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Teachers' experiences of ICT use in Grade 5 mathematics classrooms

By

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Submitted in partial fulfilment of the requirements for the degree

Master of Education
(Science, Mathematics and Technology Education)

at the

Faculty of Education
UNIVERSITY OF PRETORIA

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July 2020

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DEGREE AND PROJECT	MEd Teachers' experiences of ICT use in Grade 5 mathematics classrooms
INVESTIGATOR	Mrs Nareen Abdul-Razak
DEPARTMENT	Science, Mathematics and Technology Education
APPROVAL TO COMMENCE STUDY	08 November 2018
DATE OF CLEARANCE CERTIFICATE	05 March 2020

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Dedication

This dissertation is dedicated to my loving husband, Irfaan Mahomed-Ismail, and my parents, Ebrahim and Agtari Abdul-Razak, who have given me this opportunity to achieve this milestone in my life. I am forever grateful to all of you for having patience during the tears and frustration, and also being a part of my happiness and success. You have continuously supported, encouraged, motivated and challenged me to complete this dissertation, despite the many setbacks and challenges. May Allah (SWT) reward all of you abundantly.

Acknowledgements

First and foremost, Shukr to the ALMIGHTY ALLAH for making it possible for me to complete this dissertation

I am thankful to the following persons who have contributed to the study:

- My Supervisor, Dr Hanlie Botha, for her continuous motivation, patience and contribution to this study. Thank you for caring and supporting me wholeheartedly throughout this journey. The role you have played in my life is immeasurable.
- My co-supervisor, Dr Moodley, for her guidance, knowledge and support throughout this study.
- To all my participants – words cannot express how grateful I am for providing me the time to contribute information to making this thesis possible.
- To my parents-in-law, Ashraf and Waheeda Mahomed-Ismail, thank you for your continuous encouragement and moral support, and for being my pillar of strength throughout my journey.
- To all my family and friends – thank you that you always encouraged me and supported me to complete this journey.

Abstract

In order to compete in the 21st century, it is vital for policymakers and school leaders to create technology-based classrooms for teaching and learning. Teachers are of significant importance in implementing information and communication technology (ICT) in schools. The purpose of this study was to explore Grade 5 mathematics teachers' experiences of using ICT in teaching and learning. Furthermore, this study explored how the available resources are used, as well as the challenges that teachers experience to implement ICT tools in their lessons. This study determined how teachers perceive the use of ICT in teaching and learning. Also, the researcher addressed the professional development, technical training, as well as support the teachers received at their respective schools.

The primary research question for this study is: *"How do Grade 5 mathematics teachers from well-resourced schools experience the use of ICT within their classrooms?"* The qualitative approach was used, and a descriptive case study research design was selected to answer the research question. The technology acceptance model (TAM) was used as a basis to determine the themes of the study. The data collection strategies were questionnaires and semi-structured interviews to determine teachers' experiences of using ICT in the mathematics classroom. Purposive and convenience sampling were used to select the participants for this study. The participants comprised six mathematics teachers from three well-resourced and independent schools located in Tshwane, South Africa.

An overall conclusion is that this study reveals mixed feelings of both optimism and reluctance when using ICT in mathematics. The results prove differences in teachers' perceived experiences of ICT in mathematics teaching and learning. The individual schools as well as the teachers received different levels of training, professional development and support from the institution, and also face external and internal barriers when integrating ICT into the classroom. However, despite these barriers, it is still clear that ICT is the future

of learning. It is always important to understand that the responses of the participants represent their own perceptions.

Key Terms:

Mathematics; Private schools; Teachers; Grade 5; ICT; Learners; TAM; External barriers; Perceived Ease of Use; Perceived Usefulness; Behavioural Intention; Professional Development; Technology; Hardware; Software; Education; Classrooms; Pedagogy; Resources.

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30 March 2020

To Whom It May Concern:

Hereby I, Marisa Freya Honey, declare that I am a full-time editor and translator with more than 20 years' experience of, among other things, editing theses, dissertations and journal articles. I also wish to state that I undertook a linguistic edit of the Master's thesis, *Teachers' experiences of ICT use in Grade 5 mathematics classrooms*, on behalf of Nasreen Abdul-Razak and made suggestions for corrections to be made. If these corrections were implemented, this would have ensured language of a better quality.

My qualifications are the following (all degrees obtained at Stellenbosch University, South Africa:

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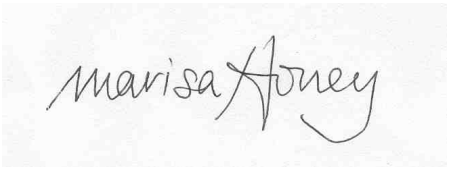
MPhil (Translation) *cum laude* (2006)

The latter degree had a large bilingual (Afrikaans and English) editing component.

Please feel free to contact me should you have any queries.

Kind regards



Marisa Honey

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List of abbreviations and acronyms

ANA	Annual National Assessment
BECTA	British Educational Communications and Technology Agency
CAPS	Curriculum and Assessment Policy Statement
CDE	Centre for Development and Enterprise
DBE	Department of Basic Education
ICT	Information and Communications Technology
IEB	Independent Examination Board
IT	Information Technology
NCS	National Curriculum Statement
NGO	Non-governmental Organisation
SASA	South African Schools Act
TALIS	Teaching and Learning International Survey
TAM	Technology Acceptance Model
TIMSS	Trends in International Mathematics and Science Study
TPD	Teacher Professional Development
UNESCO	United Nations Educational, Scientific and Cultural Organization

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1. CHAPTER 1: Introduction and contextualization

1.1 Introduction

A basic outline of the study is provided in this chapter. The background information to the study, the rationale, problem statement, and purpose of the study, its aim and objectives, as well as the research questions, are addressed here. An overview of the methodological considerations and concept clarifications are provided below. Finally, the significance of the research is also discussed, as well as the study's potential contributions.

1.2 Background to the study

It is frequently claimed that technology is a tool that can contribute towards the improvement of teaching and learning, and at the same time to the achievement of the learners in the classroom. According to Keengwe and Georgina (2013), Millennials[1] prefer to learn in a flexible and structured environment that integrates technology to enable them to become connected and productive individuals. Keengwe and Georgina (2013) further claim that technology should not drive instruction, but should be carefully integrated into the curriculum. The technological revolution has had an immense impact on developing teacher skills that will be beneficial in teaching and learning (O'Neal, Gibson, & Cotten, 2017). The noticeable benefits of technology for the curriculum can only be realised if teachers are actually integrating these tools into their pedagogy (Chigona, Chigona, & Davids, 2014). The fast growth of technology in the 21st century has resulted in the need for education and learning to develop and allow learners to keep up in the global economy. Education in the new century has brought about drastic changes in the education system and needs the cooperation of well-trained teachers, working in well-equipped classrooms and who can that possess the creative use technology creatively to facilitate a positive learning environment (Molnar, 2008). Furthermore, technology enables learners to switch from acquiring

[1] People born between 1980 and 2000.

basic knowledge to learning more about global issues by providing them withaccess to advanced technologies and tools to address the challenges of the 21st century (Van Melle & Tomalty, 2000). The National Council of Teachers of Mathematics ([NCTM], 2008, p. 24) has indicated that "[t]echnology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning". A study conducted by Joshi (2017) confirms this statement as it mentions that ICT is beneficial in mathematics teaching and learning as it improves teaching learning tactics and stimulates learner involvement in the subject. Therefore, the teaching and learning environment can thus adapt a new dynamic if teachers integrate technological tools successfully within their classrooms (Oldknow, Taylor & Tetlow, 2010).

As the world is evolving and becoming more diverse, it is evident that technology is a key aspect and plays a central role in almost all components of our lives. According to the World Economic Forum (Frezzo, 2017), about 65% of young learners entering primary schools will eventually enter occupations that currently do not exist. The Forum further reports that it is projected that 1.5 million new digitised jobs in 2020 should have been created worldwide (Frezzo, 2017). To prepare learners for this digital economy, it is of the utmost importance that the education system is aligned and prepared to equip learners for the growing demand for information technology (IT) skills. Thus, the 21st-century classrooms seek to bring together technology and human-driven education under one umbrella by creating learning experiences for learners to keep up with this new era. Although technology already plays such a major role in people's lives, it is a challenge for educators to create an effective learning environment using technology (Lawrence & Tar, 2018). It is in the hands of the educator as implementer of the curriculum to bring about this change through the appropriate and efficient use of technology in teaching and learning.

According to Gandhi and Lynch (2016), teachers who manage to integrate technology successfully into a classroom experience greater productivity in

their instructional processes, as lessons are planned well by using the variety of available resources. It is often noticed that many schools have access to resources, but are unsuccessful in making use of these learning resources, as there are many barriers that exist when technology is incorporated into teaching and learning (Mirzajani, Mahmud, Fauzi Mohd Ayub, & Wong, 2016). Ghavifekr and Rosdy (2015) state that it is important that teachers are continuously provided with technical help to implement technology effectively into educational environments. According to Groff and Mouza (2008), although there has been an increase in technological investments in schools, statistics prove that teachers only use computers once or twice a year for instructional purposes. Most of the time spent on computers is for teacher preparation purposes and administration. With this in mind, this study focuses on mathematics teachers' experiences of the use of technology in Grade 5 classrooms.

1.3 Rationale

One of the main aims of education policies in South Africa is to redress the inequalities of the past to ensure that equal resources and infrastructure are available throughout all schools in the country (Hart & Laher, 2019). There are two categories of schools in the South African education system, namely public and independent schools (Fedsas, 2015). Hart and Laher (2019) further mention that the roll-out of technology in public schools are not adequately achieved by the government and many parents are losing faith in the quality of public school education. Independent schools, also referred to as private schools, have grown vastly since 2014 and are mainly situated in the Gauteng province (Gent & Meyer, 2016). According to Immelman and Roberts-Lombard (2017), South African parents have a choice to enrol their child at any school and many affluent parents prefer the education of private schools despite the high school fees in comparison to a public school. Independent or private schools are high fee paying schools, while public schools are categorised as fee or non-fee paying schools (Immelman et al., 2017).On the other hand, as a Grade 5 mathematics teacher currently teaching in an under-resourced public school, my learners are taught mathematics in a traditional

manner on a daily basis, that is, with pen, paper and a blackboard. My personal opinion is that these learners are being deprived of the opportunities to learn with technology, which may enhance their learning compared to learners in many independent schools. According to a report by the Centre for Development and Enterprise (CDE, 2010), independent schools produce higher results due to high levels of resources and better teaching. Another report compiled by the CDE (Spaull, 2013) state that independent schools are growing at a significantly faster rate than public schools, as they receive private funding from independent organisations. Due to effective promotion of inner city independent schools it is seen that they have a range of technological tools available to use in the classroom (Immelman & Lombard, 2017). Taking this into consideration and the high school fees, it is expected that these independent schools would be equipped with technological tools and effective teacher ICT skills to be used in the teaching and learning process. Hence, in this study I preferred to focus on Grade 5 mathematics teachers in independent schools to determine the extent of ICT usage by mathematics teachers as well as their experiences of using ICT in the classroom.

1.4 Problem statement

Technology is advancing rapidly and opening avenues for a range of sectors, including education (Halili, 2019). National Government Organizations (NGOs) provide underprivileged schools with the resources needed so that the best education opportunities are provided to all learners. The use of ICT in education are trending and starting to surface and change the shape of education. Technology has surfaced the practice of interactive textbooks and educational games as well as online digital classrooms (Halili, 2019). In South Africa, these technological innovations are being introduced into both rural and urban schools in order to optimally benefit all learners (Hart & Laher, 2019). However, many of these schools receive the best technological resources, but are often incompetent to make use of the available resources (Ghavifekr & Rosdy, 2015). The success of incorporating technology into teaching and learning would depend on amongst others, ICT resources,

school leadership and ICT teacher skills of which teachers' personal attitudes are one of these skills (Becta, 2003). Also ICT benefits teachers' in their teaching practices, improves their mathematics knowledge and skills as well as allow them to effectively interact with learners, parents, colleagues and society (Haddad & Draxler, 2002). However, Becta (2003) argues that successful integration depends on the curriculum, location, class size as well as teacher digital skills. According to Hornsby, Osman, and De Matos-Ala (2013), many teachers have trouble teaching mathematics in large classes. Also, many teachers are reluctant to use these resources – for many reasons – and this results in a preference for the traditional teaching methods over using ICT (Kler, 2014) .

Mathematics teachers are aware of the importance of ICT in teaching and learning, however the pedagogical practice of ICT is limited in the South African education system (Law & Chow, 2008a). Kler (2014) further states that many teachers are comfortable in their set ways of teaching and are afraid and reluctant to change their teaching. If proper training is provided to these teachers to optimise the use of technology in teaching and learning, they will develop confidence through experience that may change their attitudes towards integrating technology into their instruction (González-Sanmamed, Sangrà, & Muñoz-Carril, 2017). Blignaut, Ellis, Els and Leendertz (2013) mention that the Technological Pedagogical Content Knowledge (TPCK) developed by Mishra and Koehler (2006) is valuable for teachers to recognise the integration and relationship between technology, content and pedagogy in integrating ICT into teaching and learning. Consequently, it is the teacher's responsibility to determine the use of ICT, combine ICT competency and mathematical knowledge as well as engage learners in technology (Blignaut et al., 2013). This change in teachers needs to transpire at a rapid pace, as learners are losing opportunities to learn through the integration of technology.

According to Sadera and Hargrave (2005, p. 292), "we live in a technology-rich society and it is expected that teachers are equipped with the knowledge

and skills to operate technological devices". They further state that teacher development organisations are giving little attention to preparing teachers to use technology effectively. According to Younie and Leask (2013), the lack of knowledge of both policymakers and school leaders is a major problem associated with technology adoption in schools. These policymakers and school leaders are not aware of the opportunities that technology creates for new pedagogical approaches in teaching. Thus, teachers are not fully aware of the epistemological and pedagogical repercussions of teaching with technology.

1.5 Purpose of the study

In this research, I examined the perspectives of Grade 5 mathematics teachers on using ICT in their teaching and learning. The incorporation of ICT in teaching and learning is linked to technology-based teaching and learning processes that are parallel to the use of learning technologies in schools (Ghavifekr & Rosdy, 2015). In the 21st century, learners are exposed to technology and thus the ability to create technology-based classrooms is vital to keep up with their ongoing demands. However, there are many barriers that are hindering teachers from successfully implementing ICT tools in the classroom. Adapting teaching and learning to completely leverage the power of the technology available is one of the greatest challenges faced by teachers today (Gillespie, 2014). Therefore, this study explored how the available resources are used, as well as the challenges that teachers experience to successfully implement these ICT tools in their lessons. I further determined how these teachers perceive and experience the use of ICT to improve teaching and learning in their classrooms, as well as what technical training and support they receive. The findings of this study may shed light on the overall experiences of teachers in their mathematics classrooms when using ICT for teaching and learning.

1.6 Aim and objectives of the study

The aim of the study is to explore mathematics teachers' experiences of ICT in well-resourced classrooms, the objectives clarify the aim of this research and mentions the following:

- Determine the extent and usage of technological resources available in mathematical classroom in private school environments;
- Come to understand how ICT can be used to improve mathematics teaching and learning;
- Explore the barriers mathematics teachers experience regarding the use of ICT;
- Discover the training and support that are available for mathematics teachers in the classroom.

1.7 Research questions

The following primary and secondary research questions drove the study:

Primary research question:

How do Grade 5 mathematics teachers from well-resourced schools experience the use of ICT within their classrooms?

Secondary research questions:

1. What are the barriers that are hindering teachers' abilities to make use of these resources?
2. In what way are the available technological resources used to enhance teaching and learning?
3. What are the views of mathematics teachers regarding the use of ICT in the classroom?
4. What technical training did the teachers receive to integrate ICT into the mathematics classroom?
5. What support is available for teachers to integrate ICT into the mathematics classroom?

1.8 Methodological considerations

A qualitative approach was used in this study to investigate the Grade 5 mathematics teachers' experiences of using ICT in teaching and learning. This method was suitable for this study, given the nature of the research questions. Qualitative research is done to explore and understand a central phenomenon within which concepts or processes are explored (Creswell & Creswell, 2018). The research questions are general and wide and aim to classify the interactions of participants with a central phenomenon (Maree, 2016). A descriptive case study research design was selected to guide the qualitative approach. A case study enabled me to gather insights into the detailed experiences of the participants as a sample population (Maree, 2016).

The research paradigm for this study is interpretivism. Interpretivists believe that there is no objective fact or truth, and therefore it is important to interpret reality (Maree, 2016). In order to obtain a perspective of multiple realities, a qualitative method is most suitable when working in this paradigm. Interpretivists hold the viewpoint that reality is socially constructed, and they "believe that the human experience of the world is subjective, and they have a concern to understand it as it is" (Cronje, 2020, p.15). Thus, as an interpretivists researcher, I relied on the views of the participants being investigated (Kankam, 2019).

Six teachers were chosen from well-resourced independent schools in Tshwane, South Africa. As part of the data collection process, teachers needed to complete a questionnaire and participate in a semi-structured interview based on their use of ICT in mathematics teaching and learning. Purposive and convenient sampling were used to select the participants for this study. The coding was done using categories defined from the literature and set out in the theoretical framework. Therefore, the data analysis followed a deductive approach. Atlas.ti software was used to code the data from the questionnaires and interviews. The trustworthiness of the study was addressed through member checking. This ensured that my interpretation of

the questionnaire and interviews was reliable. Finally, the University of Pretoria granted ethical clearance for this study so that I could proceed with the research.

1.9 Concept clarifications

As mentioned in Chapter 2 of this literature review, the literature includes various definitions of the concepts used in this study. Below is a clarification of how these concepts are defined in this study:

1.9.1 Technology: In this study, the term technology refers to 'educational technology' in teaching and learning. Educational technology refers to an array of technological tools, including media, software, hardware and networks, that are purposefully used to enhance teaching and learning in the classroom environment (Bakir, 2016).

1.9.2 Information and communication technology (ICT): This concept covers a range of hardware (tools) and software (applications of the tools). For the purpose of this study, it might mean any of the following:

Table 1.1*:* List of Hardware and Software

Hardware	Software
Laptops	Computer application
Personal computers	Word processing
Tablets	Internet
Cell phones	YouTube videos
Calculators	Audio stories or music
Digital cameras and video cameras	Electronic mail
Image scanners	PowerPoint presentations
Printers and faxes	
Televisions	
DVD players	

1.9.3 Digital tools/resources: Digital tools are another name for ICT (UNESCO, 2018). Resources also refer to digital, ICT, web or online resources. ICT is a combination of digital tools and resources that are used to communicate and manipulate information. According to Kaware and Sain (2015, p. 27), ICT is defined as a "diverse set of technological tools and resources used to communicate, and to create, disseminate, store, and manage information". These technological tools and resources are the electronic and digital devices that comprise the hardware and software mentioned above.

1.9.4 Well-resourced school: For the purpose of this study, a well-resourced school or private school, refers to a school in which the majority of the learners come from affluent homes (Immelman & Roberts, 2017). According to Gaigher, Hattingh, and Ramaligela (2014), these schools' fees are expensive and many parents are professionals. They further mention that, in a well-resourced school, class numbers are small and classrooms are well set up. Learners can easily perform group work, as there is plenty of space in the classroom. Furthermore, funds are available for the school to provide teachers with technological tools in the classroom.

1.10 Possible contributions of the study

We live in a technology-rich society and it is expected that teachers are well equipped with the required knowledge and skills to operate technological devices (Sadera & Hargrave, 2005). At times, technological tools may be available at schools, but teachers lack the knowledge, skills or support to use them effectively. The findings of this study can suggest possible solutions to particular teacher problems arising in the classroom or school that may assist in improving the teaching and learning of specific topics. It may also contribute towards the professional development of teachers with regard to knowledge, skills and understanding of ICT use in the classroom.

