classroom to print them out. Teacher D knew how to operate the technology efficiently and effectively. The chalkboard was also available for him to use, but Teacher D opted to use a whiteboard throughout the lesson, and he used it very well. The multifunction of the IWB was evident as Teacher D used it as a background when projecting and also used it to draw on it during the lesson when a clarity-seeking question arose.

Teacher I on TK: The lesson took place in an EGD lab that had 25 tables, and all tables had computers for learners to use. Teacher, I had his computer. During the lesson, Teacher I would assist learners when they encountered problems when using a computer; this showed that Teacher I had knowledge of how to operate computers. Teacher I was also comfortable when using a whiteboard, and he was drawing on it comfortably.

Teacher I on TCK: Teacher I selected the technologies very well for the lesson. The video he projected for the learners was spot on; it did the trick in trying to help learners get an idea of what Cams are all about. The researcher observed that Teacher I knew exactly how to choose technology for a specific lesson. He had AutoCAD installed on his computer as well as on the learner's computer, but since it was the first, neither of them used it. This is an indication that his choices are spot on.

Teacher I on TPK: At the front there was a whiteboard and a chalkboard with drawing sets of squares for the educator, and there was a printer that could print both A4 and A3-sized papers. Teacher, I had a laptop that was connected to that printer, and there was a router as well that was mounted on the ceiling to provide internet connection. The computers that were for the learners were installed with AutoCAD. Learners came in, and she powered up the projector and played a video from YouTube that was demonstrating the mechanism (Crank Rocker Four Bar). Learners observed the video, and she kept pausing it and emphasising important aspects. The video ended, and she projected a question that she was going to use as an example. She drew on the whiteboard using markers and set squares and showed the learners how it is done. After she was done with the demonstration, she went to her laptop and printed out a

worksheet that was going to be a classwork. While teaching, she demonstrated a high level of understanding of what she was doing. answered all the questions that were directed to her by the learners. Teaching with technology is something that came naturally to her, and she's been doing it for many years. She distributed it to the learners, and they started drawing.

Teacher H on TK: Teacher H demonstrated TK by being able to utilise all the technologies that were at his disposal. He used a whiteboard, a projector, a computer, and a printer. In doing so, I observed the TK component. Content was delivered to the learners with the aid of the above-mentioned technologies, and that is how I observed the TCK and TPK from teacher H.

Teacher H on TCK: The researcher observed teacher H teaching using the technologies that were at his disposal, and all the technologies were used in line with the content that was taught. This was an indication that Teacher H knew how to use specific technologies for specific content. Teacher H was not just using technology for the sake of using it; he was using it to help learners understand the content that was taught better. So, his TCK was observed to be spot on.

Teacher H on TPK: Teacher H switched off the light as he wanted to project a video showing how a house is built, with emphasis on the drawing of the floor plan, which is the first step when someone wants to build a house. After the video ended, he then put the lights back on and proceeded to the whiteboard to demonstrate to the learners how to draw a floor plan. Emphasis was put on the scale, windows, doors, and the hatching of the walls. His presentation was on point, and questions seeking clarification were dealt with in a convincing manner. The whiteboard was used very well; he knows what he is doing, and learners seemed to be understanding every aspect of the lesson. After he was done, he printed a worksheet from his computer and gave it to the learners to do the task as classwork. The worksheet was nicely prepared.

Teacher F on TK: The researcher observed that Teacher F had access to a printer, computer, and whiteboard. which indicated a shortage, but regardless of the lack of resources, teacher F demonstrated intensive knowledge of using the technologies that were at his disposal very well. Teacher F had a very good knowledge of using a whiteboard; the researcher established that she had been using it for many years.

Teacher F also demonstrated being knowledgeable about using a printer and a computer to print worksheets that were used as a classwork task. The researcher can conclude that Teacher F's TK was spot on, and he demonstrated a high level of knowledge in using all the above-mentioned technologies.

Teacher F on TCK: In class, there was a whiteboard in front that she was using on a daily basis as there was no chalkboard in the room. She used a whiteboard with markers and a drawing set with squares. Teacher F's office had a large printer that she uses to print worksheets for the students. All the above-mentioned technologies she used demonstrated a high level of proficiency with them. The researcher observed that Teacher F was knowledgeable about the technologies, and she had been using them for quite some time.

Teacher F on TPK: From drawing given figures, it showed that she was very familiar with what she was doing; she showed no struggles or whatsoever about using a whiteboard for drawing, and she taught very well, which indicated that the topic she was teaching had an intensive knowledge about it. As she was going on with her teaching, learners asked clarification-seeking questions, which she was glad to answer, and learners continued. When she was done, learners got the chance to do it on the worksheets that she had given them earlier. Teacher F was comfortable using the printer to print the worksheets as well as using the whiteboard in her class, which showed that she had the TK of the technologies that she used and also that she taught very well and showed that she had the knowledge for the topic she was teaching and integrated technology very well to teach and make the learners understand as all the clarification questions brought up by the learners were easily answered by her and they seemed to be understanding what was said.

4.3.2.2 Summary of Observation Results

Teachers that were observed displayed a good knowledge of using the technologies that were at their disposal. All the technologies they used showed a clear understanding of their use. Technologies used by teachers ranged from printers and whiteboards to laptops, computers, and projectors. The availability of these resources in schools was attested to by Mathevula and Uwizeyimana (2014), who revealed that TVs, photocopiers, and laptops/computers are some of the technologies that teachers

have access to for the purpose of infusing ICT. All these technologies used by teachers are the devices mentioned by Huggins and Izushi when defining ICT. ICT was defined by Huggins and Izushi (2002) as technologies that ranged from computers, interactive whiteboards, projectors, and access to the internet. This is an indication that EGD from uMgungundlovu has some idea of what ICT devices are.

From the observations, it is worth noting that all the teachers who had technologies at their disposal did manage to use them. of which was the TK aspect of it. Put simply, TK is an aspect of displaying knowledge of different technologies. This notion is shared by Koehler and Mishra (2009) and Koehler et al. (2013), who define TK as displaying knowlegde about various technologies, from low-tech technologies like pencil and paper to digital technologies like the Internet of Things, digital video, interactive whiteboards and software programs, robotics, artificial intelligence, and Big Data.And from the range of technologies teachers used, it is worth mentioning that most teachers were using the IWB. This was due to two reasons. 1. The principals removed all the chalkboards in the classrooms. 2. Teachers were loving the idea of using the IWB for teaching, as they claimed that it made their teaching much easier, and the learners were enjoying it. This assertion is backed by Bakadam and Asiri's (2012) findings that most teachers feel that IWB is an effective and convenient way to deliver learning and that it increases the level of interaction in the classroom, which in turn improves the learning experience. Furthermore, Bakadam and Asiri (2012) revealed that other teachers go as far as using the IWB as a background sheet for the projector to project on. This is what the researcher observed: some teachers were seeing an IWB as a versatile ICT tool that could be used for different teaching and learning purposes. This is further attested to by Karsenti (2016), who reported that many studies have shown that teachers are using IWB exceptionally well in teaching and learning. Karsenti (2016) further postulates that in the last 5 years, IWB has been massively introduced in schools for the purpose of teaching and learning. This saying is evident, as most schools the researcher observed in the uMgungundlovu district do have access to the IWB, and they are using it very well.

Teachers observed managed to use the technologies at their disposal very well, one of which was the TK component. Other components like TCK and TPK descend from the TK, so if one can master the TK, they can easily do so for the TCK and TPK. This

was evident in the lessons observed by the researcher as teachers who had technologies and managed to use them also did well in the aspect of delivering the content with the aid of technologies, and their pedagogical skills were used very well in conjunction with the technologies. These components of TCK and TPK are clearly articulated by Koehler and Mishra (2009) and Koehler et al. (2013), who define TCK as a component that as teachers, we need to understand which technologies are best suited for addressing subject matter. And TPK is defined as knowing how to use various technologies in the classroom and understanding that the use of technology can change the way teachers teach. However, only one educator in his school didn't have the ICT resources to infuse it. This challenge of a lack of ICT resources in schools is echoed by Mathevula and Uwizeyimana (2014), who reported that a lack of ICT resources in schools has always been an outcry from the teachers. In the same vein, Alharbi (2021) indicated that the barrier that is faced by most teachers is the lack of ICT resources in schools. But it is worth mentioning that most of the schools observed by the researcher had ICT resources.

The researcher observed that schools H and I had the adequate ICT resources that an EGD teacher could ask for. These schools had an EGD lab where they conducted their lessons, and that lab had all the ICT resources. These resources included an overhead projector, computers for learners installed with AutoCAD and IWB, internet routers, and photocopiers or printers. Other schools had been observed by the researcher to have access to the basic ICT resources, which are photocopiers and IWBs. The researcher further observed that the IWB was the most commonly used technology by the teachers, and they used it effectively. This assertion was attested to by Bakadam and Asiri (2012) and Karsenti (2016), who reported that the IWB is the most used resource by teachers and they demonstrate exceptional ability to use it. One school, which is school F, had the challenge of not having ICT resources; it only had access to the chalkboard and the photocopy machine. This was the challenge that was echoed in Mathevula and Uwizeyimana's (2014) findings that a lack of ICT resources is a challenge faced by many teachers in their schools. The same sentiment was attested to by Alharbi (2021), who found that the barrier that is faced by many teachers is the lack of ICT resources, which hinder the successful integration of ICT into teaching and learning. Despite the lack of ICT resources in one school, the researcher observed that most teachers do have access to ICT resources, and they

are using them effectively. The second most used technology was the photocopier, which was the device they were using to print or make copies of the worksheets that learners were using. Teachers exhibited high levels of competency in using an IWB and a photocopier, among other technologies at their disposal. And teachers managed to integrate these technologies well into the process of teaching and learning EGD.

4.4 CONCLUSION

This chapter dealt with the presentation of the data, interpretation, and discussion of the results. The data obtained from the classroom observation were analysed and described using the TPACK framework. The data collected from the semi-structured interviews were analysed by highlighting themes that emerged in the data. Then, the results were presented in relation to the literature reviewed and the theoretical framework. Therefore, the next chapter presents the summary of the study, limitations, conclusions, and recommendations.

CHAPTER 5: SUMMARY, LIMITATION, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

In the previous chapter, the results of the data collected from the EGD teachers in semi-structured interviews and the researcher's observation results were presented. This chapter also discussed the findings by summarising each of the findings.

This chapter provides a summary of the findings and the major conclusions of the study based on the interview results and observation findings. Finally, recommendations are made based on the findings from the literature review. The recommendations, which will be of great importance to all EGD teachers in the uMgungundlovu district, this chapter also presents the limitations of this study and recommendations for future research.

5.2 SUMMARY OF THE FINDINGS

5.2.1 Interview responses of the teachers

The interview questions that were used intended to respond to the main question: What is the state of EGD teachers' readiness for the integration of ICT in teaching and learning in uMgungundlovu secondary schools? And the sub-research questions are as follows:

RQ1: What are the challenges faced by EGD teachers in the adoption of ICT in EGD classrooms?

RQ2: What are the EGD teachers' technological knowledge in teaching and learning?

RQ3: What are different ways that EGD teachers can use to infuse ICT into teaching and learning?

The study established that for the subject EGD to be effective, ICT must be integrated. Integration of ICT assists in making abstract concepts that EGD deals with more easily understood by the learners (Pedrosa et al. 2014, Rodriguez and Rodriguez-Velazquez 2017). From the interviews, the researcher established that teachers do have ICT backgrounds from the university, which assist them in understanding the concept of

ICT. Having an ICT background in university does influence the way teachers infuse ICT into their teaching and learning. The above assertion is attested to in Chapter 2 by Quaye et al. (2015), who state that being exposed to technology while still in university does influence teachers to use it when turning professionals. As a result, EGD teachers from uMgungundlovu District are infusing ICT into teaching and learning, as most of them were exposed to technology during their training at the university. The study also established that teachers have access to basic ICT tools like IWB, photocopiers, and computers, which is enough to kick start the integration of ICT into teaching and learning, but many teachers indicated a lack of educational software like AutoCAD because the license is very expensive and there is a shortage of computers that can support AutoCAD. However, other teachers indicated that they do not have ICT tools because they were stolen after the DoE provided them. This is in line with findings in a study by Alharbi (2021). In other schools, there is a lack of ICT tools that hinder teachers from integrating ICT into the teaching and learning of EGD.

The study further established that EGD teachers are very competent in using technologies that are available to them at school; the technologies range from computers, IWB, projectors, and photocopiers. This is discussed in Chapter 2 by Karsenti (2016), who cites that most teachers are using IWB in their EGD classrooms. The only challenge they had was the use of AutoCAD, which most teachers seemed to be struggling with, which may be due to the fact that they do not have access to AutoCAD in schools. Teachers consistently remarked that the DoE needs to step up and conduct workshops so that teachers can all be on the same level in terms of using technologies for the purpose of teaching and learning.

From the interviews, the study established that teachers understand the importance of using technology in the teaching and learning of EGD. They indicated that since the world is migrating to 4IR, it is impossible to divorce education and technology, as they should go hand in hand. The nature of the subject EGD warrants the use of ICT tools so that other concepts can be best taught by teachers. The study further established that even though teachers understand the importance of infusing ICT into EGD lessons, there are still problems that hamper the process, and those problems include a lack of internet connections, power outages (load shedding), and a lack of educational software, among other challenges they encountered (Mathevula and

Uwizeyimana 2014). The study also established that most teachers were able to conduct classes during the COVID-19 lockdown. Most of them relied heavily on using WhatsApp to reach learners as physical lessons were suspended. Teachers created WhatsApp groups and used those groups to send pre-recorded lessons and sometimes use video calls. Other teachers would even send links from YouTube via WhatsApp so that learners could watch. The study did establish that not all teachers were able to conduct classes during lockdown as their learners did not have smartphones, and others did not have internet connections.

From the interviews, the study also managed to establish that COVID-19 did change the way teachers are teaching now. Teachers indicated that COVID-19 taught them to be proactive and to always live ten steps ahead, and they also indicated that COVID-19 was an eye opener as it compelled them to embrace the idea of using technology in teaching and learning, especially in EGD. The study established that the way teachers are teaching now is no longer the same due to COVID-19. So, in a nutshell, COVID-19 did influence the way EGD teachers are doing things in the uMgungundlovu District. The study further established that for all EGD teachers to be ICT equipped, they need to be trained, and the DoE must conduct workshops that will equip teachers with relevant ICT skills. According to Alazam et al. (2013) and Matongo (2022), in order for teachers to be able to infuse ICT into EGD lessons, they must be trained. Those skills will ensure that teachers are able to infuse ICT effectively, which will result in learners understanding the abstract concepts taught in EGD as these concepts are better studied using technology.

5.2.2 Researcher's observations

Observations were conducted to assist in responding to sub research questions which are RQ 1 and RQ 2 which are:

RQ1: What are the challenges faced by EGD teachers in the adoption of ICT in EGD classrooms?