1.11 The structure of the study

This study is composed of five chapters. Chapter 1 covers the background information about the problem, the reasoning, problem statement, study intent, objectives, research questions, methodological considerations, principle clarifications, study significance, and potential research contributions of the study. Chapter 2 includes a thorough analysis and synthesis of the literature review, as well as a description of the study's theoretical framework. Chapter 3 addresses the study's methodology, which includes the sample selection, data collection methods, and data analysis techniques, as well as the trustworthiness and ethical concerns of this study. Chapter 4 presents and reviews the results of the data generated by the questionnaires and semi-structured interviews. Finally, the findings and conclusions, reviews of the questions, suggestions for future research, the shortcomings of this research as well as a final reflection on the analysis are presented in Chapter 5.

2. CHAPTER 2: Literature review and theoretical framework

2.1 Introduction

This chapter covers the role of information and communication technology (ICT) in mathematics education. Firstly, it looks at mathematics philosophies within an educational context. Thereafter, it discusses the South African education system; its curriculum as well as public and private school systems. Furthermore, ICT policies promoting technology use are discussed. Thereafter, the mathematics performances in the classroom, ICT integration, the 21st century teacher skills in a mathematics classroom as well as its challenges towards ICT adoption, are discussed. In addition, ICT training and teacher professional development are mentioned. Lastly, the theoretical framework of this study is outlined and clarified.

2.2 Mathematical philosophies in education

According to Jankvist and Iversen (2014), philosophy can be split into two categories in mathematics education. The first category for teaching and learning mathematics is “philosophy as a tool”, because it allows learners to make sense of mathematical concepts, ideas and constructs such as definitions, proofs and theorems. The second category is “philosophy as a goal” to teach learners certain aspects with regard to the philosophical aspects of mathematics, such as knowledge of the epistemology or ontology of mathematical concepts. Jankvist and Iversen (2014) further state that a mathematics teacher who is philosophy-minded has an intention to deepen learners’ understanding of mathematical concepts. Expanding understanding and awareness of mathematics is exactly what a philosophically inclined teacher is supposed to be doing. Thus, the philosophy of mathematics cannot be regarded merely as a tool, but should also be goal orientated.

On the other hand, Mensah and Agyei (2019) discuss two divergent views of the philosophy of teaching mathematics. One school of thought is the absolute view, which holds onto the foundation of deductive logic and views

mathematics as objective and an absolute body of knowledge. The other school of thought, and a more recent philosophy, is fallibilism. Fallibilism is a critical theory that states we can never be sure about the truth of every scientific statement, as there is no higher evidence, no privilege or secure way to the truth. Therefore, every scientific hypothesis should be checked to determine whether it is true or false (Lauster & Hansen-Casteel, 2018). Thus, philosophy is an important aspect in any discipline, as it provides a basis for stating that mathematical knowledge is the product of human creation and intelligence. This is in contrast to the absolute view of teaching philosophy. Furthermore, philosophy provides people with a new lens through which to view the world, including the practice of teaching and learning mathematics (Mensah & Agyei, 2019).

2.3 The South African education system

A well-formulated education system is critical for teachers and learners to gain knowledge and develop skills to become successful citizens within their country (Wilmot, 2017). For the context of this study, the South African curriculum as well as the public and private schooling system will be discussed below.

2.3.1 The South African curriculum

In 1994, a change of government in South Africa introduced an inclusive and democratic political system (Wilmot, 2017). The Curriculum and Assessment Policy Statement (CAPS) (DBE, 2011, p. 8) is developed for the South African education system and describes mathematics as a “language that makes use of symbols and notations to describe numerical, geometric and graphical relationships.” Mathematics is a human pursuit that involves multiple sensory actions such as “observing, representing and investigating patterns and quantitative relationships in physical and social phenomena” (Department of Basic Education (DBE), 2011, p. 8). It contributes to developing mental processes, accuracy and problem-solving skills that manifest logical and critical thinking on a daily basis. There are a number of aims that the DBE

seeks to achieve, and it also wants to be able to develop a critical awareness of mathematical connections in four spheres, namely the social, environmental, cultural and economic spheres (DBE, 2011).

According to the Constitution of the Republic of South Africa, quality education is a basic human right that assists in developing national developmental goals. The Department of Education, in co-operation with stakeholders, introduced various initiatives to promote ICT in schools. According to Meyer and Gent (2016), the education system operates at several levels, and the integration of ICT should be different across all the levels – the macro (provincial), meso (district) and micro (teachers and school management) levels. These levels allow the government to close the gaps in education from the past and provide an opportunity to check on the progress in the different levels.

2.3.2 Public and private school education

In 1996, the South African Schools Act (SASA) established a national schooling system that categorised schools as: public and independent (Kunene, 2016). According to SASA (Kunene, 2016), public schools are defined as state owned whereas private schools are privately governed. All public and private schools use the same CAPS curriculum, however, private schools have a choice to write the NSC (National Senior Certificate) or the IEB (International Examination Board) examination for Grade 12 learners (Hill, 2019). In this light, evidence reveals that due to a weakening South African schooling system, parents are willing to invest in private resources to obtain quality education for their children (Van Der Berg, Van Wyk, Burger, Kotze, Piek & Rich 2017). Furthermore, there is a significant increase in many developing countries from public to private schooling, as many parents believe it narrows the gap created by the underperformance of a public school (Van Der Berg et al, 2017)

Accordingly, private school learners are more likely to come from wealthy backgrounds that contributes towards academic success (Waller & Maxwell, 2017). Furthermore, Van Der Berg et al., (2017) stated that private schools provide principals and teachers with better incentives for greater performance compare to public schools. Moreover, teachers at independent schools have a high intrinsic motivation, commitment towards teaching as well as greater freedom compare to public schools (Van Der Berg et al., 2017). In contrast, Waller and Maxwell (2017) state that public schools in many South African rural areas lack teachers as well as teaching and learning resources. Likewise, Hart and Laher (2019) mentioned that ICT resources are insufficient in public schools, leaving teachers inadequately incorporating it into teaching and learning. Mwapwele, Dlamini and Van Biljon (2019) mention that after ICT resources are sustainable in school settings, public or private, ICT intervention can only be improved by assessing teachers' ICT competencies, attitudes and experiences of the current resources they have used in the classroom. However, despite the difference of schools, ICT is apparent and it is important to determine the different teachers' experiences of integrating ICT in the teaching and learning context (Hart & Laher, 2019). However, for the purpose of this study, the focus is on teachers from private schools.

2.4 ICT policies promoting mathematics

Research studies reveal that ICTs have become common in primary and secondary school education systems (Chigona, Chigona, & Davids, 2014; Li & Ma, 2010; Livingstone, 2012). Although the education system in South Africa has improved slightly, mathematics still remains an underperforming subject in the country's schools. The Southern and Eastern Consortium for Monitoring Educational Quality (SACMEQ) suggests that the South African education system needs fixing, and the solution includes adopting an e-skills plan to help improve the quality of mathematics teaching and learning (Vadachalam & Chimbo, 2017). However, there are two major challenges that first need to be addressed: (i) there is a lack of policy on ICTs in education; and (ii) it is necessary to encourage improved learning through the best use of technology (Barakat, Bengtsson, Muttarak, Birhanu Kebede, Crespo Cuaresma, Samir &

Striessnig, 2016).

Jantjies and Joy (2015) posed that there is a need to establish and implement ICT policies in education. According to Vadachalam and Chimbo (2017), most of the schools in South Africa lack formal ICT policies and directives from the education system. They further state that, although the Draft White Paper on e-Education (DoE, 2003) in effect is implemented at the national level, teachers are unaware of this policy at the school level. Furthermore, the 2030 Agenda for Sustainable Development recognises the importance that ICTs have for achieving the Sustainable Development Goals [2] (SDGs) and accelerative progress in society. UNESCO (2018) has developed an ICT competency for teachers to guide teacher training across the education system. This will be discussed later.

2.5 The South African mathematics classroom

The section below discusses the mathematics performances in primary education, 21st-century skills that a teacher needs, the impact of ICT on mathematics, as well as the teachers' experiences and perspectives when integrating mathematics into the classroom.

2.5.1 Mathematics performances in primary school

Statistics South Africa (2015) states that the 2015 Millennium Development Goal Report holds that South Africa has improved with respect to the following areas: towards achieving and securing pre-primary enrolment and a significant improvement in the National Senior Certificate (NCS) of 76% in 2014. Despite these improvements, national studies such as the Annual National Assessment (ANA) and international studies like the Trends in International Mathematics and Science Study (TIMSS) prove that South

[2] Quality education (Goal 4); Gender equality (Goal 5); Infrastructure (Goal 9); Reduced inequalities within and across countries (Goal 10); Peace, justice and strong institutions (Goal 16).

African learners perform far below the international standard. Findings from national articles (Mojapelo, 2018; Spaull, 2015) prove that key issues such as inadequate infrastructure, lack of resources at schools, and a lack of school management cause poor quality education.

Reddy et al. (2012) say that the Trends in International Mathematics and Science Study (TIMSS) points out that the following five contextual factors relate to learner achievement in mathematics: learners, teachers, classroom, school and curriculum. South African studies (Arends, Winnaar, & Mosimege, 2017; Carnoy & Arends, 2012) support a positive relationship between teacher knowledge and learner performance in the mathematics classroom. Reddy et al. (2016) say that TIMSS 2015 was the first time that Grade 5 learners in South Africa participated at this level in this international study. The study showed that 88% of Grade 5 learners reported having their own mathematics textbooks, but mathematics achievement scores remained 'low' at the Grade 5 level. The outcomes of the study proved that, although scores are 'low', change is possible to achieve higher scores. Learners are moulded from a young age to develop particular mathematical skills in order to thrive in this subject. Furthermore, Reddy et al. (2016) state that good-quality pre-school settings are instrumental in boosting the levels of learners in independent and fee-paying schools. Also, both tangible assets such as books and calculators, and non-tangible assets such as attitudes and expectations, matter in the classroom (Reddy et al., 2016).

2.5.2 Impact of ICT on mathematics

As we look at technology in the world today, we notice that some innovative and promising practices in the classroom involve technology. The mathematics curriculum is a formal curriculum that explicitly states the content of the subject (Oldknow et al., 2010). Additionally, mathematics teachers have no control over the curriculum they teach; therefore it is important that they understand the intended curriculum to be able to successfully implement the curriculum. Oldknow et al. (2010) further mention that ICT should be carefully

considered when integrating it into teaching and learning as it is not only confined to an 'electronic chalkboard', but could also aid a teacher in preparing a lesson.

As we live in a digital world, ICT is being used in an endeavour to help achieve academic goals in teaching and learning (Gibson et al., 2018). In conjunction with instruction and assessment, effective schools use technology with the purpose to engage learners in subject content and to improve learning (Schifter, 2008). A study suggests that children spend seven to eight hours a day using various digital media such as watching television, playing PlayStation and using other online media (Foehr, Rideout, & Roberts, 2010). However, Scheninger (2019) claims that it is absurd to assume that, because of the time children spend on using digital media, learners know and have the skills to use technology appropriately and productively. Thus, teachers generally understand that technology can improve learning, but lack the experience, time, training and skills to effectively engage with ICT tools in the learning process (Grundmeyer & Peters, 2016).

ICT training will provide learners with hands-on experience and the opportunity to learn skills that will be useful in the technological age (Oldknow et al., 2010). The integration of ICT into the curriculum allows learners to create their own knowledge. Although ICT are seen to be significant in teaching and learning, there are also many disadvantages that are faced by mathematics teachers and learners. Teachers' experiences in the classroom are closely linked to learners' attitudes and behaviours towards using ICT in the classroom. Fox (2018) claims that the misuse of technology is becoming a threat in the classroom and becomes an obstacle to teachers. Ribble and Bailey (2004) note that there is an increase in technology misuse in learning institutions. Learners may become distracted in schools that use tablets as a learning tool. Many researchers state that access to the internet is a cause for distraction in the classroom, as tuition time can be wasted when more time than planned is spend on using the internet (McCoy, 2016; Vahedi, Zannella, & Want, 2019). Therefore, Fox (2018) claims that the solution to this problem

is that curriculum developers should provide a guide for technology use in the classroom.

From the acquisition of ICT equipment, to modifying curriculum and teaching methods and to incorporating new educational tools, the introduction of technology faces significant challenges at all levels of the school system (Johnson, Jacovina, Russell, & Soto, 2016). Thus, teachers should use the TPACK framework in mathematics, which enables them to connect technology, pedagogy, content and knowledge in ICT teaching and learning (Blignaut, 2016). Hence, teachers need to always carefully consider the type of ICT hardware or software they employ in the classroom. The intention and purpose of the ICT tool should be thought through thoroughly before it is used in a lesson and should be monitored by the teacher throughout the lesson (Blignaut, 2016).

2.5.3 21st century skills

Teachers play an essential role in delivering quality education. The variety of methods they employ in the classroom heightens the understanding of mathematical knowledge and also the overall performance in mathematics. In the past, teachers were seen as mere figures for transferring knowledge to learners using traditional teaching methods (Agyei & Voogt, 2013). These days, teachers are encouraged to become qualified and equipped with the skills needed to operate technological equipment in the classroom. According to Blink (2016), if teachers do not possess the necessary skills to use ICT tools they will naturally feel anxious. Schools should develop initiatives and plans that encourage teachers to use these tools in teaching to benefit all learners. According to Botha, Van Putten, and Kundema (2019, p. 110), the 21st century requires learners to become visually literate in order “to enhance learners’ understanding of complex concepts, accommodate their needs, promote their logical and critical thinking, and develop their communication skills.” If the teacher therefore considers ICT beneficial in the classroom, enjoys using these tools and believes that learners will progress academically,

there will be an improvement in the quality of education and learners will be given the opportunity to develop their visual literacy.

As discussed in this paragraph, many literature studies provide the specific skills that teachers need when integrating ICT in learner-centred learning approaches. Every teacher has his or her own personal preferences when teaching, and the 'one-size-fits-all' approach is not appropriate in a learner-centred classroom (Davis, Preston, & Sahin, 2009). Binkley et al. (2012, p. 35) describe the competences of the 21st century as: "creativity and innovation; critical thinking, problem solving and decision making; learning to learn and metacognition; communications; collaboration; information literacy; ICT literacy; citizenship; life and career, and personal and social responsibility." These skills are confirmed by Griffim, Care and McGaw (2012), who emphasise that learning content must be merged with new technologies.

A successful 21st-century teacher should have the ability to integrate technologies with new pedagogies in non-traditional learning environments. Classroom management skills will be different, as technology creates ways that encourage learners to enhance learning in technological literacy, and to deepen and create knowledge. The ability to interact, communicate, develop, innovate and think critically is the foundation for information development as part of lifelong learning. Thus, teacher development is crucial in this process of learning. Hennessy, Harrison, and Wamakote (2010) state that teachers serve as models for learners in the learning process. This happens through their ongoing professional development in the education system.

2.5.4 Teachers' experiences and perspectives

Every teacher has a unique experience based on his or her interactions with ICT in the classroom. According to Fullan (2007, p. 35), "educational change depends on what teachers do and think: it's as simple and complex as that". There are various factors that influence teachers' experiences regarding technological integration in the classroom. Collis and Moonen (2001) identify

personal factors related to the individual teacher, which include knowledge and skills, beliefs, time and technology engagement. There are also institutional factors that are based on the value and belief system of the school that influence the continuous use of technology in teaching. The institutional factors that hinder the interactions of teachers include resources for teachers in schools, management and colleagues, engagement in decision-making, and the availability of technical tools (Eickelmann, 2011).

Collis and Moonen (2001) suggest that, if teachers initially have a positive experience using ICT in the classroom, they are more likely to build self-confidence to incorporate technology into teaching. Other researchers (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012), on the other hand, have noticed that it is unlikely for teachers to integrate technology into teaching if they lack confidence in using technology. One of the greatest impediments to ensuring the successful integration of ICT into classrooms is limited technological resources in schools. Collis and Moonen (2001) also state that environmental factors, namely electricity and the classroom setting, influence the level of integration by teachers.

2.6 Challenges to ICT adoption

There are many challenges that teachers experience when implementing ICT in teaching and learning (Ghavifekr, Kunjappan, Ramasamy, & Anthony, 2016). Infrastructure, hardware, software, technical support, professional development, teacher training and support, technology literacy and proficiency, as well as the attitudes of the teachers, are amongst the challenges explored for the purpose of this study.

2.6.1 Infrastructure

ICT infrastructure remains a challenge in many private and public schools throughout the country. ICT integration into teaching and learning requires sizable budgets and financial support (Rabah, 2015). It is important that schools continuously upgrade their infrastructure, and this includes installing

the latest Wi-Fi systems as well as maintaining existing technological tools. Amory, Rahiman, and Mhlanga (2015) state that every school needs to implement the principles for national ICT infrastructure.

2.6.2 Hardware in schools

ICT hardware is a generic term that refers to something you can physically touch, pick up and move around the classroom. In this study, we refer to the following tools as hardware used for teaching and learning:

Table 2.1*:* ICT Hardware

Hardware
Personal computers - A personal computer is stationed in a fixed position and can only be used by one person at a time. These computers are owned and maintained by the schools and thus make it difficult for teachers to take them home and continue working at home (Belanger, 2002). Some teachers have fixed computers in their classrooms.
Laptops - A laptop computer is a portable computer that can be taken from one place to another. Teachers mainly use laptop computers for administrative purposes and to assist them in setting up presentations. Laptops have replaced most personal computers, as they help teachers to reconfigure their classroom setup to suit their technology needs (Belanger, 2002). Often, teachers use their own laptops, or the school can provide them.
Tablets/iPads - A tablet or iPad is a portable computer that uses a touchscreen as its primary input device. In general, tablets are lighter than laptops and can easily fit into a backpack or briefcase. It is one of the most common devices used by learners in private schools for teaching and learning. This lightweight device easily connects to the internet and allows resources to be easily accessible during lessons. Tablets or iPads have a long battery life and are less prone to crashes. Thus, they are a reliable form of learning support and user-friendly devices that serve well as a learner-centred pedagogy (Tay, 2016).
Cell phones - A cell phone is a small, wireless device that requires a subscription to a mobile billing setup. Calls can be made from this device, but it is also used for playing games, using applications and for access to the internet. Cell phones are used as a means to search for and collect information in the classroom (Prensky,

2005).
Calculators - A calculator is a device used for doing mathematical calculations, and has a keyboard and visual display. According to Ochkov and Bogomolova (2015), calculators are integrated into cell phones and tablets, which makes it even easier for teachers and learners to access.
Digital cameras and video cameras - Cameras capture digital images that can be stored on a computer and displayed on a screen. A video camera records video clips on videotape and displays it on a monitor.
Image scanners – These are devices used to transfer images or text directly to a computer.
Printers and faxes - A printer is a machine for printing text or pictures directly from a computer.
Televisions (TV) - A TV is a device used to translate visual images into electronic signals, and to view them on a computer electronically.
DVD players - A DVD player is a device used for playing DVDs.
Interactive white boards - This is a large electronic screen used together with a computer that is used in a classroom to display information and can also be written on by touching with a finger or special pen.

2.6.3 Software in schools

With regard to mathematics, there are numerous tools that can be used for teaching and learning. There are many benefits of incorporating educational software into multimedia content, as it encourages a higher level of interactivity (Pećanac, Lambrić, & Marić, 2011). Below is a list of the main educational software that is used in schools to promote teaching and learning.