RQ2: What are the EGD teachers' technological knowledge in teaching and learning?

The researcher observed that there is a shortage of overhead projectors, and access to AutoCAD is a serious challenge. However, this is in contrast to the findings of the

study done by Bakadam and Asiri (2012) and Karsenti (2016), which found that most EGD teachers have access to the IWB and photocopiers as the basic ICT tools. This is again one of the requirements that an EGD class should have. According to DBE (2011), it is a requirement that an EGD classroom have an overhead projector, whiteboard, and access to AutoCAD. What the researcher observed is that even though there is a shortage of other ICT tools, teachers were able to use what they had at their disposal to infuse ICT into EGD classrooms. Teachers use computers to print worksheets so that learners can draw. The researcher further observed that EGD teachers are able to use the IWB well, which is something that was alluded to in Chapter 2 by Karsenti (2016). The researcher observed that only one classroom had a challenge with ICT integration because there was no electricity in the classroom, the lights were falling from the ceiling, and the sockets were broken. The teacher relied heavily on the traditional approach. This challenge was echoed by Mathevula and Uwizeyimana (2014) in chapter 2 of the study, who said the lack of ICT resources is a challenge that is faced by many schools. Despite the lack of ICT resources in one school, the researcher observed that most teachers do have access to ICT resources, and they are using them effectively. The researcher also observed that the second most used technology after IWB was the photocopier, which was the device they were using to print or make copies of the worksheets that learners were using. Teachers exhibited high levels of competency in using an IWB and a photocopier, among other technologies at their disposal. The researcher further observed that teachers from uMgungundlovu District managed to integrate these technologies well in the process of teaching and learning EGD.

5.3 LIMITATIONS OF THE STUDY

The limitation of the study was that the researcher was not allowed to observe Grade 12. I only observed Grades 10 and 11. This was because Grade 12 was done with the syllabus and they were only doing PAT and the revision work. The researcher believes that observing Grade 12 was going to give a complete impression of what is certainly happening in EGD as far as ICT infusion is concerned, as most teachers tend to give their best when teaching Grade 12. This is because some educators did not use some ICT tools despite their being available in class. Another limitation of the study was that the researcher was only allowed to interview and observe one teacher per school. The

researcher is of the opinion that if he had access to more than one teacher per school, more data was going to be produced and the findings were going to be improved. The researcher believes that being allowed to observe lessons was a limitation to this study in the sense that if two lessons were observed, more information was going to be acquired and that was going to improve the findings. The researcher believes that observing more than once would have yielded a true reflection of how teachers teach EGD. Some of those limitations are the learners' coming late and, as such, distracting the teacher from starting lessons on time.

5.4 CONCLUSION

As stated in Chapter 1 of this study, the main objective of this study was to investigate the level of readiness of EGD teachers for the integration of ICT in teaching and learning in uMgungundlovu secondary schools. From the results of this study, it is evident that EGD teachers in uMgungundlovu district are indeed ready to integrate ICT in their teaching.

A literature review has alluded to the fact that EGD is a technical subject that deals with line work, neatness, and abstract concepts. It also alluded to the fact that most learners are poor at spatial visualisation because of a lack of resources to teach such concepts. The study stems from the problem that similar schools might be facing the same challenges.

The findings of this study showed that EGD teachers understand the importance of using technology when teaching because of the nature of the subject. The findings further revealed that if technology is used in EGD lessons, these abstract concepts can be manipulated to the advantage of learners. To achieve that, AutoCAD and other technologies must be implemented as prescribed by DBE. The findings also indicated that EGD teachers are infusing ICT with the little ICT tools that they have. All schools observed had a basic form of an ICT tool; basic tools range from an IWB to a photocopying machine. From the observations, it was revealed that EGD teachers are using the IWB exceptionally well, and they all have access to the photocopy machine, which is used to produce documents.

The literature also implies that teachers need ICT training so that they can infuse ICT into lessons. The findings revealed the same thing as teachers' indications that DBEs

need to conduct workshops so that technologically disadvantaged teachers can be capacitated. The findings also revealed that people lack the skills to use AutoCAD because schools do not have access to it. As a result, teachers were unable to use AutoCAD, which is a requirement from DBE for any EGD class. The findings also revealed that these workshops can also be used to equip teachers with relevant skills to operate AutoCAD.

The literature review further alluded to the fact that WhatsApp was the most used social platform by teachers during COVID-19 lockdown with an aim to keep teaching and learning alive. The findings echoed the same thing, as teachers indicated that they relied heavily on WhatsApp to keep classes active as physical classes were suspended. This all indicates how committed the EGD are. And they also understand the importance of using technology in EGD lessons. The findings also revealed that COVID-19 did change the way they are teaching now. They are now proactive and always ahead just in case something happens. In a nutshell, the findings revealed that COVID-19 changed their way of teaching EGD for the better, and they never looked back. The findings also revealed that EGD teachers are still using WhatsApp.

From the findings, therefore, the objectives of the study have been met, which indicated that EGD teachers from uMgungundlovu District are ready to infuse ICT into teaching and learning. The findings also indicate that there is a shortage of educational software and resources, but that does not stop teachers from using those resources that are available to the best of their abilities. The findings further revealed that for all EGD teachers to be able to infuse ICT, especially the skill of using AutoCAD, the DBE should conduct developmental programmes in the form of workshops so that teachers can be taught how to use AutoCAD. The emphasis is on AutoCAD because the literature revealed that AutoCAD can assist in making abstract concepts in EGD clearer.

5.5 RECOMMENDATIONS OF THE STUDY

Based on the findings and discussions of the study, the study recommends that the DBE in KwaZulu-Natal (KZN) provide those schools that lack ICT resources so that they can infuse ICT into their EGD lessons. In other schools, resources were available but were stolen due to a lack of security, so the study also recommends that the DBE

from KZN provide adequate security so that these resources can never be stolen again. The study further recommends that DBE should intervene and assist those teachers who are technologically disadvantaged so that all EGD teachers can be on the same level in terms of using ICT resources. This can be done by conducting workshops and training that will equip EGD teachers with relevant ICT skills. Training has been deemed effective and necessary in assisting teachers integrate ICT into teaching and learning; Figure 5.1 below indicates that.

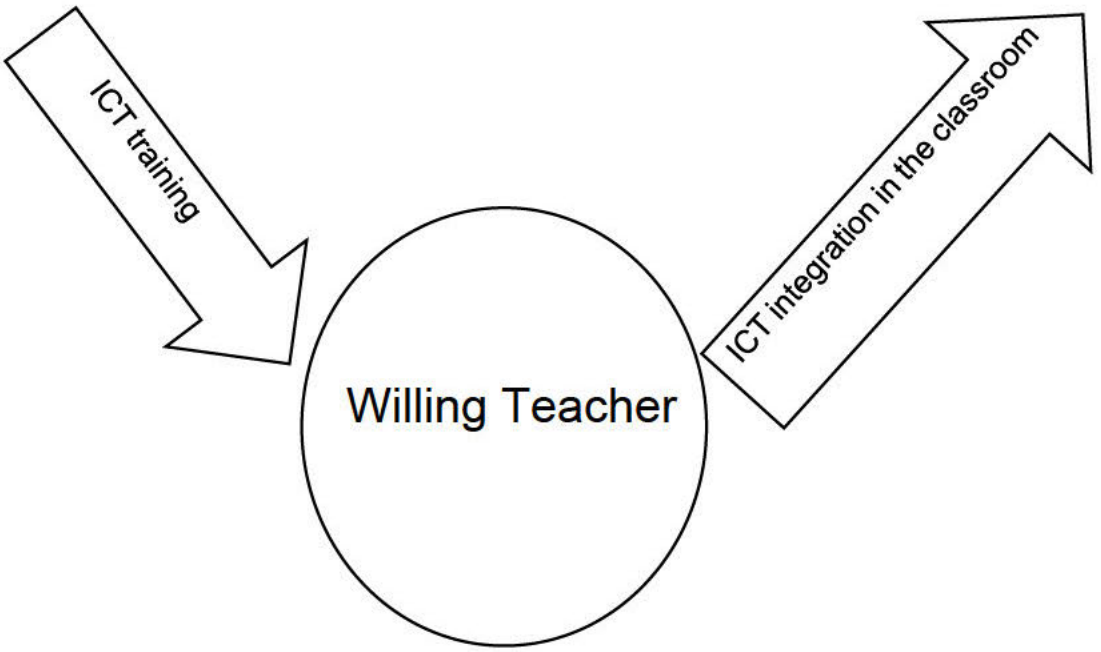

Figure 5.1: The effect of ICT training on teachers

Figure 5.1 above indicates the effect of training for the successful integration of ICT into the teaching and learning of EGD. Consequently, the study recommends that DBE provide training to technology-disadvantaged teachers so that they can integrate technology into the teaching and learning of EGD.

The study further recommends that DBE should frequently provide useful developmental programmes for teachers to be capacitated to teach using technology. Teachers indicated a lack of skill in using AutoCAD, so such workshops can also be used to provide such training to EGD teachers. Other schools had a fully functional EGD lab, but they couldn't use AutoCAD because they didn't have a license for it, so

the study recommends that DBE provide all schools that offer EGD with AutoCAD licenses.

REFERENCES

Adams, C. 2020. *Teachers need lots of training to do online learning well. Coronavirus closures gave many just days* [Online]. Available: https://hechingerreport.org/teachers-need-lots-of-training-to-do-online-learning-well-coronavirus-closures-gave-many-just-days/ [Accessed 25 April 2021].

Addandani, K. 2011. *The lack of the ability of Saudi teachers.* PhD thesis, University of King Saud, Saudi Arabia.

Akkuş, İ. & Arslan, P. Y. 2022. The Effects of Augmented Reality in the Technical Drawing Course on Engineering Students' Spatial Ability and Academic Achievement. *Journal of Learning and Teaching in Digital Age,* 7**,** 160-174.

Al-Zaidiyeen, N. J., Mei, L. L. & Fook, F. S. 2010. Teachers' Attitudes and Levels of Technology Use in Classrooms: The Case of Jordan Schools. *International education studies,* 3**,** 211-218.

Alazam, A.-O., Bakar, A. R., Hamzah, R. & Asmiran, S. 2013. Teachers' ICT skills and ICT integration in the classroom: The case of vocational and technical teachers in Malaysia. *Creative Education,* 3**,** 70.

Alenazi, A. A. 2018. WhatsApp Messenger as a Learning Tool: An Investigation of Pre-Service Teachers' Learning without Instructor Presence. *Journal of Education and Training Studies,* 6**,** 1-8.

Alharbi, A. 2021. A review of the internal and external factors affecting teachers' ICT use in Classroom. *International Journal of Education and Research,* 9**,** 105-116.

Alvi, M. 2016. A manual for selecting sampling techniques in research.

Aslan, A. & Zhu, C. 2016. Influencing Factors and Integration of ICT into Teaching Practices of Pre-Service and Starting Teachers. *International Journal of Research in Education and Science,* 2**,** 359-370.

Asmara, R. 2020. Teaching english in a virtual classroom using whatsapp during COVID-19 pandemic. *Language and Education Journal,* 5**,** 16-27.

Badri, M., Al Rashedi, A. and Mohaidat, J., 2013, March. School teachers' technology readiness–An empirical study applying readiness factors and teacher type categorization. In *Proceedings of the 2013 International Conference on Information, Business and Education Technology (ICIBET 2013)* (pp. 583-586). Atlantis Press.

Bai, Y., Mo, D., Zhang, L., Boswell, M. & Rozelle, S. 2016. The impact of integrating ICT with teaching: Evidence from a randomized controlled trial in rural schools in China. *Computers & Education,* 96**,** 1-14.

Bakadam, E. & Asiri, M. J. S. 2012. Teachers' perceptions regarding the benefits of using the interactive whiteboard (IWB): The case of a Saudi intermediate school. *Procedia-Social and Behavioral Sciences,* 64**,** 179-185.

Barbour, M. K. 2014. Training teachers for a virtual school system: A call to action. *K-12 Education: Concepts, Methodologies, Tools, and Applications.* IGI Global.

Becker, S., Bryman, A. & Ferguson, H. 2012. *Understanding research for social policy and social work 2E: themes, methods and approaches*, policy press.

Bere, A., 2012, November. A comparative study of student experiences of ubiquitous learning via mobile devices and learner management systems at a South African university. In *Proceedings of the 14th annual conference on world wide web applications* (pp. 4-17).

Bernardes, M. and Oliveira, G., 2021, September. Teaching practices of computer-aided technical drawing in the time of COVID-19. In *23rd International Conference on Engineering and Product Design Education (E and PDE 2021)*.

Bhandari, P. 2020. An introduction to qualitative research. *Noudettu osoitteesta https://www. scribbr. com/methodology/qualitativeresearch/#:~: text= Qualitative% 20research% 20involves% 20collecting,* 20.

Bhat, A. 2020. Qualitative research: Definition, types, methods and examples. *Questions Pro*.

Bhatia, M. 2018. *Your guide to qualitative and quantitative data analysis methods* [Online]. Available: https://humansofdata.atlan.com/2018/09/qualitative-quantitative-data-analysis-methods/ [Accessed 26 May 2021].

Bloom, D. A., Reid, J. R. & Cassady, C. I. 2020. Education in the time of COVID-19. *Pediatric Radiology,* 50**,** 1055-1058.

Bornman, E. 2016. Information society and digital divide in South Africa: results of longitudinal surveys. *Information, Communication & Society,* 19**,** 264-278.

Braun, V. & Clarke, V. 2006. Using thematic analysis in psychology. *Qualitative research in psychology,* 3**,** 77-101.

Cardullo, V. M., Wilson, N. S. & Zygouris-Coe, V. I. 2018. Enhanced student engagement through active learning and emerging technologies. *Student engagement and participation: Concepts, methodologies, tools, and applications.* IGI Global.

Caulfield, J. 2019. *How to Do Thematic Analysis | Step-by-Step Guide & Examples* [Online]. Available: https://www.scribbr.com/methodology/thematic-analysis/ [Accessed 14 September 2022].

Check, J. & Schutt, R. K. 2011. *Research methods in education*, Sage Publications.

Chirinda, B., Ndlovu, M. & Spangenberg, E. 2021. Teaching mathematics during the COVID-19 lockdown in a context of historical disadvantage. *Education Sciences,* 11**,** 177.

Copriady, J. 2014. Self-Motivation as a Mediator for Teachers' Readiness in Applying ICT in Teaching and Learning. *Turkish Online Journal of Educational Technology-TOJET,* 13**,** 115-123.

Creswell, J. W. 2014. The selection of a research approach. *Research design: Qualitative, quantitative, and mixed methods approaches***,** 3-24.

Crittenden, J. C. 2009. *The attitudes and perceived self-efficacy of Mississippi career and technical educators toward information and communication technology*, Mississippi State University.

Das, K. 2019. Role of ICT for better Mathematics Teaching. *Shanlax International Journal of Education,* 7**,** 19-28.