Table 2.2: ICT Software

Software
Computer application - This refers to educational applications that can be downloaded from an application (App) store. Software applications can be used with tablets, iPads and cell phones. They require data or internet in order to download

them onto the device. These applications can be used at any time and learners usually enjoy using them due to ease of access. These Apps refer to software loaded onto a computer that requires a licencing agreement. There is a variety of educational gaming software available on the market. This software is a combination of gaming and education in one. It is very effective for young learners, as it motivates them to learn.
Word processing - This includes Microsoft Word, which is the most common software used by teachers to develop class lists, mark sheets, examination papers or any typed communication. Another program is Microsoft Excel, which allows teachers to keep record of learner marks. Lastly, Microsoft PowerPoint is used by teachers to design presentations on the content to make learning easier and more attractive.
Internet - The World Wide Web (WWW) refers to the internet, which is filled with tons of information relating to a single topic. The internet is our main source of knowledge these days. It is updated continuously with the latest information. Teachers can use the internet to assist them in developing lessons that are entertaining, as well to obtain information that is recent.
YouTube videos - Videos are a popular source and are commonly used by many people. There are a variety of videos available that promote learning by using moving images and sounds to keep learners interested.
Audio stories or music - Audio stories or music is usually played from a radio and has only voice recognition.
Communication via electronic mail, electronic discussion and electronic chat - This refers to electronic mail. These days, many people use e-mails to communicate, as it is faster and allows teachers/parents to keep contact regarding the monitoring of learners' work.
PowerPoint presentations - These include presentations prepared by the educator that are presented in front of the class.

2.6.4 Technical support

Technical support is another complex challenge that prevents teachers from adopting ICT in teaching and learning. Several studies (Bingimlas, 2009; Carver, 2016) state that technical support is a major barrier for teachers when integrating ICT in teaching and learning. Technical barriers may include waiting for websites to launch, connecting to web browser, printers failing to

connect to the computer, malfunctioning computers, and working on outdated computers or laptops. These types of barriers cannot be avoided when integrating ICT in the classroom (Ghavifejr, 2016; Mirzajani, 2016). Classrooms, as well as the whole school environment, need good technical support to overcome the barriers when integrating ICT into teaching and learning. In addition, hiring IT professionals in the school setting can decrease the need for technical support (Singhavi & Basargekar, 2019).

2.6.5 Professional development, teacher training and support

Teacher professional development (TPD) refers to teachers' learning, the way they learn and how they use their expertise to improve student learning in practice (Avalos, 2011). UNESCO (2018) states that TPD should not be considered a once-off event, but rather a lifelong learning process. James and McCormick (2009) argue that schools should have a support system for TPD and thus should be given the opportunity to plan, implement and evaluate their teaching practices. Opfer (2016) says that teacher professional development is a necessity for teacher improvement in teaching and learning. Likewise, Dlamini and Mbatha (2018), mention that using ICT to transform education and improve learning activities should be implemented by using meaningful and effective development activities for teachers using ICT. Moreover, the IEA study (Law, Pelgrum, & Plomp, 2008) showed that the use of ICT in classrooms was linked positively to the attendance of ICT-related professional development workshops. Koh's (2019) study proved that teachers who received professional development gained the skills to infuse their pedagogical knowledge with technology integration.

UNESCO (2018) states that ICT competency for teachers describes three approaches: information acquisition, deepening of knowledge, and knowledge development. Figure 1 represents Version 3 of the ICT Competency Framework for Teachers, developed as a framework to direct teacher training on the use of ICT resources in education. These approaches are critical in the development continuum for education transformation and improvement. They

also have different implications for developments in the education system, such as understanding ICT in education, training and evaluation, pedagogy, digital technology implementation, organisation and administration, and professional learning for teachers. Amory et al. (2015) state that a regulatory framework exists in ICT, but there is no evidence of the implementation of it in TPD. TPD should be seen as a framework for pre-service, in-service and continuing growth in the education system in order for teachers to remain confident in their teaching and learning.

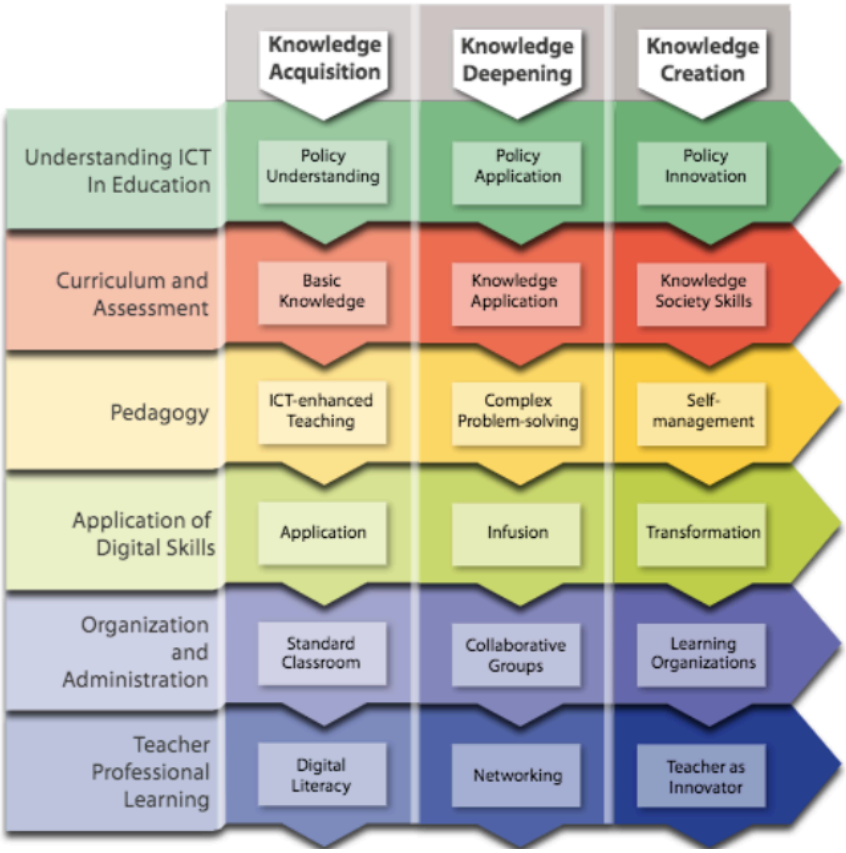


Figure 1: UNESCO (2018) ICT competency framework for teachers

ICT should not only be used to scaffold learners, but should also be used for TPD (UNESCO, 2018). Using ICT in the classroom does not only require teachers to have subject content knowledge, but also technical skills and knowledge of ICT. Suryani (2010) claims that teachers who use technology in their classrooms have the duty to not only update their subject knowledge, but also their technological skills. Dlamini and Mbatha (2018) mention that South

Africa continues to struggle with the usage of ICT in education and teacher professional development, although the country has invested massively in this sector. In addition, UNESCO (Khoroshilov, 2010) clarifies that the first step to improving ICT in education is to improve teacher development. Thus, teacher development is one of the most significant factors for using ICT effectively in the classroom.

TALIS (OECD, 2009) reported that 25% of teachers indicated that they required a high need for ICT teaching skills. As time passes, it is becoming increasingly important that teachers are able to use ICT tools in their teaching. Leendertz (2013) has developed a set of guidelines for the professional development of Mathematics teachers using ICT which states that integration and implementation begins with the DBE followed by the provincial department, school management team and the mathematics teachers themselves. Moreover, university and teacher training institutions should train pre-service teachers to connect their technological, pedagogical and content knowledge to integrate ICT into education (Sun, Strobel, & Newby, 2017). Furthermore, Koh's (2019) study proved that teachers who received professional development gained the skills to infuse their pedagogical knowledge with technology integration.

The skills learnt during teacher training differ vastly from those in the classroom. Dlamini and Mbatha (2018) emphasise that teachers learn different strategies during teacher training; however, the situation is completely different when they employ these strategies in the classroom. Gudmundsdottir and Hatlevik (2018) state that most training in ICT lacks attention to the context in which teachers' teach. ICT teacher development training is costly and differs in design (Dlamini & Mbatha, 2018). Every teacher possesses a different level of ICT knowledge and, at times, the training does not fulfil the requirements of every teacher. However, De Clercq and Shalem (2014) claim that professional development programmes vary in duration and pace according to the level of every teacher. Also, the resource

material and artefacts have to be taken into consideration in teacher development.

Research studies state that there is a lack of integration of ICT into the organisational culture at the school and district level (Amorey et al, 2015; UNESCO, 2018). Educators, together with school management teams, make less use of ICT in the implementation of their responsibilities. Teachers and principals are isolated from e-learning knowledge units, thus leading them to have superficial knowledge of e-education policies. The new system adopted by many schools is the South African School Administration and Management System (SA-SAMS). This system has enhanced the quality and efficiency of capturing data at the institutional level. However, this system is not web-enabled, thus its functionality is questioned, as it is underutilised. This results in on-going technical and user support problems, causing schools to use other software (Amory et al., 2015).

2.6.6 Technological literacy and proficiency

Technological literacy can be defined as the whole of the intellectual process that individuals need to understand about the relationship between technology and themselves and technology and society (Ergün, Fidan, & Yildirim, 2019). Being technologically literate means to be knowledgeable about technology that enables one to use technology accurately and effectively. According to a study conducted by Ergün et al. (2019), a teacher who is technology literate will have positive benefits for the future of teaching and learning. This will enable the teacher to develop fun and innovative ways of using ICT in the integration of mathematics teaching and learning. However, a study conducted in the United Kingdom revealed that teachers with less than 10 years experiences often created their own digital resources (Morante & Loez, 2008). In addition, it is noticed that younger teachers are more likely to adapt the use of ICT in mathematics classrooms.

Technological proficiency is the ability a teacher possesses to use technology effectively and professionally in the classroom. The teacher has the skills and ability to organise information and produce high-quality products created by using ICT. A presentation to the Parliamentary Portfolio Committee in 2014 stated that training related to ICT integration training was under way through Intel South Africa, in collaboration with the DBE (Gant & Meyer, 2016). Furthermore, Gant and Meyer (2106) mention that in 2014, the status of teachers' ICT proficiency in South Africa stated that 26% of teachers have basic ICT skills, while only 7% possess intermediate skills in the use of ICT in teaching and learning. Therefore, teachers' lack of proficiency in the classroom is another explanation for their reluctance to integrate technology into teaching and learning (Carver, 2016). Teachers who have less technological experience will have low technological proficiency, as they will not be able to use its tools productively and to their full capacity. Furthermore, a teacher with low proficiency may be reluctant to adopt new technology (Boot et al., 2017).

2.6.7 Attitudes

A study conducted by Jimoyiannis and Komis (2007) identified three separate teacher groups – a group of teachers with positive attitudes, a group of teacher with negative attitudes, and a third group with optimistic views about ICT in education. Player-Koro (2012) further suggests a model of different variables relating to teachers' use of ICT in classrooms. This model shows that there are two factors that influence the use of ICT the most, namely the teachers' positive attitudes and a strong sense of self-efficacy in using computers in education. Surprisingly, the study further states that teachers' confidence in using ICT generally does not necessarily contribute to teachers' use of ICT in classrooms.

A study conducted using 700 Nigerian secondary school teachers focused on the effect of the use of ICT by teachers on the implications for further advancement of ICT, and showed that most teachers consider ICT as very

useful and that it makes teaching and learning simpler (Tella, Tella, Toyobo, Adika, & Adeyinka, 2007). According to a study conducted by Uluyol and Sahin (2016), three factors were highlighted that motivate teachers to use ICT in the classroom: incentives, support and benefits. The incentives assist teachers' decisions to use ICT; support assists them in overcoming challenges in ICT use; and benefits help teachers to continue to use ICT.

2.7 International studies of ICT in mathematics teaching and learning

Mdlongwa (2012) describe ICT as a global network and a platform to exchange ideas, information and share knowledge through devices such as cellphones or computers. Although research is conducted on ICT in education; the UNESCO Institute for Statistics argue that it remains a major challenge collecting data regarding ICT in an education setting (Barakat et al., 2016). Many countries around the world have developed ICT policies for successful integration into teaching and learning in order to achieve national goals of reducing the digital divide, for example, Nigeria views ICT as significant and has integrated it as a tool for transformation in their educational policies (Rena, 2008; Achimugu, Oluwagbemi & Oluwaranti, 2010; Gibson, Broadley, Downie & Wallet, 2018). However, despite the ICT policies many countries face challenges during implementation in the school and classroom setting (Kazima & Winter, 2013). Ghanaian teachers from public schools state a lack of sufficient ICT skills and face discomfort when integrating ICT in teaching and learning (Yidana & Maazurre, 2012). A study conducted by Munyengabe, He & Yiyi (2018) reveal that public schools in Rwanda have a high need to use ICT tools in teaching and learning in primary schools. Furthermore, Rwandan teachers lack technological knowledge related to teaching and learning processes. Likewise, schools in Swaziland lack basic ICT infrastructure to support ICT integration and teachers are not competent in using ICT into teaching and learning (Simelane, 2013).

An international study on ICT integration in European schools state that ICT is diffused widely with continuous development in the United Kingdom as 75% of

primary school are connected to the internet, 97% of these schools have access to the internet in the classroom and 85% of primary schools teachers possess high confidence to use ICT (Morante & Lopez, 2008). Likewise, in 2006 it was found that 96 % of teachers in Danish primary schools used ICT in their teaching, where ICT was mainly used for planning and preparation rather than teaching time. Therefore, it is noted that ICT is present in primary education in several developed countries. In contrast, to many developing countries with underperforming economies (Barakat, et al., 2016).

In this context, to further investigate teachers' experiences of ICT in a mathematics classroom, the most widely known framework, Technology Acceptance Modal (TAM), have been used in this study. The next section explains this framework in relation to the study.

2.8 Theoretical framework

A theoretical framework best suited to this study as determined from the literature review is that of the technology acceptance model (TAM), originally developed by Fred Davis in 1985 (Chuttur, 2009). TAM was based on Ajzen and Fishbein's 1975 Theory of Reasoned Action (TRA) and by Ajzen's 1985 Theory of Planned Behaviour (TPB) (Venkatesh & Davis, 2000). Using these two theories, TAM was fitted to the context of technology acceptance and usage (Olushola & Abiola, 2017). This theoretical model is one of the most significant models on theories of human behaviour. The purpose of TAM as a system is to recognise determinants involved in computer acceptance in general, and to observe an array of behaviours related to technology usage (George & Ogunniyi, 2016). The model's main purpose is to demonstrate that the motivation of users can be calculated by three factors: perceived ease of use, perceived usefulness, and attitude towards using the system (Chuttur, 2009). For the purpose of this study, TAM is used as a framework to assess Grade 5 teachers' extent of ICT usage in mathematics, how ICT can improve teaching and learning, ICT barriers experienced by teachers as well as training, support and professional development experienced by teachers.

Figure 2 below illustrates the TAM model that demonstrates the relationship between the different variables.

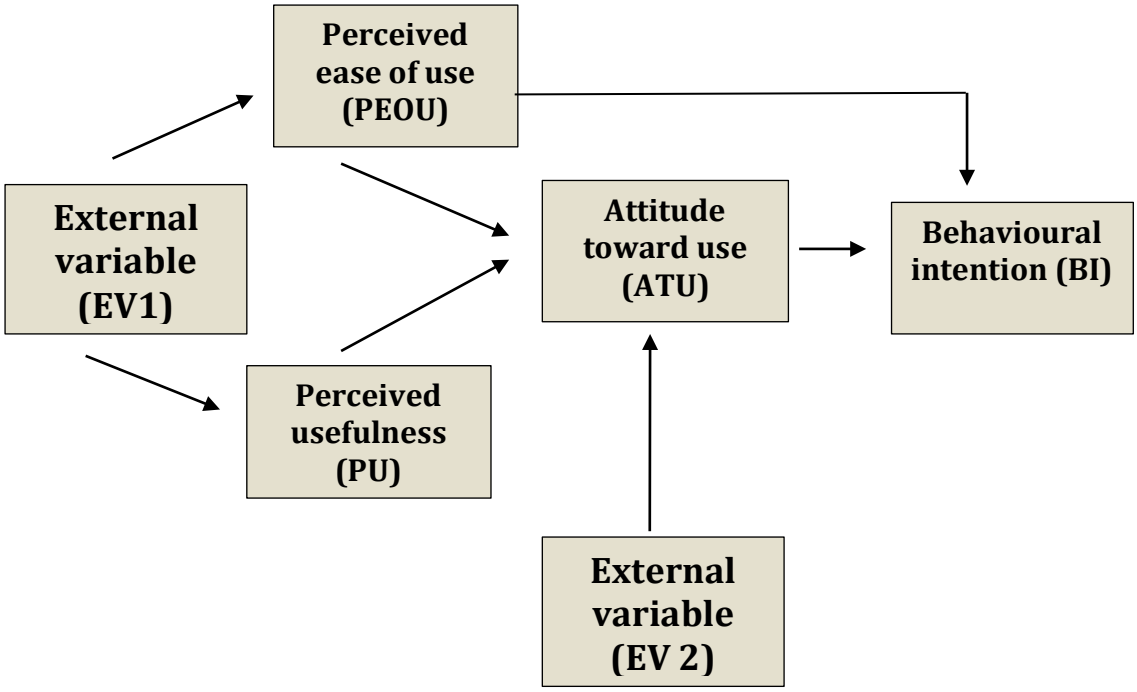


Figure 2: Technology acceptance model [adopted from Davis (1985)]

This framework specifies the relationship between these essential factors that determine the relationship between individuals and technology systems. As depicted in the framework above, each variable is explained in relation to its contextualisation:

External variable (EV 1): Within the context of integrating technology into teaching and learning, the external variables consists of the barriers that teachers face that are beyond their control. This external variable has a direct influence on the perceived ease of use (PEOU) and perceived usefulness (PU) of using the technology. These external variables refer to *contextual* factors, such as access to resources, technical support and training in the school environment. Other challenges include, but are not limited to, inadequate accessibility of resources and network connectivity, limited school ICT facilities, lack of effective training, limited time and lack of teacher skills (Ghavifekr et al., 2016).

Perceived usefulness (PU): This concept is defined as the degree to which a person regards technology as enhancing performance in the classroom (George & Ogunniyi, 2016). An individual will adopt a new technology if they consider the technology to be useful in the classroom. The following factors are key elements to determine if the teacher will use the technology in the future: the ICT tools will work more efficiently, performance at work, increased productivity, efficiency and, lastly, how useful the actual tool is (Ghavifekr et al., 2016).

Perceived ease of use (PEOU): The perceived ease of use indicates the level of easiness to use the technology, which should be easy to understand and free from physical and mental effort (George & Ogunniyi, 2016). An individual develops a positive attitude if the technology is easy to use in the classroom. ICT tools should be easy to acquire, clear and logical, easy to use, easy to control and easy to remember (George & Ogunniyi, 2016).

Attitude towards use (ATU): Attitude towards using the system refers to the positive and negative feelings of individuals about performing a target behaviour. Central to the behaviour of a teacher to use ICT in the classroom is his or her attitude towards using technology. An individual's attitude is affected by three factors: perceived ease of use, perceived usefulness, and an external variable.

Behavioural intention (BI): This relates to the degree to which the teacher has made a conscious decision whether or not to conduct the behaviour in the future. Intention has a close link to actual behaviour that the individual will carry out in the classroom.

External variable (EV 2): This external variable has a direct impact on the attitude towards using (ATU) the technology. These variables include *personal* factors, such as anxiety, literacy/ability, inspiration, personal beliefs, teaching philosophy and feelings of inadequacy.

Thus, the TAM framework suggests that users' BI determines the ATU of a technology, which is an outcome of an individual's attitude towards using a particular ICT tool. Tran and Stoilescu (2016) state that TAM focuses more on the beliefs about the technology than the outcomes of using it. It is widely noted that, depending on a person's gender, age or experience, these will affect how they perceive technology. Stols et al. (2015) state that South African mathematics teachers fail to use technology optimally during instruction. In a more recent study, Graham, Stols and Kapp (2020) mention that, even though teachers are provided with the required resources, technical support and ICT knowledge, they will not necessarily implement ICT usage in the classroom. This ultimately leads to the determinant that the use of technology is a matter of a person's beliefs. The TAM works perfectly for this study, as it interprets the information we are seeking to explore through the research questions. The themes used in this study were derived from the TAM model and were used to address the research questions.