DBE 2011. Curriculum and assessment policy statement: Grades 10-12 Engineering Graphics and Design. Department of Basic Education Pretoria.

DBE 2021. *National Senior Certificate. Diagnostic report part 3:Teachnical subjects. Government printers.* Pretoria.

DoE, S. A. 2004. *White Paper on E-education: Transforming Learning and Teaching Through Information and Communication Technologies (ICTs)*, DoE.

Du Toit, J. 2015. Teacher training and usage of ICT in education. New directions for the UIS global data collection in the post-2015 context. *UNESCO Institute for Statistics, Retrieved,* 16.

Erişti, S. D. B., Kurt, A. A. & Dindar, M. 2012. Teachers' views about effective use of technology in classrooms. *Turkish online journal of qualitative inquiry,* 3**,** 30-41.

Etikan, I., Musa, S. A. & Alkassim, R. S. 2016. Comparison of convenience sampling and purposive sampling. *American journal of theoretical and applied statistics,* 5**,** 1-4.

Faloye, S.T., Ajayi, N.A. and Raghavjee, R., 2020, May. Managing the challenges of the digital divide among first year students: A case of UKZN. In *2020 IST-Africa Conference (IST-Africa)* (pp. 1-11). IEEE.

Favaretto, M., De Clercq, E., Gaab, J. & Elger, B. S. 2020. First do no harm: An exploration of researchers' ethics of conduct in Big Data behavioral studies. *Plos one,* 15**,** e0241865.

Fraillon, J., Ainley, J., Schulz, W., Duckworth, D. & Friedman, T. 2019. *IEA international computer and information literacy study 2018 assessment framework*, Springer Nature.

Fricker, R. 2012. Target populations, sampling, frames, and coverage error. *Naval Postgraduate School Monterey, California. Management Among Supermarkets in Nakuru Town, Kenya*.

Garg, R. 2016. Methodology for research I. *Indian journal of anaesthesia,* 60**,** 640.

Gebhardt, E., Thomson, S., Ainley, J. & Hillman, K. 2019. Teacher gender and ICT. *Gender differences in computer and information literacy.* Springer.

Ghavifekr, S., Kunjappan, T., Ramasamy, L. & Anthony, A. 2016. Teaching and Learning with ICT Tools: Issues and Challenges from Teachers' Perceptions. *Malaysian Online Journal of Educational Technology,* 4**,** 38-57.

Glasel, A. 2020. reasons why teachers don't use technology in the classroom—what can EdTech companies learn. *The EdTech World*.

Gon, S. & Rawekar, A. 2017. Effectivity of e-learning through WhatsApp as a teaching learning tool. *MVP Journal of Medical Sciences***,** 19-25.

Guest, G., Namey, E. & Chen, M. 2020. A simple method to assess and report thematic saturation in qualitative research. *PloS one,* 15**,** e0232076.

Guion, L. A., Diehl, D. C. & Mcdonald, D. 2011. Triangulation: establishing the validity of qualitative studies: FCS6014/FY394, Rev. 8/2011. *Edis,* 2011**,** 3-3.

Higgins, S. J. 2014. *Does ICT improve learning and teaching in schools?*

Hismanoglu, M. 2012. Prospective EFL teachers' perceptions of ICT integration: A study of distance higher education in Turkey. *Journal of Educational Technology & Society,* 15**,** 185-196.

Howard, S. K. & Mozejko, A. 2015. Teachers: technology, change and resistance. *Teaching and digital technologies: Big issues and critical questions***,** 307-317.

Huggins, R. & Izushi, H. 2002. The digital divide and ICT learning in rural communities: examples of good practice service delivery. *Local Economy,* 17**,** 111-122.

Jegede, P. O. 2009. Age and ICT-related behaviours of higher education teachers in Nigeria. *Issues in Informing Science & Information Technology,* 6.

Jhurree, V. 2005. Technology integration in education in developing countries: Guidelines to policy makers. *International Education Journal,* 6**,** 467-483.

Jt, H.-E. & Mbachu, C. 2015. The place of information, communication and technology (ICT) in teaching and learning in Nigerian tertiary institutions. *American Journal of Educational Research,* 3**,** 340-347.

Jung, I. 2005. ICT-pedagogy integration in teacher training: Application cases worldwide. *Journal of Educational Technology & Society,* 8**,** 94-101.

Karsenti, T. 2016. The interactive whiteboard: Uses, benefits, and challenges. A survey of 11,683 students and 1,131 teachers. *Canadian Journal of Learning and Technology/La revue canadienne de l'apprentissage et de la technologie,* 42.

Khoza, S., 2018. A TEACHING STRATEGY FOR SECTIONAL DRAWING CONCEPT: A CASE OF PRE-SERVICE TEACHERS IN A JOHANNESBURG UNIVERSITY, SOUTH AFRICA. In *INTED2018 Proceedings* (pp. 9655-9661). IATED.

Khoza, S. D. 2013. Difficulties in sectional drawing: a case of student teachers at a university based in the Eastern Cape.

Khoza, S. D. 2021. The Burden on Online Teaching and Learning in South African Secondary Schools: An Attempt to Respond To A 'New Normal'. *Journal of Educational Studies,* 20**,** 109-121.

Kivunja, C. & Kuyini, A. B. 2017. Understanding and applying research paradigms in educational contexts. *International Journal of higher education,* 6**,** 26-41.

Koehler, M. & Mishra, P. 2009. What is technological pedagogical content knowledge (TPACK)? *Contemporary issues in technology and teacher education,* 9**,** 60-70.

Koehler, M. J., Mishra, P. & Cain, W. 2013. What is technological pedagogical content knowledge (TPACK)? *Journal of education,* 193**,** 13-19.

Kumar, S. & Phrommathed, P. 2005. Basic Conceptual Model. *New Product Development: An Empirical Study of the Effects of Innovation Strategy, Organization Learning, and Market Conditions***,** 5-42.

Kurt, S. 2018. TPACK: Technological pedagogical content knowledge framework. *Educational Technology, May,* 12**,** 2018.

Li, C. & Lalani, F. 2020. *The COVID-19 pandemic has changed education forever. This is how* [Online]. Available: https://www.weforum.org/agenda/2020/04/coronavirus-education-global-covid19-online-digital-learning/ [Accessed 26 April 2021].

Lindén, A., 2013, July. The importance of technology management in the ICT requirements definition process. In *2013 Proceedings of PICMET'13: Technology Management in the IT-Driven Services (PICMET)* (pp. 2283-2295). IEEE.

Macharia, J. K. & Pelser, T. G. 2014. Key factors that influence the diffusion and infusion of information and communication technologies in Kenyan higher education. *Studies in Higher Education,* 39**,** 695-709.

Mafenya, N. P. 2022. Exploring technology as enabler for sustainable teaching and learning during Covid-19 at a university in South Africa. *Perspectives in Education,* 40**,** 212-223.

Magubane, T. 2021. *Grade 12 results were better than expected in spite of the challenges of Covid-19 lockdown* [Online]. Available: https://www.iol.co.za/mercury/news/grade-12-results-were-better-than-expected-in-spite-of-the-challenges-of-covid-19-lockdown-240ae834-937c-47ed-bdeb-bc5207826afe [Accessed 08 August 2022].

Maharaj-Sharma, R. & Sharma, A. 2017. Using Ict In Secondary School Science Teaching–What Students And Teachers In Trinidad And Tobago Say? *European Journal of Education Studies*.

Mahdi, H. S. & Al-Dera, A. S. A. 2013. The Impact of Teachers' Age, Gender and Experience on the Use of Information and Communication Technology in EFL Teaching. *English Language Teaching,* 6**,** 57-67.

Makgato, M. 2016. Difficulties of student teachers in the engineering graphics and design course at a South African university: Snapshot on sectional drawing. *Eurasia Journal of Mathematics, Science and Technology Education,* 12**,** 703-715.

Makgato, M. & Khoza, S. 2016. Difficulties experienced by pre-service teachers and lecturers in engineering graphics and design course at a university in South Africa. *International Journal of Educational Sciences,* 14**,** 157-166.

Malik, A. A., Memon, P. A., Ali, H., Mallah, M. A., Bux, K. & Haq, M. U. 2022. Impacts of Coping Strategies for Electricity Load Shedding among University Students. *Pakistan Journal of Medical & Health Sciences,* 16**,** 1165-1165.

Mashile, T. 2017. *Technology integration and the digital divide: understanding factors that impact on educators' ability to integrate technology in South African classrooms.* University of Pretoria.

Mathevula, M. D. & Uwizeyimana, D. E. 2014. The challenges facing the integration of ICT in teaching and learning activities in South African rural secondary schools. *Mediterranean Journal of Social Sciences,* 5**,** 1087.

Matiwane, Z. 2019. Public schools to go digital within six years: Cyril Ramaphosa. *times live*.

Matongo, M. 2022. Teacher readiness to teach using ICT in classroom pedagogy in Zimbabwean primary schools. *Journal of African Education,* 3**,** 45-66.

Mccombes, S. 2019. Understanding different sampling methods. *Scribbr. Retrieved from: https://www. scribbr. com/methodology/sampling-methods*.

Mndzebele, N. 2013. Teachers readiness in using ICT in the classroom: The case of a developing country. *International Journal of Information and Education Technology,* 3**,** 409.

Msila, V. 2015. Teacher Readiness and Information and Communications Technology (ICT) Use in Classrooms: A South African Case Study. *Creative Education,* 06**,** 1973-1981.

Mukhari, S. 2016. Teachers' experience of information and communication technology use for teaching and learning in urban schools (DEd thesis). *Pretoria: University of South Africa*.

Munje, P. N. & Jita, T. 2020. The impact of the lack of ICT resources on teaching and learning in selected South African primary schools. *International Journal of Learning, Teaching and Educational Research,* 19**,** 263-279.

Mustafina, A. 2016. Teachers' Attitudes toward Technology Integration in a Kazakhstani Secondary School. *International Journal of Research in Education and Science,* 2**,** 322-332.

Naicker, T. 2017. *Exploring teacher readiness to integrate information and communication technologies into the teaching and learning process: a case study of two Gauteng schools.*

Nordling, L. 2020. South Africa flattens its coronavirus curve—and considers how to ease restrictions. *Science*.

Patino, C. M. & Ferreira, J. C. 2018. Inclusion and exclusion criteria in research studies: definitions and why they matter. *Jornal Brasileiro de Pneumologia,* 44**,** 84-84.

Pedrosa, C. M., Barbero, B. R. & Miguel, A. R. 2014. Spatial visualization learning in engineering: Traditional methods vs. a web-based tool. *Journal of Educational Technology & Society,* 17**,** 142-157.

Prieto, G. & Velasco, A. D. 2010. Does spatial visualization ability improve after studying technical drawing? *Quality & Quantity,* 44**,** 1015-1024.

Punch, K. F. & Oancea, A. 2014. *Introduction to research methods in education*, Sage.

Quaye, F., Ametepe, W. & Annan, N. K. 2015. The Impact of ICT on Teaching and Learning in Tertiary Institutions: A Case Study of Wisconsin International University College, Ghana. *Journal of Information Engineering and Applications,* 5**,** 8-14.

Radović-Marković, M. 2010. Advantages and disadvantages of e-learning in comparison to traditional forms of learning. *Annals of the University of Petroşani, Economics,* 10**,** 289-298.

Raman, K. & Yamat, H. 2014. Barriers teachers face in integrating ICT during English lessons: A case study. *Malaysian Online journal of educational technology,* 2**,** 11-19.

Rapanta, C., Botturi, L., Goodyear, P., Guàrdia, L. & Koole, M. 2020. Online university teaching during and after the Covid-19 crisis: Refocusing teacher presence and learning activity. *Postdigital science and education,* 2**,** 923-945.

Rastogi, A. & Malhotra, S. 2013. ICT skills and attitude as determinants of ICT pedagogy integration. *European Academic Research,* 1**,** 301-318.

Rehman, A. A. & Alharthi, K. 2016. An introduction to research paradigms. *International Journal of Educational Investigations,* 3**,** 51-59.

Rodriguez, J. and Rodriguez-Velazquez, L.G., 2017, April. Spatial visualization skills in courses with graphics or solid modeling content. In *2017 IEEE Global Engineering Education Conference (EDUCON)* (pp. 1778-1781). IEEE.

Saul, M. 2019. What's the difference between qualitative and quantitative research.

Schlosser, L. & Simonson, M. 2006. Distance education: Definition and glossary of terms (2nd Editio.). *Bloomington: Association for Educational Research and Technology*.

Sharma, G. 2017. Pros and cons of different sampling techniques. *International journal of applied research,* 3**,** 749-752.

Siddiquah, A. & Salim, Z. 2017. The ICT facilities, skills, usage, and the problems faced by the students of higher education. *EURASIA Journal of Mathematics, Science and Technology Education,* 13**,** 4987-4994.

Skhephe, M., Caga, N. P. & Boadzo, R. M. K. 2020. Accounting teachers' readiness for e-learning in the Fourth Industrial Revolution: a case of selected high schools in the Eastern Cape, South Africa.

Solutions, S. 2017. What is credibility in qualitative research and how do we establish it. Retrieved from Statistics Solutions: https://www. statisticssolutions.com

Sotsaka, D. & Singh-Pillay, A. 2020. Meeting the challenges first year engineering graphic design pre-service teachers encounter when they read and interpret assembly drawing. *Journal of Education***,** 72-86.

Sotsaka, D. T. S. 2015. *An exploration of the interface between Grade 11 Engineering Graphics and Design teachers' understanding of Assembly Drawing and their practice: a case study of the uThukela District, KwaZulu-Natal.*

Sotsaka, D. T. S. 2019. *Unmasking how pre-service engineering graphics and design teachers read and interpret assembly drawing at a university of technology: a case study in Umgungundlovu, KwaZulu-Natal.*

Sumeracki, M. 2018. Different research methods: Strengths and weaknesses. *Retrieved from*.

Taherdoost, H. 2016. Sampling methods in research methodology; how to choose a sampling technique for research. *How to Choose a Sampling Technique for Research (April 10, 2016)*.

Tallvid, M. 2016. Understanding teachers' reluctance to the pedagogical use of ICT in the 1: 1 classroom. *Education and Information Technologies,* 21**,** 503-519.

Tasir, Z., Abour, K. M. E. A., Halim, N. D. A. & Harun, J. 2012. Relationship between Teachers' ICT Competency, Confidence Level, and Satisfaction toward ICT Training Programmes: A Case Study among Postgraduate Students. *Turkish Online Journal of Educational Technology-TOJET,* 11**,** 138-144.

Trucano, M. 2005. Knowledge Maps: ICTs in Education-What Do We Know about the Effective Uses of Information and Communication Technologies in Education in Developing Countries? *Online Submission*.

Van Der Spoel, I., Noroozi, O., Schuurink, E. & Van Ginkel, S. 2020. Teachers' online teaching expectations and experiences during the Covid19-pandemic in the Netherlands. *European journal of teacher education,* 43**,** 623-638.