2.9 Summary

This chapter has outlined the importance of mathematical philosophies in education, ICT policies, the curriculum enacted by the South African education system as well as statistics based on past research studies. Furthermore, the literature review gave insight into the 21st Century South African classroom; barriers and challenges for ICT adoption, including the hardware and software used in teaching mathematics were discussed. Teacher professional development, training and support relating to technology were also detailed. Lastly, this chapter dealt with the theoretical framework for this study. The next chapter focuses on the research philosophy, choice of method, research strategy, research techniques and procedures. We also look at the quality criteria and ethical considerations for this study.

3. CHAPTER 3: Research design

3.1 Introduction

This chapter describes the research design, represented using a research onion (Saunders & Tosey, 2013). This research onion portrays the different layers in research design, namely the philosophy of research, methodological choice, research strategies, time horizons, and techniques and procedures.

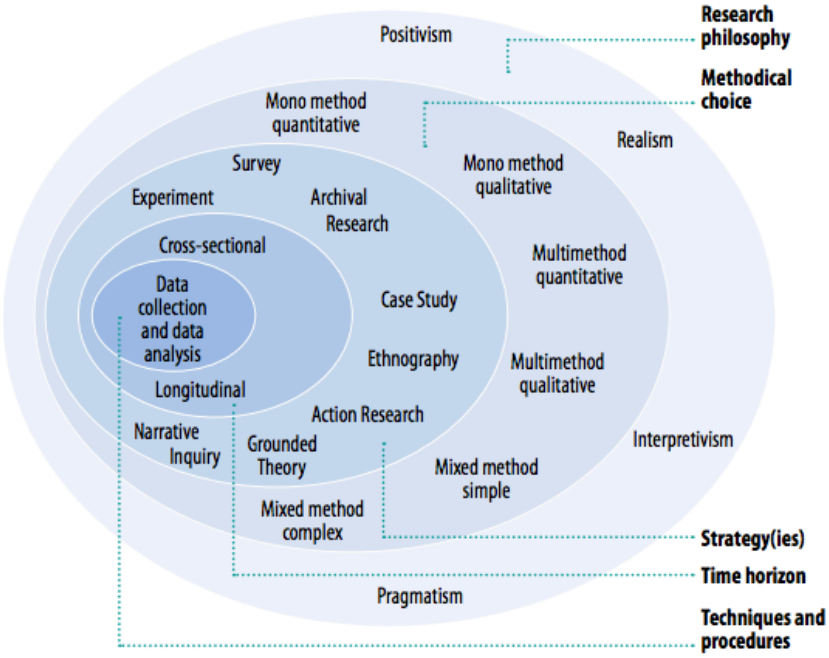


Figure 3.1: Research design (Adapted from Saunders & Tosey, 2013)

The research onion explicitly displays the layers in the research design, and each layer is explained in this chapter. The explanation starts with the research philosophy, as the outer layer that guides the study. The research method, research strategy and data collection techniques are also discussed. The chapter ends with a discussion of the quality criteria and ethical considerations.

3.2 Research philosophy

The key theoretical perspective that forms the foundation of this research is interpretivism. The constructivist paradigm is often used interchangeably with interpretivism. This paradigm is derived from the fact that human beings have their own interpretations of the world, and that the techniques and knowledge they use to understand human and social sciences differ from those of the physical sciences (Hammersley, 2013). Therefore, interpretivists adopt a relativist ontology in which there is no single truth, but rather multiple interpretations of a single reality. The interpretivist paradigm allows researchers to explore and develop a profound understanding of the phenomenon and its complexity in an exclusive setting, instead of generalising to the entire population (Creswell, 2007). Furthermore, interpretivists focus on a particular context and believe that reality is socially constructed. According to Kankam (2019), interpretivist researchers explore the relationships of human beings deeply, and the role they play in the environments in which they create a social fabric. Essentially, this paradigm reflects the importance of interpreting the participants within a context that gives rise to the recognition of subjective understanding (Kelly, Dowling, & Millar, 2018).

This research is a study of teachers' experiences of ICT use in Grade 5 mathematics classrooms. Interpretivists seek to interpret and understand a concept and the world in which they live, and believe reality is socially constructed, that there are multiple realities and that reality is subjective in nature. In terms of this paradigm, they develop subjective meanings of their experiences (Maree, 2016). Accordingly, true research can only be conducted by interpreting the subject deeply. Hence, along the lines of this paradigm, I gathered data from six mathematics teachers who teach at various private schools and had subjective experiences of the classroom. As an insightful conversation with the participants was established, I could gather rich data, which was imperative to answering the research questions. In the next section

the methodological choice that guided this research study is explained in detail.

3.3 Methodical choice

Thanh and Thanh (2015) state that most researchers believe that interpretivists favour the use of qualitative methods in their studies. Maree (2016) describes research as a logical and structured procedure that investigates a definite problem that requires a solution or answer. He further states that research also provides the needed information that guides researchers to make knowledgeable decisions to deal successfully with any difficulties that may be experienced. Thus, in order to successfully organise the information, the qualitative approach was used as a driving force in this study in order to explore and discuss the mathematics teachers' experiences in teaching and learning. As there are many dynamics that exist in teaching, qualitative approaches are considered more effective than quantitative techniques (Lochner, Wieser & Mischo-Kelling, 2012). The qualitative approach assisted me to explore the *understanding* and *experiences* of these mathematics teachers. The characteristics of the interpretivist paradigm in its approach to reality are in contrast with the positivist paradigm, which uses the quantitative approach in research. Willis (2007) states that a qualitative approach offers rich data, which is essential for interpretivists to fully understand the phenomenon. Many researchers (Denzin, 2017; Preissle, 2006; Van Maanen, 1979) have created their own definitions that reflect the nature of qualitative research. Taking each definition into consideration, the most concise definition is that qualitative researchers are concerned with how people understand and interpret their worlds, how they make sense of their world, and how they use their experiences to construct their own meanings (Merriam & Tisdell, 2016).

The researcher is the main instrument for data collection in qualitative analysis, and the essence of the work is usually carried out in a natural setting. Maree (2016) further states that qualitative research enables the researcher to develop his or her understanding through oral communication,

as well as process, clarify and summarise the data. In this research method, it is essential to check for accuracy of interpretation and explore unusual responses obtained in the study. The research methodology for this analysis is illustrated in Table 3.1.

Table 3.1: Outline of the Research Methodology

Research method	Qualitative				
Research strategy	Descriptive case study design Cross-sectional				
Main question	How do Grade 5 mathematics teachers from well-resourced schools experience the use of ICT in their classrooms?				
Research sub-questions	**Question 1** What are the barriers that hinder teachers' abilities to make use of these resources?	**Question 2** In what way are the available technological resources used to enhance teaching and learning?	**Question 3** What are the views of mathematics teachers regarding the use of ICT in the classroom?	**Question 4** What technical training did the teachers receive to integrate ICT into the mathematics classroom?	**Question 5** What support is available for teachers to integrate ICT into the mathematics classroom?
TAM model	Perceived external barriers	Perceived ease of use Perceived usefulness	Attitude towards use External variables Behavioural intention	Professional development	Professional development
Participants	Six Grade 5 mathematics teachers from well-resourced, independent schools in Tshwane				
Data collection techniques	• Questionnaire • Semi-structured Interview				

Techniques per question	Questionnaire Semi-structured Interview
Data analysis	Deductive data analysis – a set of categories that were pre-determined in the conceptual framework.
	Atlas.ti software was used to code the data.

3.4 Research strategy

A *descriptive case study* research design was selected to guide the qualitative approach. Case studies as a research design explore and examine real-life issues through detailed contextual analysis of a limited number of participants and their relationships (Maree, 2016). Using a case study in this research enabled me to gather insights into the detailed experiences of the participants as a sample population.

A case study is about studying the phenomenon within its context. A researcher will select a case and study its relationship with its context. A case study is an intensive investigation of the phenomenon under investigation. A case study method was appropriate for this research study as it facilitated an intensive study and an in-depth analysis of a social unit that helped in clarifying established theory. In-depth and comprehensive information was collected through this method to gather data. A case study allowed me to use methods such as interviews and questionnaires, which were appropriate for this study.

3.5 Time horizons

The timeframe for this study was *cross-sectional.* This means that information was collected from the different participants in different contexts over the same period of time (Doja et al., 2016). This study was conducted at only four different private schools in Tshwane due to time constraints. Thus, data were collected over a limited period of time before it was interpreted.

3.6 Research techniques and procedures

This section discusses the researcher's role in selecting participants and sampling procedures for the study, the data collection strategies, the approach to data analysis, the instruments used for data collection, and the data collection procedures.

3.6.1 Selection of participants and sampling procedures

According to Patton (1990, p. 184), "in qualitative research there are no rules for the sample size". Maree (2016) further states that the sample size depends on the depth of the research question, the type of research design, the skills and experience of the researcher, and the time and funds available for the researcher to conduct the research. In this study, *purposive* and *convenience* sampling were used, as members were chosen with the purpose to represent a specific phenomenon. The sample size is an important consideration, as it determines the level to which the researcher can make generalisations. As I am a Grade 5 mathematics teacher, it was appropriate for me to select Grade 5 mathematics teachers as participants in this study. ICT is significant in primary schools as it aids learners to learn effectively and use these skills in the future of their education (Munyengabe et al, 2018). I currently work at a public school and there is a lack of technological resources for teaching and learning. As a mathematics teacher I had the drive to investigate the extent of ICT usage in private schools. Thus, for the purpose of this study, the sample size was chosen carefully in order to gather the most appropriate information and answer the research question in an informed manner.

The target population for this study therefore was Grade 5 mathematics teachers from independent and well-resourced schools. These teachers were from varying backgrounds, disciplines, and technological and educational experience. A sample of six Grade 5 mathematics teachers from four different schools in Tshwane were used for this study. Teachers A and B belonged to

School 1, Teachers B and C belonged to School 2, Teacher E came from School 3 and Teacher F came from School 4. These schools were chosen based on their location being accessible to the researcher. The sample size has to be feasible in terms of money and time, and practical issues of accessibility had to be considered (Maree, 2016). Time and practicality were key issues in this study. Thus, although a larger sample size would have been preferred, time and resources were limited. Table 3.2 below lists the inclusion and exclusion criteria for the sample.

Table 3.2: Inclusion and Exclusion Criteria

	Criteria
Inclusion	Independent, well-resourced schools Located In Tshwane Grade 5 mathematics teachers Male and female teachers Different races and backgrounds Different performance levels
Exclusion	Government/public schools Non-mathematics teachers

3.6.2 Data collection process

It is important to determine the appropriate data collection techniques, as this will enable the researcher to get the most reliable and accurate information. With qualitative studies, the methods are usually interviews, focus groups, and observations. The data collection methods that were used for this study were questionnaires and an individual, semi-structured interview schedule.

Data collection was done at four well-resourced independent schools in Tshwane. Initially, it was hoped to use six teachers from three private schools, but due to teacher commitments an alternative school had to be contacted. The principals of all four schools were asked for permission to have their

teachers participate in the study. Three letters of consent were given to each school: for the head of school holdings, the principal and the Grade 5 mathematics teacher. Once permission was granted by the head of school holdings and the principal, the Grade 5 mathematics teachers were contacted personally to make arrangements. The data collection process involved the teacher completing a six-page questionnaire that took less than 30 minutes to complete. Thereafter, a suitable date and time were arranged to conduct an interview within a week. The interview took no longer than 60 minutes. This data collection process was consistent for all six teachers.

The data collection process took place during the first term of the school year in 2019. Table 3.3 provides a timeline that reflects the dates on which each teacher was given a questionnaire and then participated in an interview.

Table 3.3: Timeline for Data Collection

Participant	Data collection instrument	Date
Teacher A	Questionnaire	26 February 2019
	Interview	05 March 2019
Teacher B	Questionnaire	04 March 2019
	Interview	11 March 2019
Teacher C	Questionnaire	04 March 2019
	Interview	11 March 2019
Teacher D	Questionnaire	07 March 2019
	Interview	14 March 2019
Teacher E	Questionnaire	07 March 2019
	Interview	14 March 2019
Teacher F	Questionnaire	28 March 2019
	Interview	04 April 2019

3.6.3 Instruments for data collection

The instruments that were used for data collection were questionnaires and semi-structured interviews. Each method is discussed in detail below.

3.6.3.1 Questionnaire

Questionnaires can be regarded as written interviews where data is obtained regarding teachers' experiences (Maree, 2016). Although, a questionnaire is classified as a quantitative instrument, for the purpose of this study it was used as a strategy to gather 'primary data' in order to explore and discuss these mathematics teachers' experiences in teaching and learning (Harris & Brown, 2010). A structured questionnaire was used in this study to assess the opinions, beliefs, attitudes and current mindset of a particular population (Maree, 2016). Questionnaires are instruments that are easy to use and that elicit information that the researcher is looking for. The questionnaire was a simple six-page document that required the participant to circle or tick the applicable answers. The data collected from the questionnaire composed of demographic questions followed by closed ended questions that provided information about the teachers' experiences. Participants responded to prompts by selecting from predetermined answers (Harris & Brown, 2010).

The questionnaire in this study was based on the TAM framework. The flow and sequence of the questionnaire enabled the participants' to carefully understand the purpose of the research. Each sub-research question was categorised and organised in a manner that linked with the variables in the TAM model. Furthermore, the content of the questionnaire related to the broader research questions as well as to the understanding of relevant concepts and relationships. The questionnaire was self-administered by the participants and given to them to answer within one week on their own to prevent the researcher influencing their views. This technique of collecting data enabled the researcher to interpret and organise information that assisted in answering the main research question.

3.6.3.2 Interviews

Maree (2016) states that an interview is a two-way conversation between the interviewer and participant. The interviewer asks the participant the relevant questions with the intention to collect relevant data. This enables the interviewer to come to understand the teachers' beliefs, views, opinions and experiences. An interview allows the researcher to gain valuable insight into the situation through the eyes of the participant. These interviews consisted of open-ended questions that guided the conversation and gathered insight into the teachers' training, support and use of technology. All the interviews were conducted in English.

A semi-structured interview schedule was used to conduct the individual interviews, for which a set of guided questions was used to elicit a discussion. Each interview question was categorised according to the TAM framework. During the interview, I treated the participants with respect and gave them the space to express their thoughts and perspectives. The interview was audiotaped with the permission of the participants, after which I transcribed the interviews.

3.6.4 Data analysis approach

Flick (2018) states that scholars should consider the importance of data collection and analysis, as well as the relationship between theory and data. He further states that there are two ways in which the relationship between these two variables are related in the research process. Firstly, you can relate data in a linear-sequential approach, which means that the data is first collected and then analysed. This is in contrast with an iterative approach, in which there is an interplay between data collection and analysis.

Flick (2018) states that, in qualitative research, patterns, concepts and theories begin to emerge from the data as the researcher interacts with the data. Deduction begins from a particular theory or rule and examines how the

raw data supports the rule. In qualitative research, deduction often means that data is analysed according to an existing theoretical framework. The aim of this approach is not to 'test' the theory, but to adopt the theory as an analytical tool when collecting data. In addition, Flick (2018) mentions that this approach allows researchers to attend to detail in data that otherwise might be overlooked. The theoretical framework forces the data into its relevant themes or categories.

The data collected during the research process is valid information that the researcher can use to help answer the research questions. The aim of qualitative research is to seek for patterns, concepts, themes and meanings. This study adapted a deductive data analysis strategy that analysed data according to pre-determined categories as identified in the framework. This approach complemented the main research question, as themes and codes were apparent in the form of the TAM framework.

The reasons for using a deductive approach:

- The research question was used to group the data and then look for similarities and differences;
- In this study, time and resources were limited.

3.6.5 Data analysis procedures

Qualitative data analysis is concerned more with meaning, whereas quantitative data analysis is expressed numerically. Bogdan and Biklen (1982) define qualitative data analysis as "working with the data, organizing them, breaking them into manageable units, coding them, synthesizing them, and searching for patterns" (p. 145). The method of qualitative data analysis entails making sense of various text or image data. According to Creswell (2007), data analysis is a process that involves preparing data for analysis, conducting different analyses, and also moving deeper and deeper into understanding the data. Representing the data and interpreting the larger meaning of the data are critical to this process. Furthermore, Creswell (2007)

states that data analysis involves collecting open-ended data based on questions asked during the study and developing an analysis from the information supplied by the participants. The steps are described in detail below:

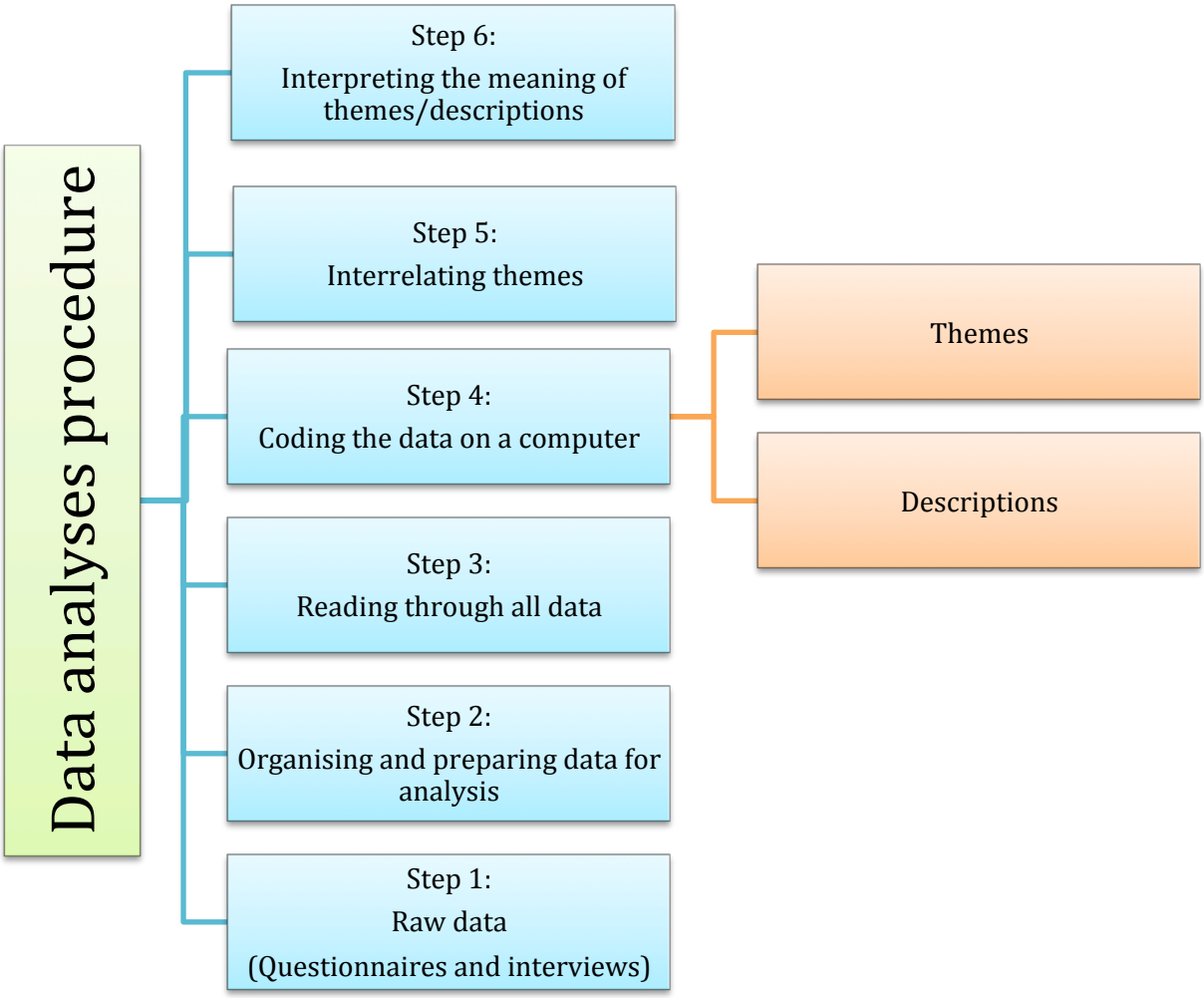


Figure 3.2: Data analysis process

Step 1: Raw data. Participants have completed the questionnaires and interviews have been conducted. The interviews are audio-recorded and are in their original form. These instruments and tools are needed to begin with the data analysis process.

Step 2*:* Organise and prepare the data for analysis. In this step, the data needs to be transcribed as text in a word document. The data needs to be sorted and arranged by optically scanning the data into different categories.

Step 3*:* Read through all the data. In this step, a general sense of the information and the overall meaning of the information should be gained. This step allows the researcher to get to know the data. The researcher needs to read and re-read all data, writing down impressions and becoming familiar with the data collected.

Step 4*:* Coding the data on a computer. According to Creswell (2007), coding is the method of organising the information into chunks before bringing meaning to it. For this qualitative study, computer software was employed to effectively code the data into relevant themes. Atlas.ti is computer-aided software that was used to analyse and interpret the data through coding and annotating activities (Friese, 2019). Data analysis in qualitative research is an ongoing process, and the Atlas.ti software enables researchers to make sense of, interpret and theorise about the data that is collected from the interviews and questionnaires. Therefore, in this study, the researcher recorded all questionnaire and interview notes in a blank Microsoft document and the Atlas.ti software assisted in breaking the data into themes. The Atlas.ti software created a description of the participants.

Step 5*:* Interrelated themes. A narrative passage was used to convey the findings of the analysis. A chronology of events, and a detailed discussion of several themes and interconnected themes are provided. Visuals such as bar graphs and tables are used in conjunction with the discussions to summarise and give an overview of the findings.

***Step 6**:* The final step in the data analysis involved interpreting the meaning of the data. In this step, the researcher's personal interpretation, experiences and history are involved in the study. Previous literature or theories are used to compare findings.

3.7 Quality criteria

In qualitative research there are several ways to assess the quality criteria of the field of research. According to Creswell (2010), validity is one of the strengths of qualitative research and indicates trustworthiness regarding the activities associated with the phenomenon. It is based on determining whether the findings are accurate from the standpoint of the researcher, participants or readers. The following validity strategies were used in this study to enhance its trustworthiness (Korstjens & Moser, 2018):

Table 3.4*:* Quality Criteria

Quality criteria	Strategy
Credibility	This refers to the correspondence between the way the respondents actually perceive social constructs and the way the researcher portrays their viewpoints. In this study, I chose quotes from the interviews carefully to fit with the purpose of the study.
Transferability	The researcher gives a 'thick' description and avoids generalisations in this study and gains an understanding of the participants' perspectives to enhance the trustworthiness of the study.
Dependability	The extent to which the researcher relates the research findings to similar findings in a similar context. Multiple data sources were used to interpret the data.
Confirmability	Confirmability was ensured in this study by using audio-recorders to record the participant interviews. According to Korstjens and Moser (2018), transcripts should be checked to make sure no mistakes are made during transcription.

3.8 Ethical considerations

For the purpose of this qualitative study, the researcher took into consideration that there was a need to interact with the participants involved in the study to gain an insight into the teacher's experiences. There were many ethical issues that were addressed before, during and after the research was conducted. The researcher should always respect the rights, desires, values and needs of the participants in the study (Creswell, 2008). Miles and Huberman (1994) list some of the issues that researchers need to consider when analysing data:

- Obtain informed consent from the heads of schools, principals and teachers
- Obtain ethical clearance from institution/university concerned
- Be aware of possible harm and risk involved
- Ensure honesty and trust
- Ensure privacy, confidentiality and anonymity

As Silverman (2000) states, the relationship between the researcher and the subject during research is a delicate aspect and needs to be considered carefully in terms of the principles and values of the researcher. Cultural sensitivity is an important aspect to be taken into consideration during research. Thus, strict ethical guidelines were followed during the entire research process in order to uphold the participants' confidentiality, privacy, dignity, human rights and anonymity, and their right to withdraw from the study at any point.

The first step in conducting this research was to gain approval for the study from the ethics committee of the University of Pretoria. Silverman (2016) states that ethics is very important in conducting research, and universities try their best to protect the rights and dignity of the participants. Therefore, once the ethics committee had approved this study, the data collection process was undertaken to complete the study. Several other ethical considerations were

also taken into consideration to ensure that the study was conducted in an appropriate manner.

According to Silverman (2000), researchers should always respect their participants when they enter their private spaces to conduct research. Thus, the heads of school holdings, principals and participants had to sign letters of consent to participate in this study (see Appendix A). After the participants read the letters, they gave their consent by signing the letters. Most of the participants were contacted via email to arrange for a suitable date and time for both the participant and researcher. This allowed communication to be kept on a professional level. All individual interviews were conducted at the participants' respective schools. Again, before conducting each interview, the participants' were verbally reminded about their rights and ethical issues relating to the research. Permission to audiotape the interview was given by the participants, and they were also reassured that only the researcher and her supervisors would have access to these audio records. The questionnaire was anonymous and contained no references to the participant his/her school. Pseudonyms were used during the course of the study to refer to the participants.

3.9 Summary

This chapter outlined the research methodology, strategies, research techniques and procedures, selection of participants and also the process of analysing the research data. Quality criteria and ethical considerations were also looked at. The next chapter presents the data and discusses the research findings of this study.

4. CHAPTER 4: Presentation and discussion of findings

4.1 Introduction

This chapter presents the findings and discusses them according to the themes set out in the theoretical framework, namely the TAM model. The framework highlights the relationship between individuals and the technology used. The primary focus in this study was on Grade 5 mathematics teachers' experiences of the use of ICT in their classrooms. The chapter commences with information regarding the six participants and the coding of the data, and finally the presentation of each participants' data, relating it to the literature review.

4.2 Data analysis process

Firstly, questionnaires were used to tabulate the biographical information of each teacher: age, gender, qualification, experience and computer usage. Thereafter, the teachers' responses in the questionnaires were analysed. The responses were categorised according to a rating scale: 1 - Strongly agree; 2 - Agree; 3 - Neutral; 4 - Disagree and 5 - Strongly disagree. Bar graphs are used to present the data of the six teachers. The data from the interviews was used to further explain and give details of the findings from the questionnaires.

4.3 Pre-determined themes

A deductive data analysis approach was used when coding the data based on the themes in the TAM model. The themes are: perceived external barriers (EV 1); perceived ease of use (PEOU); perceived usefulness (PU); attitude towards use (ATU); behavioural intention (BI); and external barriers (EV 2) that affect the teachers' attitudes to using ICT in the classroom. Figure 4.1 below depicts the respective themes identified in this study through the TAM model.

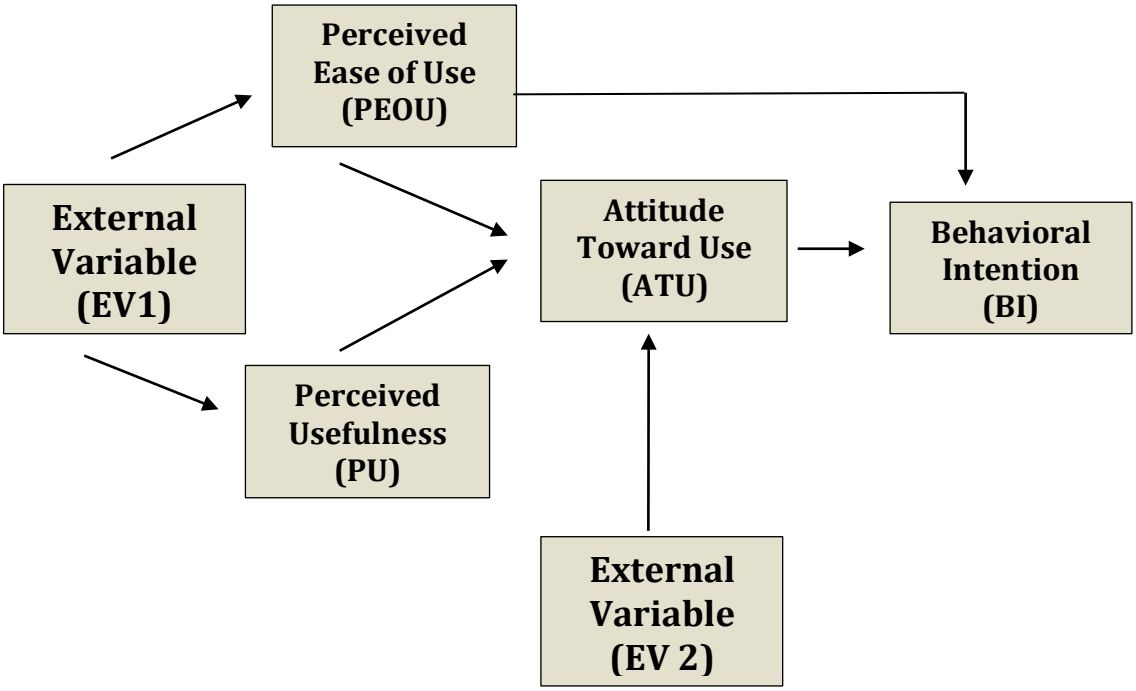


Figure 4.1: TAM model [adapted from Davis (1985)]

4.4 Information regarding the six participants

In this section, the biographical information of the six participants is provided. A pseudonym was assigned to teachers to protect their identities. Six teachers were sampled from four well-resourced schools. Table 4.1 below provides an overview of each participant.

Table 4.1: Biographical Information

School	Participant	Age category	Gender	Qualification(s)	Experience	Computer usage in mathematics
1	Teacher A	18-35 years	Female	BEd Degree in Senior Phase	6-10 years	Computer or laptop in 1-3 lessons in teaching and learning

2	Teacher B	18-35 years	Male	PGCE[3] in Senior and FET[4] Phase	1-5 years	Computer or laptop in every 1-3 lessons in teaching and learning
2	Teacher C	18-35 years	Female	BEd Degree in Intermediate Phase; Honours degree in Education	1-5 years	Computer or laptop in every 1-3 lessons for teaching and learning
1	Teacher D	36-55 years	Female	BEd Degree in Education	16-20 years	Laptop or computer in every 4-6 lessons teaching and learning
3	Teacher E	18-35 years	Female	BEd Degree in Intermediate/Senior Phase Advanced Diploma in Education specialising in special needs	6-10 years	Laptop or computer every 4-6 lessons for teaching and learning
4	Teacher F	18-35 years	Female	PGCE in Senior and FET Phase	1-5 years	Computer or laptop every 1-3 lessons for teaching and learning

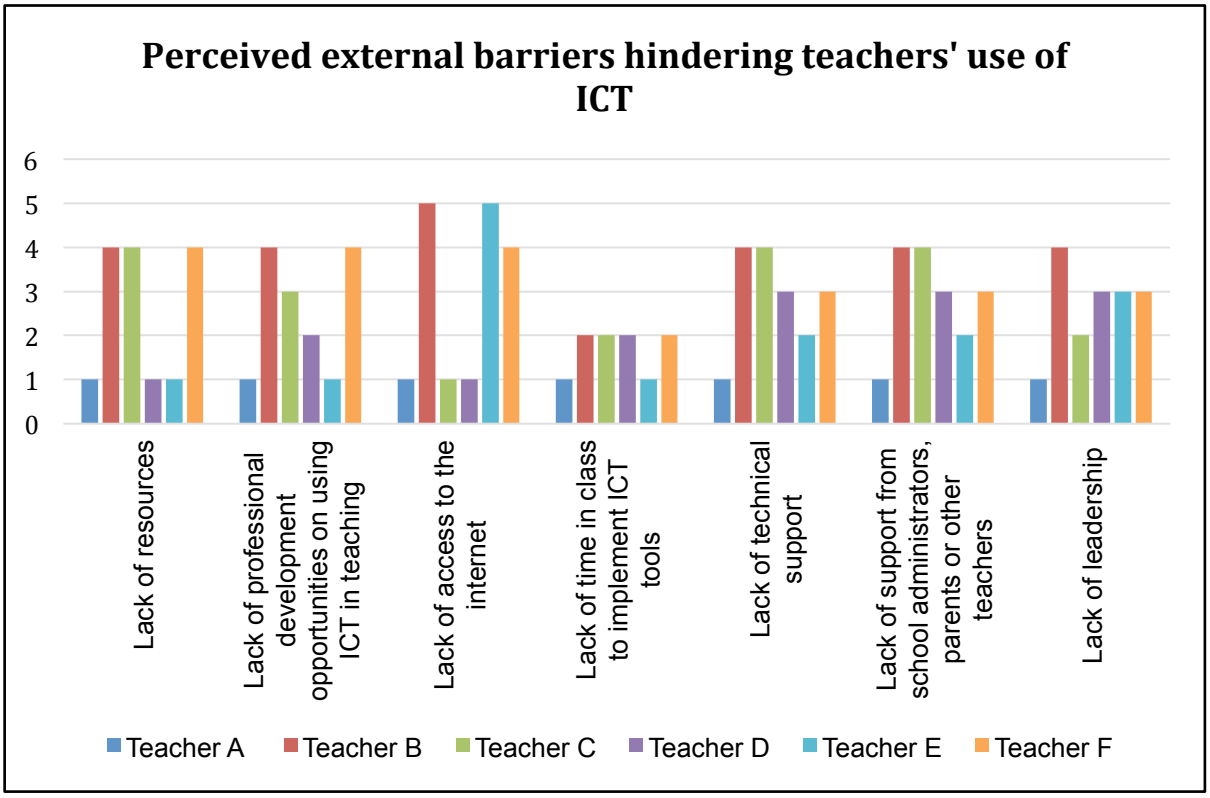
4.5 Presentation of data

In the section below, the results are analysed and discussed according to the theoretical model. The data from the teachers' questionnaires (Annexure 7.2), are discussed in conjunction with the data from the interviews (Annexure 7.3).

[3] Postgraduate Certificate in Education
[4] Further Education and Training

4.5.1 External barriers (EV 1)

In the questionnaire, the predetermined barriers were listed and the teachers had to select each barrier that hindered them when teaching with ICT and rate it on a scale from 1 to 5. The barriers that were listed are: lack of resources, lack of professional development opportunities, lack of access to the internet, lack of time in class to implement ICT tools, lack of technical support, lack of support from school administrators, parents or other teachers, and lack of leadership. Figure 4.2 shows a graph that compares each teacher's response in relation to the external barriers mentioned.



KEY:

1- Strongly agree
2- Agree
3- Neutral
4- Disagree
5- Strongly disagree

Figure 4.2: Perceived external barriers hindering teachers' use of ICT

4.5.1.1 Lack of resources (hardware and software)

The results show that Teachers A, D and E strongly agreed that a lack of resources was a barrier in using ICT in teaching, while Teachers B, C and F disagreed with lack of resources as a barrier. As mentioned earlier, a lack of resources for the purposes of this study included hardware and software. These results prove that the lack of resources were the same for teachers from the same school. Teachers A and D (School 1) strongly agreed with the lack of resources; and Teachers B and C (School 2) both disagreed with the lack of resources for using ICT in their schools. This lack of resources differs from school to school.

Teachers A and D mentioned that they had projectors, laptops and the basic resources required to use ICT in teaching. However, Teacher D mentioned that, although they had ICT resources, there sometimes were a few learners who did not have iPads at home and at school and this became a disadvantage to those learners.

On the other hand, Teachers E and F mentioned that they utilised Apple software for ICT integration in the classroom. Teacher E added that Apple devices are not user friendly and restrict her to use only Apple-friendly applications. She stated:
"*There's only Apple TV… so if I have something that somebody maybe sent me a link on my phone I can't open it. I have to email it to myself and then open the email at school because it's only projected by Apple."*

She added that there was a lack of appropriate mathematics software that was specific to the needs of learners in the intermediate phase. Teacher F mentioned that teachers are not stationed in their own classrooms and need to move around, and certain classrooms did not have the resources available. Likewise, Teacher B also mentioned that teachers are not stationed in their own classrooms, which makes using ICT tools difficult. He stated that *"not all of the classrooms have complete access to the technology like to the*

PowerPoint and the videos". In addition, Jantjies and Joy (2016) state that the lack of technology to be incorporated into classroom lessons is currently affecting learning in South Africa.

4.5.1.2 Lack of professional development opportunities

Teachers A and E strongly agreed that a lack of professional development opportunities was a barrier when using ICT in teaching. Teacher D also agreed that this is a barrier in ICT. Teacher C was neutral about professional development as a barrier. However, Teachers B and F disagreed that the lack of professional development opportunities was a barrier to ICT in teaching.

The findings from the teachers confirms TALIS (OECD, 2009) reports that there is a high need for ICT teaching skills. In contrast to Opfer's (2016) views of the necessity of teacher professional development for teacher improvement in teaching and learning, teachers A, C, D and E mentioned that there was an absence of professional development opportunities in their schools. These teachers mentioned that they received basic workshops, but these did not do enough to instil full confidence in them for using ICT in the classroom. Teacher A stated that they received professional development workshops at the beginning of every year, but thereafter no opportunities are created for the teachers.

Likewise, teacher E commented: *"I do have the skills but using only Apple I'm so restricted so sometimes I just leave it … because there's no one to actually train you to use it."* This finding is in agreement with the IEA study (Law et al., 2008) as it proves a negative relationship between the usage of ICT tools and a lack of professional opportunities. On the other hand, teacher F did not consider professional development as a barrier as her school provided professional development sessions for the teachers once a week. These sessions provided them opportunities for development such as formulating electronic exam papers and finding online resources. This is similar to Koh's (2019) findings which stated that teachers who received professional development gained the skills to infuse their pedagogical knowledge with

technology integration. Thus, the above research proves that there is a need to provide teachers with professional development opportunities.

4.5.1.3 Internet

Teachers A, C and D strongly agreed that a lack of access to the internet hinders their ability to use ICT, while Teacher F disagreed and Teachers B and E strongly disagreed that the lack of access to the internet is a barrier to using ICT in the classroom. Teacher A claimed that *"If you don't have Internet that is where the problem is because I can't access my e-books, use my projectors and everything. So the barrier for me will be when there's no Internet access."* Teacher C commented that Wi-Fi was the main source for using ICT successfully in teaching and learning. She stated:

"I think the thing that prevents me the most is actually Wi-Fi, being able to get into the internet, using the applications appropriately because most of the applications that we use requires Wi-Fi to connect and if we don't have Wi-Fi then it doesn't help."

Teacher A stated that the lack of internet forced teachers to use the whiteboard and start writing again. She referred to this as going back and doing everything like the "olden days". On the other hand, Teachers B, E and F disagreed that the internet was a barrier to teaching, as they had access to the internet at all times. Teacher E commented that load shedding was another hindrance towards using Wi-Fi in the classroom. This gave teachers another reason to use the whiteboard and learners were forced to write by copying notes from the board.

4.5.1.4 Time

Lack of time in the classroom was a major factor that many teachers regarded as a hindrance to implementing ICT in teaching and learning. Teachers A and E strongly agreed and Teachers B, C, D and F agreed that time is a major hindrance to implementing ICT in teaching and learning. After the inappropriate

implementation of resources, time and training are the next factors that hinder the use of ICT in the classroom (Morris, 2010). Teacher B stated, *"there's a lack of time to cover all the material and to implement the technology*". He added that time is limited in the classroom and changing and setting up in different classrooms consume time.

Teacher E commented that:
"Time management is a big problem and with the CAPS having so much of work in so little time". Teacher F commented that *"time and sometimes just to switch on the laptop and restart it and sign in again and to maintain order in the classroom, get the kids to organise and settled down wastes time."*

All the teachers mentioned that teaching was demanding and they had a busy time schedule to complete the recommended teaching and learning activities. In a study conducted by Al Asmari (2011), it was found that teachers suffered from a lack of time to prepare ICT materials for lessons. Jones (2004) identified a lack of time as impeding the usage of ICTs in classrooms. Vadachalam and Chimbo (2017) mention that teachers need time to conduct online research, and to learn how to integrate ICTs into lessons. Thus, teachers cannot successfully implement ICT into teaching and learning.