Van Greunen, K. K., Alida Veldsman, Johan Botha 2021. Enhancing ICT readiness of schools in South Africa.

Wyk, B. V., Mooney, G., Duma, M. & Faloye, S. 2020. Emergency Remote Learning in the Times Of Covid: A Higher Education Innovation Strategy. 2020 2020 Kidmore End. Academic Conferences International Limited, 499-XXI.

Yip, C., Han, N.-L. R. & Sng, B. L. 2016. Legal and ethical issues in research. *Indian journal of anaesthesia,* 60**,** 684.

Yuen, A. H. K., Law, N. & Wong, K. C. 2003. ICT implementation and school leadership. *Journal of Educational Administration,* 41**,** 158-170.

Yunus, M. M. & Wekke, I. S. 2009. The application of multicultural education and applying ICT on Pesantren in South Sulawesi, Indonesia.

APPENDICES

APPENDIX A1: DOE GATEKEEPERS LETTER

KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

OFFICE OF THE HEAD OF DEPARTMENT

Private Bag X9137, PIETERMARITZBURG, 3200
Anton Lembede Building, 247 Burger Street, Pietermaritzburg, 3201
Tel: 033 392 1063
Email: Phindile.duma@kzndoe.gov.za

Enquiries: Phindile Duma **Ref.**:2/4/8/4076

Mr PB Mlambo
224 Bhece Drive
Buffer Strip
PIETERMARITZBURG
3201

Dear Mr Mlambo

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"TEACHERS' READINESS TOWARDS THE INTEGRATION OF INFORMATION AND COMMUNICATIONS TECHNOLOGY INTO TEACHING AND LEARNING: A CASE OF ENGINEERING GRAPHICS AND DESIGN TEACHERS IN UMGUNGUNDLOVU DISTRICT, KWAZULU-NATAL"**, in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the Intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 23 May 2022 to 02 May 2025.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Phindile Duma at the contact numbers above.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

UMGUNGUNDLOVU DISTRICT

Mr GN Ngcobo
Head of Department: Education
Date: 26 May 2022

GROWING KWAZULU-NATAL TOGETHER

APPENDIX A2: ETHICAL CLEARANCE

Institutional Research Ethics Committee
Research and Postgraduate Support Directorate
2nd Floor, Berwyn Court
Gate 1, Steve Biko Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2375
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

28 October 2022

Mr P B Mlambo
224 Bhece Drive
Buffer Strip
Pietermaritzburg
3201

Dear Mr Mlambo

Teachers' readiness towards the integration of information and communications technology into teaching and learning: A case of Engineering Graphics and Design teachers in uMgungundlovu District, KwaZulu-Natal.
Ethical Clearance number IREC 242/22

The DUT-Institutional Research Ethics Committee acknowledges receipt of your gatekeeper permission letter.

Please note that FULL APPROVAL is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the DUT-IREC according to the DUT-IREC Standard Operating Procedures (SOP's).

Please note that any deviations from the approved proposal require the approval of the DUT-IREC as outlined in the DUT-IREC SOP's.

Yours Sincerely

Prof J K Adam
Chairperson: DUT-IREC

APPENDIX B: LETTER OF INFORMATION AND INFORMED CONSENT

Title of the Research Study : Teachers' readiness towards the integration of information and communications technology into teaching and learning: A case of Engineering Graphics and Design teachers in uMgungundlovu District, KwaZulu-Natal.

Principal Investigator/s/researcher: Mr Philani Brian Mlambo, M-Ed.ACE

Co-Investigator/s/supervisor/s: Dr MSA Maeko, D-Ed and Dr SD Khoza, D-Ed

Hello,

My name is Philani Brian Mlambo, I am a student doing research for my Master of Education in Adult and Community Education at the Durban University of Technology, Indumiso campus, South Africa. You are invited to volunteer for a research study titled: *Teacher's readiness towards the integration of information and communications technology into teaching and learning: A case of Engineering Graphics and Design teachers in uMgungundlovu District, KwaZulu-Natal.* And the purpose of this study is to investigate EGD teachers' level of readiness towards the integration of ICT into teaching and learning and recommend ways you can adopt towards integrating ICT into teaching and learning. This will help you stay relevant in the educational system since everything is migrating to digital.

To gather the information, I will be asking you some questions via individual interview and lesson or classroom observation. In addition, I will also require permission to record the interviews. This study addresses the infusion of ICT into teaching and learning in EGD subject. So, the conclusion and recommendation from this study will help most EGD teachers not only in UMgungundlovu District but in the entire country. It is envisaged that there will be new discoveries about infusing ICT into teaching EGD. Such discoveries may be used in the professional development of EGD teachers to enable them effect improvement in teacher classroom instruction. This is how this study will benefit you.

This study will use a minimum of 10 EGD teachers who were hired before COVID-19 era and are from uMgungundlovu District. Not signing a consent form will results in not being considered for participation. Taking part in this study is voluntary and you are not pressured into taking a decision now about participating in this study. You are

entitled to discuss the study with their family and friends and are under no obligation to commit at this stage. For this purpose, a copy of the Letter of Information document is available to you to take home. The study is aimed at ensuring that every EGD teacher is able to infuse ICT into teaching and learning smoothly as this is the crucial component that every teacher should have as we are in the fourth industrial revolution (4IR) era where everything is being done digitally. Secondly, to assist EGD teachers to transition smoothly from COVID-19 era to post COVID-19 era.

The objectives of this study are as follow:

- To investigate challenges faced by EGD teachers in the adoption of ICT in EGD classrooms.
- To understand teacher's technological knowledge towards the use of technologies in teaching and learning of the subject.
- To recommend different ways EGD teachers could use to infuse ICT into teaching and learning.

Please note that:

- Your confidentiality is guaranteed, as your inputs will not be attributed to you in person but reported only as a population member opinion.
- The individual interview may last for about 15 to 20 minutes and may be split depending on your preference.
- Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only.
- Data will be stored in secure storage and destroyed after 5 years.
- You have a choice to participate, not participate or stop participating in the research. You will not be penalised for taking such an action.
- The study and procedures involve no unforeseeable physical discomfort. However, as a participant, you might come across challenging questions that might need you to decide whether to respond or not to respond to.
- The research aims at investigating teachers' readiness towards the integration of information and communications technology into teaching and learning: A case of Engineering Graphics and Design teachers in uMgungundlovu District, KwaZulu-Natal.
- Your involvement is purely for academic purposes only, and there are no financial benefits involved.
- Your involvement in this study is free of charge, no financial contributions are expected from you.
- The study and procedures involve no unforeseeable physical discomfort. However, as a participant, you might come across challenging questions that might need you to decide whether to respond or not to respond to.

Should you have an questions please do not hesitate to contact me on 063 016 0793, my supervisor Dr MSA Maeko on 072 401 9633, my co-supervisor Dr SD Khoza on 084 300 4549 or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can also be reported to the Acting Director: Research and Postgraduate Support Prof K Motaung on TtiDirector@dut.ac.za

CONSENT

Full Title of the Study: Teachers' readiness towards the integration of information and communications technology into teaching and learning: A case of Engineering Graphics and Design teachers in uMgungundlovu District, KwaZulu-Natal.

Names of Researcher/s: Mr PB Mlambo

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Mr PB Mlambo about the nature, conduct, benefits, and risks of this study - Research Ethics Clearance Number: _____,
- I have also received, read, and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during this research which may relate to my participation will be made available to me.