4.5.1.5 Lack of technical support

Teacher A strongly agreed and Teacher D agreed, whereas Teachers C and F were neutral that the lack of technical support was a barrier when using ICT. Teacher A commented: *"I can't fix the tablet or something I don't know what happened to the tablet, I have to reach the IT people and they are always on hand."* Teacher C stated: *"If it is a technical problem such as sound not projecting through or the picture not showing clearly that would be time consuming."* Lastly, Teacher F stated: *"It is a smartboard but a lot of times the senses don't really work but you can actually use it but it's quite delayed so I use my laptop one by one."* On the other hand, Teachers B and E disagreed that a lack of technical support was a barrier in teaching with ICT.

Teacher D also mentioned that power failures were also a major barrier when integrating ICT into lessons. Teacher F commented that load shedding hindered performance and forced teachers and learners to use traditional methods. Studies show that technical support is of importance in the success or failure of ICT integration in teaching and learning (Carver, 2016). Teachers B and E did not regard technical support as a major barrier, as they stated that technical support was available on the school grounds whenever it was required. Vadachalam and Chimbo (2017) further mention that teachers fear encountering technical problems while using ICTs and being unable to fix them. Technical support also requires proactive and consistent maintenance of ICTs, and most schools lack any form of technical support.

4.5.1.6 Lack of support from school administrators, teachers and parents

Teacher A strongly agreed, Teacher E agreed, and Teachers D and F were neutral about a lack of support from school administrators, parents and teachers. On the other hand, Teacher B and C disagreed that there was a lack of support from these crucial participants in the education system. Teacher E explained that she felt that there was a need for a more supportive structure amongst colleagues at school. Additionally, Teacher B mentioned that some teachers were negative about using ICT, but he did not feel that it played a massive role in the day-to-day teaching of many teachers. Teacher F claimed that the HODs and their mentor teachers support teachers at their school. She stated that her mentor teacher made considerable use of PowerPoint presentations and YouTube videos, as she was stationed in her own classroom. Samancıoğlu, Bağlıbel, Kalman and Sincar (2015) state that support from school administrators is important in ICT integration, as educational administrators create a vision, provide staff training, share resources amongst staff and ensure organisational order in school settings.

4.5.1.7 Lack of leadership

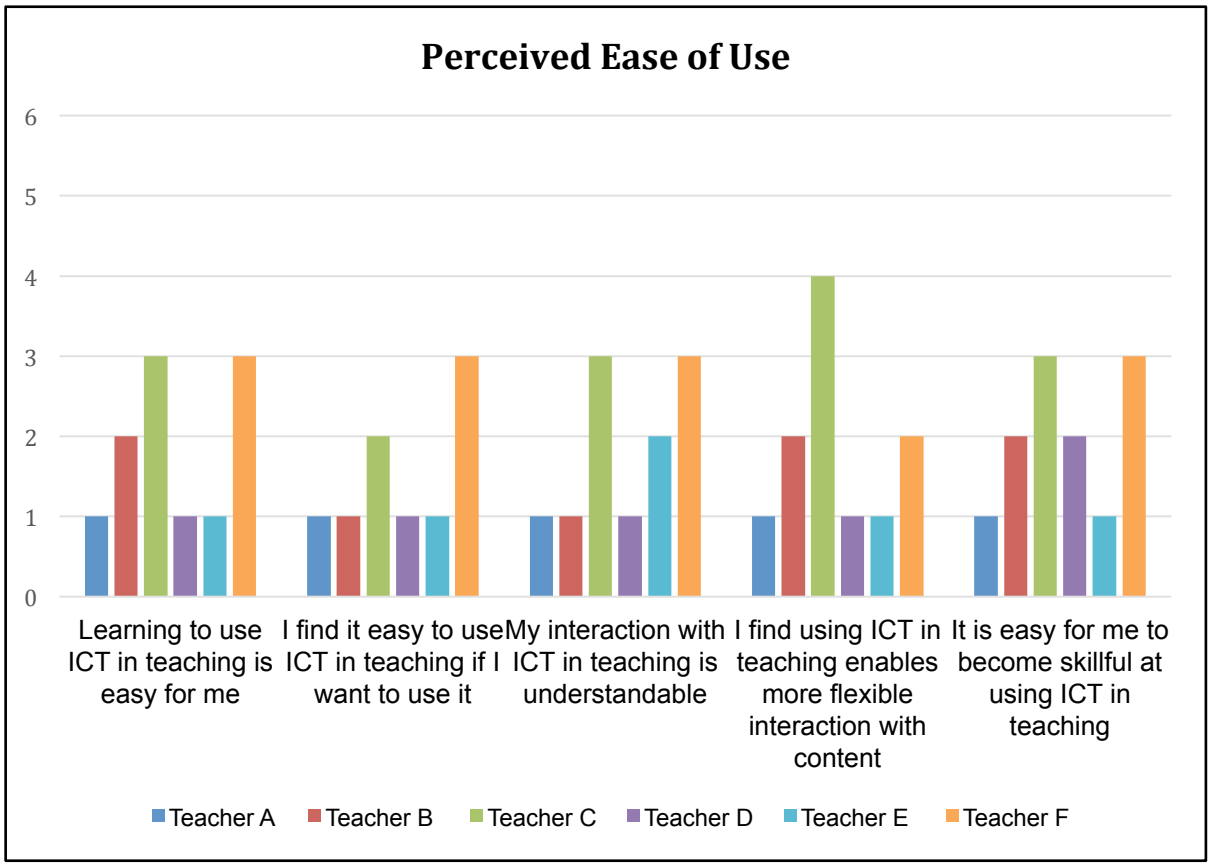
Teacher A strongly agreed, Teacher C agreed, while Teachers D, E and F were neutral about a lack of leadership. However, Teacher B strongly disagreed that there is a lack of leadership with regard to ICT in the classroom, stating, "*We are encouraged to use it but we are not monitored on how often we use it."* On the other hand, Teacher A stated that the HODs monitor their ICT usage and rates their ICT skills when assessing a lesson.

Teachers C, D, E and F did not receive a form of leadership when enacting ICT in the classroom. Leadership in schools that adapt the use of high technology has a positive impact on the effectiveness of ICT integration within the school organisation (Raman & Shariff, 2017). Flanagan and Jacobsen (2003) relate that ICT in education requires a fundamental and systematic change in education. The support and understanding of school principals play a significant role in ICT integration in schools. Byrom and Bingham (2001) state that leadership is considered the single most important factor affecting the success of introducing technology into schools. Likewise, several researchers, such as Tondeur, Keer, Braak, and Valcke (2008), as well as the British Educational Communications and Technology Agency (BECTA) (Jones, 2004) state that teachers need effective leadership and adequate support to use ICT in the classroom.

Samancıoğlu et al. (2015) state that school principals as ICT leaders are expected to find strategies for how to use modern technologies in order to meet the demands of the educational setting. A good ICT leader will set up a technology committee at school, communicate with staff in order to improve learner achievement, and create standards for effective and efficient technology use in an educational setting. Msila (2015) states that if leaders deliver greater empowerment, teachers will in turn benefit and learn ICT skills. In the study conducted by Samancıoğlu et al. (2015), research proves that there is a positive but weak correlation between technology integration and the communication of technology leadership.

4.5.2 Perceived ease of use (PEOU)

Figure 4.3 provides five statements relating to the theme PEOU. The answers of each teacher are compared in the graph below.



Key:

1- Strongly agree
2- Agree
3- Neutral
4- Disagree
5- Strongly disagree

Figure 4.3: Perceived ease of use

4.5.2.1 Learning to use ICT in teaching is easy for me

Teachers A, D and E strongly agreed that learning to use ICT in teaching was easy for them, teacher B agreed, while Teachers C and F were neutral. According to a study conducted by Flewitt, Kucirkova, and Messer (2014),

teachers are reluctant to use technology in their classrooms, as they view it as a distraction. They further state that others view technology as providing inappropriate information, whereas some are not confident in their ability to use technology. According to Wong (2016), teachers seem to have some intention to use technology in their teaching if they perceive it to be easy to use.

4.5.2.2 I find it easy to use ICT in teaching if I want to use it

Teachers A, B, D and E strongly agreed, Teacher C agreed and Teacher F was neutral about finding ICT easy to use in teaching. Most of the teachers agreed with this statement, as it is a matter of the mind. Teachers play a vital role in ensuring that ICT implementation is successful. As teachers are the main providers of knowledge, they should be able to adjust to new strategies of sharing information. If teachers are not willing to change, then their resistance to change can be a major barrier to their usage of ICT in education.

4.5.2.3 My interaction with ICT in teaching is understandable

Teachers A, B and D strongly agreed, Teacher E agreed and Teachers C and F were neutral about their understanding when interacting with ICT. All six teachers said that they possessed basic ICT skills of showing videos and managing a PowerPoint presentation. Teacher B claimed that, although these tools were exciting and engaging, they were not used on a daily basis. Similarly, Teacher F mentioned that she did not use ICT in every lesson. All the teachers had already been using ICT tools in some form in teaching. Serow and Callingham (2011) state that teachers often use technological tools in the classrooms but are unaware of the potential they have to promote development in mathematics classrooms. Although these tools are used in the classroom, there is still much room for growth.

4.5.2.4 I find using ICT in teaching enables more flexible interaction with content

Teachers A, D and E strongly agreed, while Teachers B and F agreed that ICT enables more flexible interaction with the content. However, Teacher C disagreed with this statement. Teacher C believed that ICT could have a positive or negative connotation in the classroom. It could be positive in the sense that learners can become interested to learn, and negative as they see the iPad as offering leisure activities instead of actual learning activities. Teacher B stated that a YouTube video could be used as an icebreaker in a lesson and to raise the morale of the learners. He further stated that ICT is sometimes beneficial for relaxation activities and is a good resource to use beyond the curriculum, as also indicated by Teacher F. Thus, although ICT can be used to improve life, it can also be disruptive. Thus, teachers should use their judgment and use it at their own discretion.

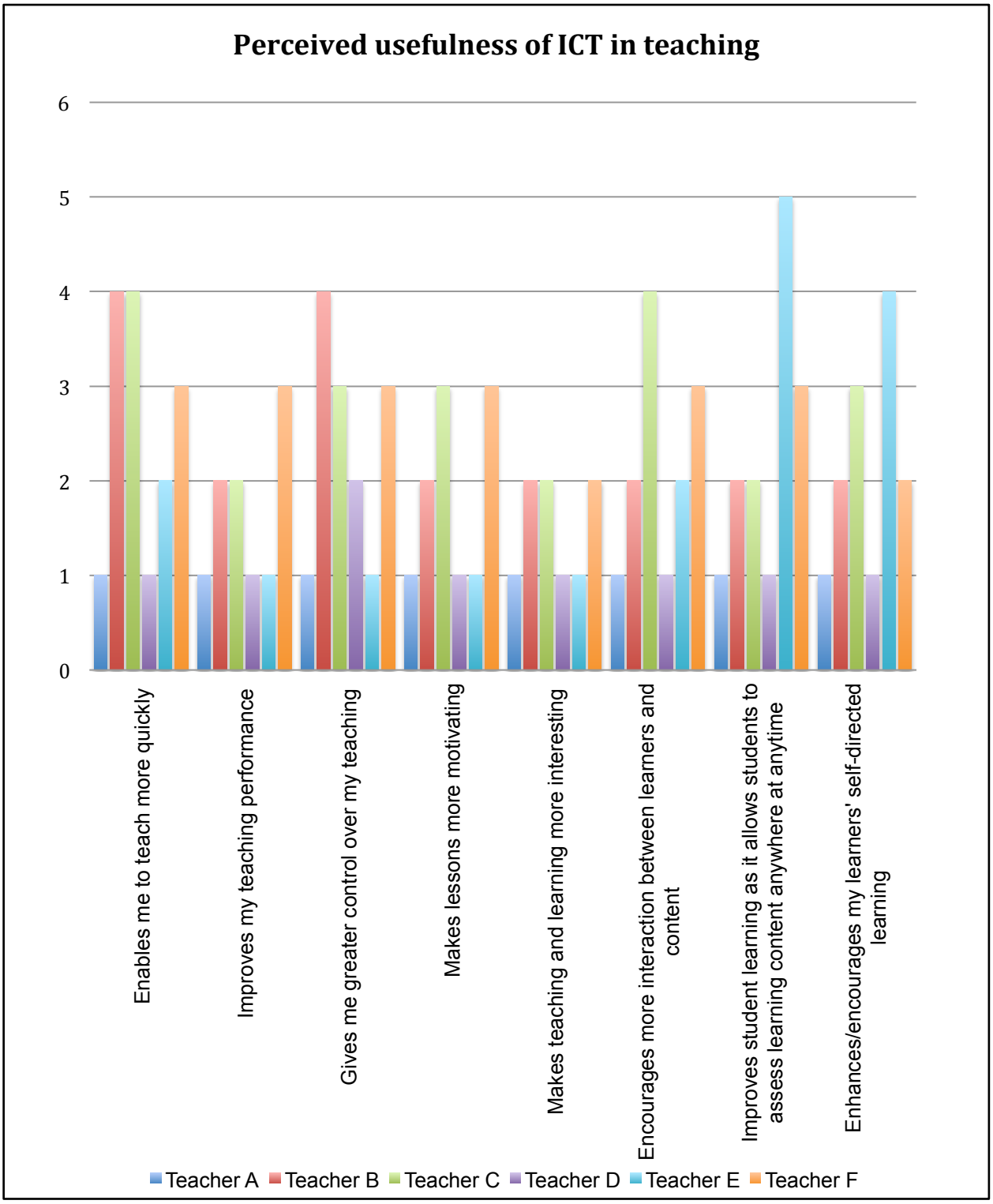
4.5.2.5 It is easy for me to become skilful at using ICT in teaching

According to Jantjies and Joy (2015), the level of teacher skills and perspectives determines their use of technology in a traditional classroom. Teachers A and E strongly agreed, Teachers B and D agreed, and Teachers C and F were neutral about becoming skilful at using ICT in teaching.

All six of these teachers used ICT in teaching in some way or the other. Teacher B stated: "*Yes basic ICT skills … yes … so like showing videos and PowerPoint and those things I can do.*"

4.5.3 Perceived usefulness (PU)

The graph below depicts a few statements about what each teacher believes would enhance his or her job performance. Each statement indicates how the teachers perceive the usefulness of technology in the classroom.



Key:

1- Strongly agree
2- Agree
3- Neutral
4- Disagree
5- Strongly disagree

Figure 4.4: Perceived usefulness of ICT in teaching

4.5.3.1 Enables me to teach more quickly

Teachers A and D (School 1) strongly agreed and Teacher E agreed that ICT enabled them to teach more quickly. In contrast, Teachers B and C (School 2) disagreed that ICT enabled them to teach faster. However, Teacher F was neutral. Teacher D stated that ICT makes life easier, as you can use it for convenience. She claimed that teachers are bound to get tired and then you can make use of recorded lessons and learners can learn from this. In this way, time is saved and work is on track. Similarly, Teacher E mentioned that, in terms of time management, she was managing better using the iPad. On the other hand, Teacher C commented that ICT might save time by presenting work on the projector or using an iPad, but it could also be time consuming, depending on the situation.

4.5.3.2 Improves my teaching performance

Teachers A, D and E strongly agreed and Teachers B and C agreed that ICT improved their teaching performance. However, Teacher F was neutral regarding this matter. Teacher D stated that, when she teaches data handling, it is easier to project graphs on the board with a projector. It saves time drawing and ensuring graphs are drawn accurately. Teacher F claimed that technological tools in the classroom were definitely good resources to use, as we are living in a new era and learners are already exposed to these tools. The challenge is to utilise these tools to improve learning, because they can be destructive as well.

4.5.3.3 Gives me greater control over my teaching

Teachers A and E strongly agreed, Teacher D agreed and Teachers C and F were neutral about ICT giving them greater control over their lessons. However, Teacher B disagreed. Teacher B claimed that, although ICT is enjoyable and interactive for the learners, the videos or games are not directly related to the curriculum. He stated the main objective for him was to go

through the course material, and that ICT often wasted time in the classroom. According to Koh (2019), several studies have found that mathematics teachers face challenges when integrating ICT into lessons to support mathematics learning.

4.5.3.4 Makes lessons more interesting

Teachers A, D and E strongly agreed, Teacher B agreed and Teachers C and F were neutral about ICT making lessons more motivating. Teacher B said the following: *"It just helps to make the lesson for interesting, more fun and uhm just get the moral up of the learners so that they not just overworking."* Teacher A commented that, in these days, children are technologically advanced and technology therefore is vital to attract their attention, an opinion shared by Teacher B. Furthermore, Teacher E mentioned that ICT integration into a lesson was an alternative resource for learners that have ADD and ADHD. She stated:

> *"Especially those learners who have a problem just sitting and listening to the teacher, because you get kids that are very bored. ADD and ADHD are diagnosed to every second child and this is an alternative to them nagging and doing something."*

4.5.3.5 Makes teaching and learning more interesting

Teachers A, D and E strongly agreed and Teachers B, C and F agreed that ICT made teaching and learning more interesting. It is noticeable that all six teachers were in agreement that ICT makes teaching and learning more interesting. However, they commented that it depended on the usage by each teacher, which may differ. Teacher B stated that ICT tools are useful in teaching and learning, but should not replace actual teaching.

Additionally, Teacher A said that if a particular class was slightly behind, it would become boring for some of the learners. When teachers are equipped, learners can see they are technologically advanced and this makes learning

fun and they enjoy it. Thus, Teacher A mentioned that she would randomly do a pop quiz on a Friday so that it triggers the interest of the learners.

4.5.3.6 Encourages more interaction between learners and content

Teachers A and D strongly agreed, Teachers B and E agreed and Teacher F was about whether ICT encourages more interaction between learners and content. However, Teacher C disagreed that this was the case. Teacher E stated that she used online applications to help learners who require additional support in mathematics. In this way, parents can assist learners and monitor their progress at home. Also, she mentioned that she was part of the school 'Juniortekkie'[5] programme for the intermediate phase, and that this gave her an opportunity to learn with the learners at the same time.

4.5.3.7 Improves student learning

Teachers A and D strongly agreed, Teachers B and C agreed and Teacher F was neutral about whether ICT improves student learning because it allows students to access learning content anywhere at any time. However, Teacher E strongly disagreed. Teacher E held the view that ICT distracts from learning. She firmly believed in traditional pedagogy and using ICT tools only as a stimulus in the classroom. Although Teacher A agreed, she stated that: "*it's a 50/50 because I still have some of my learners who get easily distracted.*" Additionally, she said it at times was impossible to observe the entire classroom. Learners are often distracted by their iPads and play games or browse the internet. Thus, this remained a challenge in the classroom. Likewise, Teacher D mentioned that there sometimes was misuse of technology, as learners used the internet to find answers. Furthermore, Teacher E indicated that, once you start playing a YouTube video, learners insist that they are shown more videos, and the videos make learning reliant on videos.

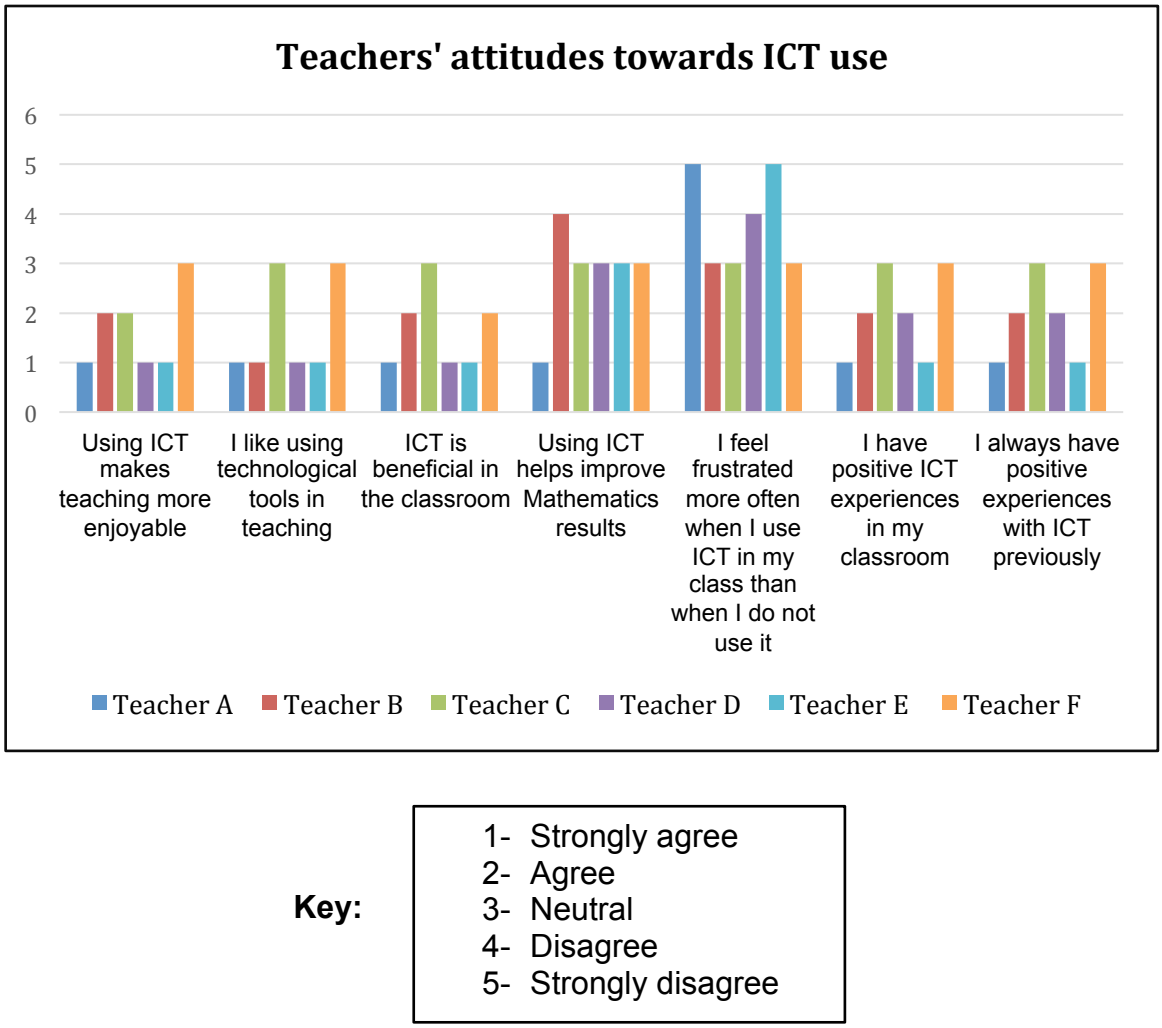
[5] Technology programme as an extracurricular activity at the school.

4.5.3.8 Enhances learners' self-directed learning

Teachers A and D strongly agreed, Teachers B and F agreed and Teacher C was neutral about whether ICT enhances or encourages learner self-directed learning. However, Teacher E disagreed that this was true. Teacher D further commented that ICT sometimes encourages laziness because learners become reliant on technology and refuse to write down notes. Thus, sometimes ICT works to the disadvantage of the learners as Teacher F mentions that there is no ICT in an examination.

4.5.4 Attitude towards use (ATU)

The following chart depicts the attitudes of the teachers in using ICT in teaching and learning:



Key:

1- Strongly agree
2- Agree
3- Neutral
4- Disagree
5- Strongly disagree

Figure 4.5: Teachers' attitudes towards ICT use

4.5.4.1 Using ICT makes teaching more enjoyable

A teacher's attitude is crucial for ICT integration, and teachers who fail to have the right attitude cannot implement curricular changes appropriately. Teachers A, D and E strongly agreed that ICT makes teaching more enjoyable. Teacher B and C agreed, whereas Teacher F was neutral about ICT making teaching more enjoyable. Teacher A stated: *"It's a 50/50 because I still have some of my learners who get easily distracted."* Teacher B: *"It makes it more fun and interactive with the learners because I'll often play sing-along songs."* Teacher E:

> *"Definitely! Especially those learners who have a problem just sitting and listening to the teacher. Because you get kids that are very bored. ADD and ADHD are diagnosed for every second child… this is an alternative to me nagging and doing something."*

Teacher F:

> *"So for me I think its not to be completely reliant on it but more to use it just to enhance the learning experience and to encourage them to go out and look for their own Apps and because they all have phones basically."*

Overall, the results revealed that all six teachers upheld the concept that using ICT made teaching more enjoyable. From the comments of teachers A, B, E and F, it is clear that ICT is used to enhance teaching and learning and does not replace learning in the classroom. Likewise, Sangrà and González-Sanmamed's (2010) findings demonstrate that ICT is used to develop low-level teaching and learning processes. Thus, ICT is used to strengthen traditional teaching practices in the classroom.

4.5.4.2 I like using technological tools in teaching

Next, Teachers A, B, D and E strongly agreed that they liked using technological tools in teaching, although Teachers C and F had neutral views on this. Teacher A stated:
"It is a must, that's one thing it is a must and our kids are not like use in the olden days. If you don't use technology you are boring. They want this, they want millennial things of doing things." Therefore, as Wamokote (2010) mentioned that teachers are depicted as models for learners in the classroom to use ICT in teaching and learning.

When asked the question, "Describe your experiences of ICT in your mathematics classroom?" Teachers B, D and F respectively responded: *"I think it makes it more exciting and engaging."* (Teacher B) *"… in Maths it makes my life easier."*(Teacher D*). "Yeah it does… I think again just with the same… it also makes me more interested as a teacher in teaching Maths, it gives me more ideas and it stimulates them a bit more so that it's not just one dimensional not just the textbook and writing, textbook and writing."* (Teacher F)

This confirms Ertmer et al., (2012) findings that teacher confidence is a crucial factor when using ICT in the learning process. Furthermore, these findings mirror Collis and Moonen's (2001) study that teachers are likely to integrate technology if they have positive experiences in the classroom.

4.5.4.3 ICT is beneficial in the classroom

Teachers A, D and E strongly agreed, while Teachers B and F agreed, that ICT is beneficial in the classroom. Teacher E mentioned that, as the generations are progressing, it is fundamental that learners can graphically see a pictures as well as hear sounds and songs related to the content. Teacher F: *"I think it's definitely a good resource, if its available to you definitely make use*

of it…" Teacher C was neutral in this regard, saying: *"I use it… where I feel it is required for me to use it my advantage and to the advantage of the learners."*

4.5.4.4 Using ICT helps improve mathematics results

Teacher A strongly agreed that ICT helps improve mathematics results. Teachers C, D, E and F were neutral about this, whereas Teacher B disagreed that ICT makes a difference in learner achievement. Teacher B stated that he thought *"that it's just as easy to use examples around the classroom like for instance teaching angles say well you know a right angle is the corner of the classroom."* He further stated that he preferred using practical illustrations in many different ways to using technology. He also mentioned that ICT could be used for relaxation, boost the morale of the learners and sometimes just to reinforce an already learnt topic.

4.5.4.5 I feel frustrated when I use ICT in my classroom

Teachers A and E strongly disagreed and Teacher D disagreed that ICT frustrated her in the classroom. Teachers B, C and F were neutral in this regard. Teacher A was a young graduate and was eager to and confident about using ICT in the classroom. She mentioned that, when there was a problem, she tried to assist the learners or, if she could not, she called the in-house IT support for assistance. On the other hand, Teachers E and F mentioned that they felt anxious when they were not in control of a situation. Teacher F said: *"I'm just an anxious person when it comes to using ICT."* She claimed she was anxious as she did not use ICT on a daily basis and was afraid that something would go wrong when attempting to use it during a lesson. Additionally, Teacher E claimed that learners were the best psychologists and could pick up on this during a lesson.

4.5.4.6 I have positive experiences with ICT

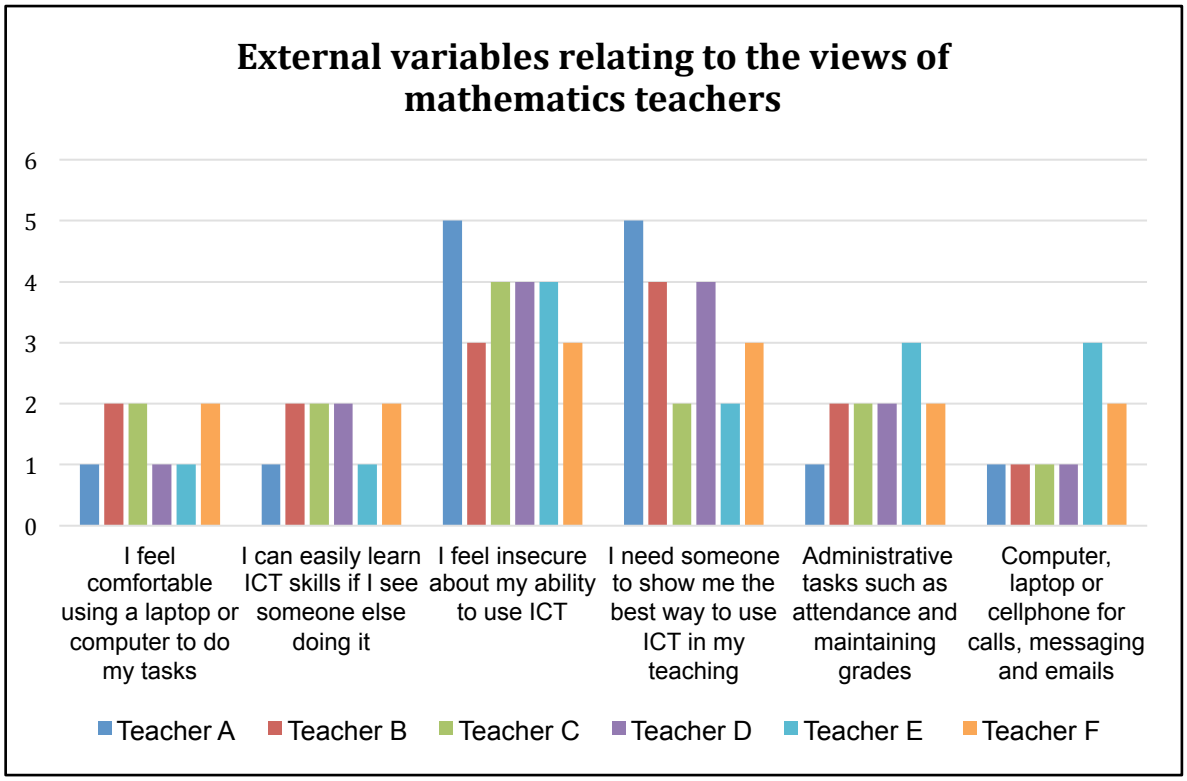
A successful teacher is one who has a positive attitude in the classroom. Teachers A and E strongly agreed that they had positive ICT experiences in the classroom. These teachers were newly qualified teachers who used technology in their higher institutions. Msila's (2015) says that the attitudes of newly qualified staff are different from those of experienced teachers. Teachers B and D agreed, while Teachers C and F were neutral about having positive experiences. Msila (2015) states that teachers have certain attitudes due to the challenges computer-assisted teaching brings to the classroom.

4.5.4.7 I had positive past experiences using ICT

Teachers A and E strongly agreed having positive past experiences with ICT. Teachers B and D agreed and Teachers C and F were neutral in this regard. Teacher B stated: *"It's been positive because I will show a two or three minute video and it will be a good ice breaker and something for them to get into the lesson."* Overall, it seems that the teachers had positive past experiences using ICT for learning. However, there is always a hindrance that makes them reluctant to use it during a lesson.

4.5.5 External variables

According to the TAM model, the following external barriers depicts a comparison on the views of the mathematics teachers in this study:



Key:

1- Strongly agree
2- Agree
3- Neutral
4- Disagree
5- Strongly disagree

Figure 4.6: External barriers relating to mathematics teachers' views

4.5.5.1 I feel comfortable using a laptop or computer to do my tasks

Teachers A, D and E strongly agreed that they were comfortable using a laptop or computer to do tasks. Teachers B, C and F agreed that they were comfortable using these resources. As depicted in Table 1, all six teachers used a computer or laptop in some way for teaching and learning. Teacher E explained that using a laptop or computer enabled her to be more organised, as she could find a folder and locate the required documents.

4.5.5.2 I can easily learn ICT skills if I see someone else doing it

Teachers A and E strongly agreed, and Teachers B, C, D and F agreed that they could easily learn ICT skills if they saw someone else doing it. The teachers were claimed to be lifelong learners and that, if they were continuously trained to use these tools, it would become habitual in the classroom.

4.5.5.3 I feel insecure about my ability to use ICT

Teacher A strongly disagreed, while Teachers C, D and E disagreed and teachers B and F were neutral regarding their confidence in using ICT. The teachers' lack of confidence can be related to several factors, including the fear of using ICTs due to a lack of skills. Furthermore, Vadachalam and Chimbo (2017) mention that resistance to change and negative attitudes are present when teachers do not understand or believe in the good intentions of ICTs in education. Often, a teacher who has not yet experienced the numerous benefits of ICT will not be motivated or ready to include ICTs in education.

Teacher B gave his reason: *"I see that ICT is beneficial but it can be a nuisance as I am still learning to use it properly."* Teacher B explained that he had mixed feelings as he was still discovering how to maximise the potential of ICTs in the classroom. Teacher F stated that technology was advancing continuously and it sometimes happened that the learners taught the teachers.

4.5.5.4 I need someone to show me the best way to use ICT in my teaching

Teacher A strongly disagreed, Teachers B and D disagreed, Teacher F was neutral and Teachers C and E agreed that they needed someone to show them the best way to use ICT in their teaching. As Teacher F stated, there is a need to create software that is directly related to the CAPS curriculum. In this

way, learning will be productive and, if teachers are trained correctly, it will improve their confidence using ICT in the classroom.

4.5.5.5 Administrative tasks such as attendance and maintaining grades

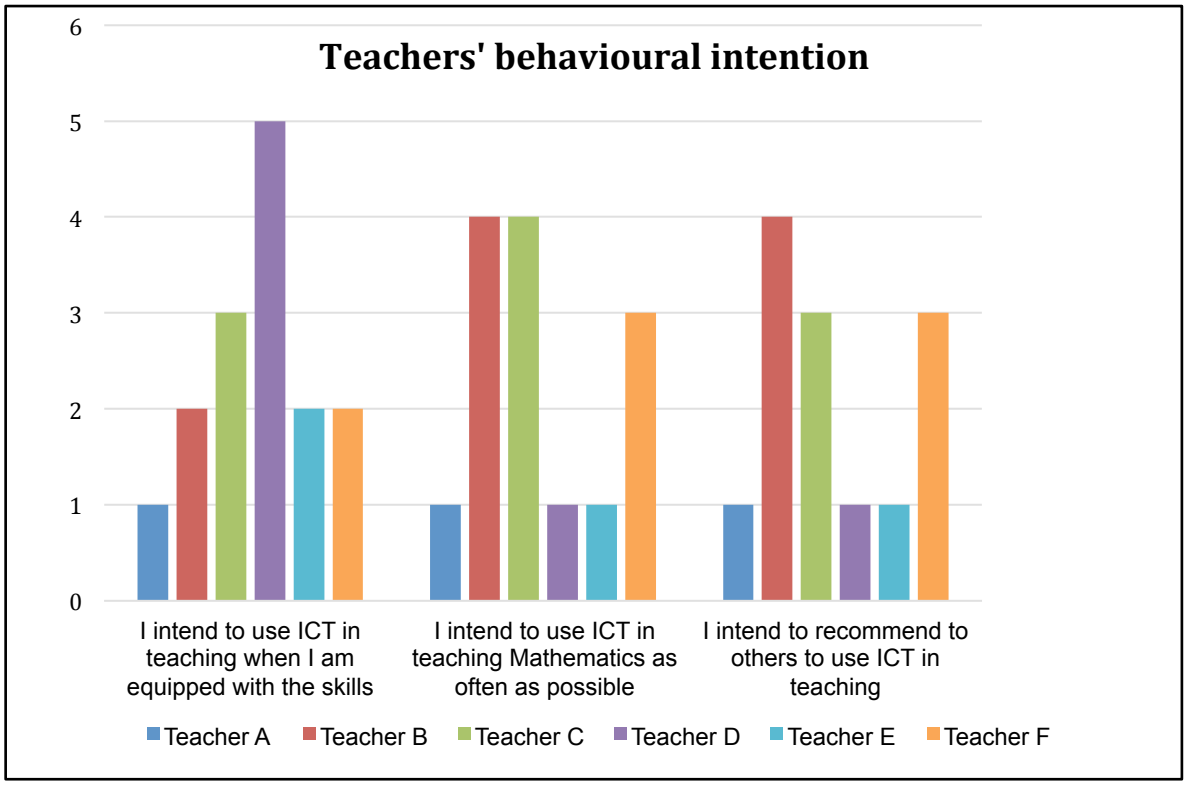
Teacher A strongly agreed, Teachers B, C, D and F agreed and Teacher E was neutral about using ICT for administrative tasks, such as attendance and maintaining grades. Teacher A explained that using a laptop or computer to record marks was compulsory and every school used specific software that was approved by the Department of Education. The software keeps track of learners' absenteeism and records learners' progress, and teachers are required to capture learners' marks on this platform. These findings mirror a study conducted by Morante and Lopez (2008) which indicate that teachers in European countries most commonly use these tools for administrative purposes.

4.5.5.6 Computer, laptop or cell phone for messaging and emails

Teachers A, B, C and D all strongly agreed that they utilise a computer, laptop or cell phone for messaging and email. Teacher F agreed and Teacher E was neutral regarding these external variables.

4.5.6 Behavioural intention

A teacher's behavioural intention is based on several factors. Figure 4.5 below lists three factors that illustrate teachers' behavioural intention.



Key:

1- Strongly agree
2- Agree
3- Neutral
4- Disagree
5- Strongly disagree

Figure 4.7: Teachers' behavioural intention

4.5.6.1 I intend to use ICT in my teaching when I am equipped with the skill

Teacher A strongly agreed and Teachers B, E and F agreed that they intended to use ICT in teaching when they were equipped with the skills. Teacher C was neutral in this regard, although Teacher D strongly disagreed that this was the case. All six teachers used basic ICT skills in teaching and learning. Teacher D was an older teacher and, as stated by Teacher A, older teachers are fixed in their traditional methods. However, older teachers are knowledgeable about the content, while younger teachers are constantly teaching them technologically. Teacher C mentioned that, even though she equipped herself

with these skills, she preferred the pen and paper approach in teaching mathematics. She further said that teachers should not rely on ICT in teaching, and merely showing a video to learners does not necessarily mean they understand the content.

4.5.6.2 I intend to use ICT in teaching mathematics as often as possible

Teachers A, D and E strongly agreed that they intended to use ICT in teaching mathematics as often as possible. Teachers B and C, however, disagreed, while Teacher F was neutral. Teacher A commented that learners are technologically advanced and, if a teacher does not use ICT in the classroom, learners become uninteresting in the lessons. She further mentioned that technology in isolation will not work, as the teacher needs to be available. Teacher C mentioned that it was critical that the teacher remained the central role in the classroom. She stated that teachers should utilise ICT, but should not rely on it. Teacher D mentioned that ICT was a good 'additional resource' in the classroom. Lastly, teacher F stated that learners still need human interaction and ICT should be used to enhance the learning environment.

Likewise, Teacher B stated that he thought *"it's a nice tool to have but it's one of many tools and it can be useful but then it shouldn't take [the] place of actual teaching."* In the end, mathematics is practical and a teacher always needs to go back to basics. Researchers (Jimoyiannis & Komis, 2007; Sangcap, 2010) show that a favourable attitude towards ICT generally encourages ICT integration, while negative attitudes discourage the use of ICT.