Full Name of Participant	**Date**	**Time**	**Signature / Right Thumbprint**

I, Mr PB Mlambo herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

Full Name of Researcher	**Date**	**Signature**
Full Name of Witness (If applicable)	**Date**	**Signature**
Full Name of Legal Guardian (If applicable)	**Date**	**Signature**

APPENDIX C: INTERVIEW SCHEDULE

INTERVIEW SCHEDULE

FACULTY OF ARTS AND DESIGN

SCHOOL OF EDUCATION

DURBAN UNIVERSITY OF TECHNOLOGY

Teachers' readiness towards the integration of information and communications technology into teaching and learning: A case of Engineering Graphics and Design teachers in uMgungundlovu District, KwaZulu-Natal.

(INTERVIEW FOR ENGINEERING GRAPHICS AND DESIGN TEACHERS)

The interview questions below will assist the researcher in investigating the level of readiness in EGD teachers in integrating ICT into teaching and learning. The findings of the study will assist both the researcher and yourself (EGD teachers). The interview will not take more than 15 minutes for each you.

1. In terms of gender, please indicate whether you classify as a Male, Female or Prefer not to specify.

2. How long have you been teaching EGD?

3. By qualification, are you an EGD teacher? Please specify your majors.

4. During your undergrad studies (university) did you do any module/s related to using technology in teaching and learning? If yes, what it is that was mainly taught?

5. What technologies are available to use in this school for the purpose of teaching and learning EGD?

6. From the above responses how many you can say you are good at using them?

7. What is your view about the concept of using technology in your teaching and learning?

8. How often do you use technology in your EGD lessons? Why?

9. So far, what are the challenges that you have experienced in using technology?

10. How were you conducting classes during the COVID-19 lockdown?

11. Did COVID-19 influences the way you are teaching now, or you are still teaching the same way you did before COVID-19 ?

12. What do you think can be done to assist teachers who are technologically disadvantaged?

(*Technologically disadvantaged teachers – are those teachers with little or no previous access to technology)*

THANK YOU FOR YOUR TIME

APPENDIX D: CLASSROOM OBSERVATION SCHEDULE

CLASSROOM OBSERVATION SCHEDULE

FACULTY OF ARTS AND DESIGN

SCHOOL OF EDUCATION

DURBAN UNIVERSITY OF TECHNOLOGY

Teachers' readiness towards the integration of information and communications technology into teaching and learning: A case of Engineering Graphics and Design teachers in uMgungundlovu District, KwaZulu-Natal.

A student in the above-named department in the Faculty of Arts and Design of the Durban University of Technology is conducting a study on *the readiness of EGD teachers in the integration of ICT into teaching and learning.* This observation schedule forms an important part of the study. Please note that this exercise is purely for academic purpose.

DATE: _____ **Name of institution:** _____

Time: _____

CRITERIA	REMARKS

1. Technological Knowledge (TK)	
2.Technological Content Knowledge (TCK)	
3. Technological Pedagogical Knowledge (TPK)	

Adapted from: TPACK framework by (Koehler and Mishra 2009)

THANK YOU FOR YOUR TIME

APPENDIX E: A LETTER TO THE SCHOOL PRINCIPAL REQUESTING PERMISSION TO CONDUCT RESEARCH

The principal,

Sir/Madam

RE: Permission to conduct research

My name is Philani Brian Mlambo, I am a master's candidate studying at the Durban University of Technology, Indumiso campus, South Africa. I am conducting research entitled: "***Teachers' readiness towards the integration of Information and Communications Technology into teaching and learning: A case of Engineering Graphics and Design teachers in uMgungundlovu District, KwaZulu-Natal"*** To gather the information, I will need access to Engineering Graphics and Design class for lesson observation and participate in an individual interview. Permission will also be sought from the individual teacher.
Please note that:
• Your confidentiality is guaranteed as your inputs will not be attributed to you in person but reported only as a population member opinion.
• You have a choice to participate, not participate or stop participating in the research. You will not be penalised for taking such an action.
• The research aims at investigating EGD teachers' readiness towards the integration of ICT into teaching and learning.
• Your involvement is purely for academic purposes only, and there are no financial benefits involved.
• If you are willing to grant me access to your school please indicate by call or email.

Cell. No.: 063 016 0793

e-mail : 21648090@dut4life.ac.za

My supervisor Dr MSA Maeko on 072 401 9633, my co-supervisor Dr SD Khoza on 084 300 4549 or the Institutional Research Ethics Administrator on 031 373 2375. Complaints can also be reported to the Acting Director: Research and Postgraduate Support Prof K Motaung on TtiDirector@dut.ac.za

Thank you for your contribution to this research.

APPENDIX F: LETTER TO THE PRINCIPAL

Letter to the Principal

Dear Sir/Madam

My name is Philani Brian Mlambo (21648090). I am a master's student in the School of Education at Durban University of Technology. I am doing research on investigating ***Teachers' readiness towards the integration of information and communications technology into teaching and learning: A case of Engineering Graphics and Design teachers in uMgungundlovu District, KwaZulu-Natal.***

My research will require one EGD teacher in your school to participate in this study by answering questionnaires. These questionnaires will investigate the level of readiness in teachers toward the integration of ICT into teaching and learning. Teacher's response will be anonymous.

The reason I have chosen this school it is because it is one of the few schools around Pietermaritzburg that offers EGD . I'm a technical teacher by a qualification and I am interested in the integration of ICT within the curriculum, particularly the teachers' knowledge on the effectiveness integration of ICT into teaching and learning. I am inviting your school to participate in this research, and I wish to express that your participation is voluntary and that any of your staff can refrain from participating should they feel so inclined.

The research participant will not be advantaged or disadvantaged in any way. He/she will be reassured that they can withdraw their permission at any time during this project without any penalty. There are no foreseeable risks in participating in this study. The participant will not be paid for this study.

The name of the research participant and identity of the school will be always kept confidential and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed 5 years after completion of the project.

Please let me know if you require any further information. I look forward to your response as soon as is convenient.

Yours sincerely,

Philani Brian Mlambo

224 Bhece Drive, Buffer Strip,

Pietermaritzburg, 3201

Email: 21648090@dut4life.ac.za Cell: 063 016 0793

Supervisor: Dr. MSA Maeko Email: maekos@dut.ac.za

Co-supervisor: Dr. SD Khoza, Email: khozasd@tut.ac.za

APPENDIX G: EDITING CERTIFICATE

Marieta Grundling (MBA)

366 Rosemary Street
Grootfontein Country Estates
Pretoria, 0081
081 354 1596
edit@profeditmba.co.za
17 April 2023

To Whom It May Concern

This serves to confirm that the dissertation: ***Teachers' Readiness Towards the Integration of Information and Communications Technology into Teaching and Learning: A Case of Engineering Graphics and Design in UMgungundlovu District, Kwazulu-Natal*** by **Philani Brian Mlambo (21648090)** was edited. The language, presentation, and referencing system (both in-text and against the Reference List), were checked and corrected.

M Grundling

APPENDIX H: TURNITIN REPORT

Masters Dissertation for MR PB Mlambo_Final_March_2023

ORIGINALITY REPORT

10%	9%	7%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	researchspace.ukzn.ac.za Internet Source	2%
2	uir.unisa.ac.za Internet Source	1%
3	Submitted to Kenyatta University Student Paper	1%
4	www.scribd.com Internet Source	<1%
5	Submitted to University of Witwatersrand Student Paper	<1%
6	"Second Handbook of Information Technology in Primary and Secondary Education", Springer Science and Business Media LLC, 2018 Publication	<1%
7	etd.uum.edu.my Internet Source	<1%
8	edocs.maseno.ac.ke Internet Source	<1%