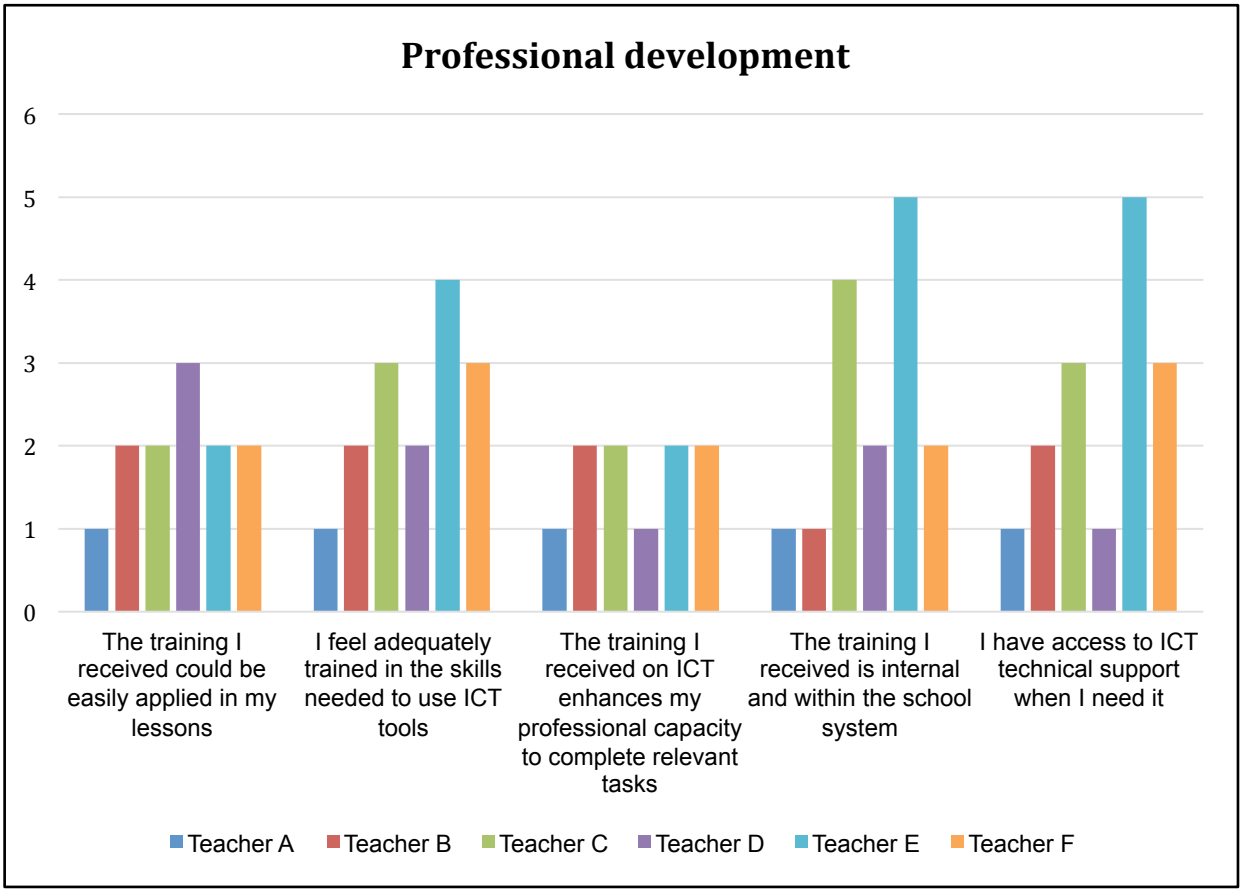
4.5.6.3 I intend to recommend to others to use ICT in teaching

Lastly, Teachers A, D and E strongly agreed to recommend to others the use of ICT in teaching. Teacher B disagreed and Teachers C and F were neutral regarding recommending ICT to other teachers. Teacher B stated the following reasons: *"Yes I would recommend it … uhm and its up to their judgment how much they can use it at their own discretion."* However, in his questionnaire, he

disagreed on recommending others to use ICT. Thus, it is evident that teachers held their own views on ICT, depending on their personal experiences in the classroom.

4.6 Professional development

The graph in Figure 4.8 below shows the professional development capacity of the six teachers, and each is analysed according to their professional development.



Key:

1- Strongly agree
2- Agree
3- Neutral
4- Disagree
5- Strongly disagree

Figure 4.8: Professional development

4.6.1 The training I received could easily be applied in my lessons

Teacher A strongly agreed, Teachers B, C, E and F agreed and Teacher D was neutral regarding the training they had received. All the teachers stated that the training they received had made a difference in the way they used these technological tools in teaching mathematics. Teacher A mentioned that she always used technology at university and it had become a norm to use it in the classroom. Likewise, Teacher D said she had completed a computer-training certificate, and Teacher E had also done computer training on the integration of technology in the classroom. Teacher F relied on the basic training she had received at university. Therefore, all the teachers were exposed to ICT skills prior to the classroom, which was at the level of a higher institution. However, due to the fact that technology is ever-evolving, teachers need to equip themselves continuously with the latest skills.

4.6.2 I feel adequately trained in the skills needed to use ICT

Teacher A strongly agreed, Teachers B and D agreed, Teachers C and F were neutral, whereas Teacher E disagreed that she was adequately trained in ICT. Teacher A was a young university graduate who had been exposed to using ICT at university. This gave her the confidence and enjoyment to use ICT in the classroom. Teacher B felt that he was still learning to use technology, while Teacher D felt she was an older teacher and needed to be updated continuously with regard to the latest technological developments. On the other hand, Teacher E stated that she lacked training and would prefer more training in using ICT. The reason Teacher E disagreed was that she had the basic ICT skills, but was not adequately trained in using Apple devices in the classroom, and thus required training in Apple for ICT teaching and learning.

4.6.3 The training I received on ICT enhances my professional capacity to complete relevant tasks

Teachers A and D strongly agreed, and Teachers B, C, E and F agreed with this statement, which proves that teacher training makes a difference when

using technological tools in the classroom. However, Teacher D mentioned that it would be interesting to learn how to create activities that would be useful in the classroom. Msila (2015) also states in her study that effective and meaningful workshops that could boost teacher computer competence would change teachers' attitudes towards ICT.

4.6.4 The training I received is internal and within the school system

Teachers A and B strongly agreed, Teachers D and F agreed, Teacher C disagreed and Teacher E strongly disagreed with this statement. Teachers A, B, D and F received internal training from the school. Teachers C and E mentioned that they had not received any internal training regarding the use of ICT in mathematics teaching. Teachers A and D belonged to School 1 and both had received internal training. However, Teachers B and C were from the same school and there is a contrast in their responses regarding internal training. Thus, it can be noted that training is not consistent for teachers in the same school.

4.6.5 I have access to ICT technical support when I need it

Teachers A and D agreed, Teacher B agreed, Teachers C and F were neutral and Teacher E disagreed with this statement. Teachers A, B, C, D and F mentioned that there was an IT support team available on call at the school whenever they were needed. The reason teacher C had mixed feelings was because it wasted time calling the person and sorting out the situation. Teacher F claimed that they were training a helper to assist with any technical issues and at times he could not solve the problem completely. Teacher E stated that, when faced with a technical difficulty, no one was available to assist in solving the situation and this wasted time in the classroom.

4.7 Conclusion

In this chapter, the data were presented and discussed, and the findings were related to the literature. The participants' responses were analysed and

interpreted according to the TAM framework. In Chapter 5, the recommendations and conclusions of the study are presented, the research questions, conclusions, implications and recommendations for improvements, limitations of this study as well as a final reflection are discussed.

5. Chapter 5: Recommendations and Conclusions

In this chapter, the research questions are addressed, conclusions are drawn and the implications and recommendations are stated. The limitations of this study, as well as the final reflection, are also presented. The research questions are addressed based on the findings from this research study.

5.1 Discussion of the research questions

The main research question was: “How do Grade 5 mathematics teachers from well-resourced schools experience the use of ICT within their classrooms?” The secondary research questions assisted in answering the primary research question. To address these sub-questions, a questionnaire was used to identify the barriers and a semi-structured interview was used to understand the reasons for these barriers in teaching and learning mathematics.

5.1.1 *Sub-question 1*: What are the barriers that hinder teachers’ abilities to make use of these resources?

As mentioned in Chapter 2, the external variables have a direct influence on the PEOU and PU in using ICT to teach mathematics. The barriers referred to in this sub-question are the contextual factors that include, amongst others, access to resources, internet connection, limited time, ICT facilities, as well as technical support and training. Both contextual factors and technical support and training are imperative for successfully implementing ICT in the classroom, as they affect teachers’ perceptions regarding their own proficiency in using ICT in the classroom.

It was evident that a lack of time is the major hindrance experienced by all six teachers in their classrooms. Sufficient time is required for learning and for integrating ICTs into teaching and learning. This is in agreement with Waghid, Waghid and Waghid’s (2016) study, which reported that a lack of time and

syllabus coverage were hurdles that decreased the use of ICT in teaching and learning.

So, although the technology is available, teachers complain about the time used to set up the technology and to get started, which decrease teaching time. Thus, they suggest that it would be an ideal setting if ICT resources are set up in advance, which would make them easier to use. It is clear that ideal conditions are not yet in place in these school settings. In instances where the hardware and software are in place, concerns are related to the location of the ICT, as well as the acquisition of pedagogy and skills by the teachers.

Subsequently, a lack of appropriate hardware and software was reported as a barrier in the classroom. This was followed by a lack of access to the internet, such as Wi-Fi in a classroom. Similarly, in a study conducted by Padayachee (2017), the principal barriers mentioned were a lack of infrastructure in classrooms, along with the inadequate use of the existing infrastructure, a lack of internet access, or the absence of the necessary tools such as data projectors. Furthermore, the barriers included a lack of professional development opportunities, a lack of leadership, a lack of technical support and, lastly, a lack of support from school administrators, parents and other teachers.

5.1.2 *Sub-question 2*: In what way are the available technological resources used to enhance the teaching and learning?

The PEOU and PU are two aspects that determine how the available resources are used in teaching and learning. The research reveals that there is a relationship between the PEOU and PU. It is essential that a technological tool is easy to use in order for it to be used appropriately. In Wong's (2015) study, it was found that teachers used a tool if they regarded it as really helpful, and disregarded it otherwise. Ultimately, the BI of using ICT in the classroom depends on the PEOU and PU.

It is evident that all teachers use ICT in some form in the classroom. However, usage is limited, as ICT hardware and software are not being utilised to their full potential, which may have led to an improvement in classroom instruction and education. Teachers feel that ICT could be used to enhance concepts and should not be used on a daily basis. Researchers (Delialioglu, 2012; Huey-Min et al., 2017) state that ICT tools are not essential for educating learners; however, these tools should be used to make the learning process more interactive, engaging, adaptive and efficient.

The most common form of ICT hardware is laptops, projectors and iPads used by teachers. The most commonly used ICT software is the internet, YouTube and applications for mathematics games. Teachers reported using YouTube videos as an introduction to a new topic or for a deeper understanding of a particular mathematics topic. iPads are used for additional learning, such as playing a game regarding a particular topic. Some teachers mentioned using an iPad for mathematics quizzes or using applications to support learners in relation to a specific topic. However, iPads are not used on a daily basis due to the fact that some learners do not have iPads. This leads to unfairness in learning in the classroom. As mentioned by Teacher E, in the intermediate phase level it is against the school rules to use a cell phone during class. Thus, iPads offer an alternative way to experience these digital tools.

Furthermore, it was also noted that teachers use laptops and computers more for administrative purposes, such as creating classroom activities, setting examination papers and memorandums, as well as capturing marks. The PEOU and PU have a direct effect on the ATU. This will be discussed in relation to the next question.

5.1.3 *Sub-question 3*: What are the views of mathematics teachers regarding the use of ICT in the classroom?

The views on using ICT in the classroom were on the teachers' attitudes towards using ICT in teaching and learning. The external variables (EV 2),

such as teachers' personal feelings and emotions, have an impact on their ATU. From the research, it is evident that age, skills and interest make a difference in the usage of ICT in the classroom. The younger educators are more equipped with operating ICT tools as they also use technology on a daily basis. The older teacher (Teacher D) was rigid in her instructions and preferred traditional ways of teaching, as she was reluctant to change her methods. According to Willis, Lynch, Fradale, and Yeigh (2019), traditional teachers might be less inclined to support the implementation of ICT in the classroom.

In general, the participants had a positive attitude towards using ICT in teaching. However, they were not entirely eager to use it due to the barriers they faced on a daily basis. The Department of Basic Education and Early Childhood Development (Gent & Meyer, 2016) suggests that there is one factor that is essential when implementing ICT in the classroom: *purpose*. Benekos (2016) says that a good teacher will always have a purposeful, thought through or meaningful pedagogically based implementation of learning in the classroom. In the same way, ICT should be used as a tool with a purpose to reach an outcome (Willis et al., 2019).

The teachers also held the view that using ICT creates a lack of energy, as learners are easily distracted and rather view ICT as something for relaxation. Also, the teachers felt that the majority of time in a lesson is wasted if the digital tool needs to be set up for every lesson. This relates to the findings from sub-question 1 above.

5.1.4 *Sub-question 4*: What technical training did the teachers receive to integrate ICT into the mathematics classroom?

The level of professional development a teacher has comprises the technical training and support of the teachers. According to Wong (2015), the first step to using ICT in teaching and learning is for the teachers to accept technology. Many of these teachers learnt to use ICT tools by experimenting on their own. Most of the training teachers received as at university. These mathematics

teachers claim that there are no guidelines in place for implementing ICT in the classroom. A few teachers only received internal training from their individual schools and recommend that they be sent for further training to improve their skills in the use of ICT.

The results show that ICT training plays a significant role in the implementation of ICT in teaching and learning. There is an interest in training amongst the teachers; however, the study reports limited knowledge regarding the use of computers in teaching. Li and Ma (2010, pg. 220) state that the "effectiveness of mathematics learning with technology is highly dependent on many other characteristics such as teaching approaches, type of programs and type of learners". Teachers state that training should be conducted using the appropriate software. Workshops should be hands-on and practical, and should allow teachers to create lessons and apply the skills learnt during the ICT training. Radović, Marić, and Passey (2019) conducted a study on technology-enhancing mathematics learning behaviours and found that there is a need for appropriate training to support ICT in education. If teachers were provided the necessary training, there could be an increase in technology usage in mathematics teaching and learning. Thus, these factors are essential to promote ICT in mathematics classrooms.

It is noted that the age and experience of the teacher have an impact on their perceived use of ICT in the classroom. The results show the teachers between the ages of 18 and 35 years are more willing to use ICT in the classroom. Basargekar and Singhavi (2017) found that older teachers who have many years' experience fear being replaced by ICT tools. Thus, training should be introduced to remove these fears, as well as to create a positive attitude towards the use of ICT in teaching and learning.

5.1.5 *Sub-question 5*: What support is available for teachers to integrate ICT into the mathematics classroom?

The mathematics in this study claimed that they were left on their own to use the tools and were not supported in the classroom. The support received by these participants was based on the professional development they received at their schools. It is evident that there is a lack of support for mathematics teachers in the ICT department. The results show that there is a need for better support for teachers to participate in professional development in schools. It is in the hands of policymakers and school leaders to ensure that these development opportunities are effective and meet the demands of teachers. The NCTM (2015) mentions that teachers are orchestrators and coaches of strategic ICT use in the classroom, and the curriculum is critical in ensuring the strategic use of these digital tools.

Principals, HODs and education management are aware of the importance of ICT and encourage teachers to use it, but they do not monitor their usage in the classroom. According to studies by Al Harbi (2014) and Ghamrawi (2013), the school principal plays a major role in ICT implementation in a school. A school principal is responsible for providing support and encouragement to teachers, as well a good working environment to encourage teachers to use ICT. Furthermore, Uluyol and Sahin (2016) mention that teachers' intrinsic and extrinsic motivations play a crucial role when deciding to use ICT in teaching. Intrinsic motivation is increased by the way teachers perceive the instructional advantages of ICT, while extrinsic motivation is increased by expectations, encouragement and support from teachers, parents, learners as well as school leaders.

5.1.6 Summary

In this section, the secondary research questions were addressed using the results from the interviews and questionnaires. There are several barriers that hinder the six mathematics teachers' abilities to make use of these resources.

These teachers limit the usage in the classroom of both the hardware and software resources that are available at schools. Hardware is limited to using laptops, projectors and iPads; software is limited to projecting YouTube videos and using applications on the iPads. Teachers have different perspectives of using ICT for teaching and learning. The technical training teachers receive is limited in the educational setting. Teachers claimed that there was a lack of support and encouragement to use ICT, and thus suggest an increase in support towards the use of these digital tools in the classroom.

5.2 Conclusions

Although this research tapped into the views and perceptions of a small sample size, the findings are in line with the literature reviewed. For the purpose of this study, I sought to address the main research question: *"How do Grade 5 teachers from well-resourced schools experience the use of ICT within their classrooms?"* The findings of this study reveal feelings of both optimism about and reluctance when using ICT. The results show that there are numerous barriers to using ICT in mathematics teaching and learning. However, despite these barriers, there is still belief that ICT is the future of learning. It is always important to understand that the responses of the participants represent their perceptions. Nonetheless, teachers' behaviour is influenced by their perceptions. Additionally, this study confirms Mwapele et al. (2019) study that despite financial, technical and insufficient digit skills teachers are ready to integrate ICT into teaching and learning.

Teachers view ICT merely as an additional resource in the classroom. However, according to Willis et al. (2019), ICT should be included in the classroom with purpose and should be incorporated into pedagogy based on meaningful implementation. Teachers' beliefs and perceptions should be taken into consideration when doing teacher training, as teachers establish the extent of ICT use in the classroom (Gandhi & Lynch, 2017). It is noted that teachers do not have a motivating and trusting atmosphere in their classrooms that will enable them to increase their usage of ICT. Designing and implementing an ICT plan may enable participation by the entire teaching staff. In this way,

schools may be given opportunities to reflect on, improve and find innovative ways to use ICT in education. There is a drastic need to empower these catalysts of change.

In conclusion, ICT hardware and software need to be chosen with a curricular goal in mind to prevent it being a distraction. Teachers need to be educated in the field of ICT and should experience its usage in teaching and learning as positive. Ultimately, teachers also need to be confident and competent in ICT to create an interactive environment. They should possess more than basic ICT skills and have a deep understanding to incorporate these skills into mathematics lessons. Finally, it is the responsibility of curriculum developers and school leaders to develop teachers' knowledge and skills to purposefully implement ICT in the classroom.

5.3 Implications of the study and recommendations for improvement

The six teachers used in this study represented a continuum of mathematics teachers in well-resourced schools. In order for ICT to be used continuously for teaching mathematics in private schools in South Africa, the following points need attention:

- Intervention is required for ICT teacher training and support for mathematics teachers. The training needs to focus on ICT usage in general, as well as subject-specific applications. Teacher training workshops should promote self-learning as well as lifelong learning. Detailed and specific programmes need to be designed to ensure educators are not only experts in using computers, but can also use ICT effectively and appropriately in their mathematics teaching. According to UNESCO (2018), teachers need to be ICT competent in order to develop their learners for the future, and this can only happen through teacher training and on-going support.

- There is an urgent need to develop a framework or policy that will integrate ICT in the mathematics curriculum. A specific framework will guide leaders as well as mathematics teachers to follow and implement ICTs at the individual schools. The Department of Education (Bialobrzeska & Cohen, 2005) has presented guidelines on the management and usage of ICTs to public schools in Gauteng. The policy provides a framework for ICT usage in schools. Thus, it is in the hands of the school governing body, policymakers as well as school leaders to ensure these schools create ICT guidelines and successfully implement it in the classrooms.
- Although the selected schools are considered well-resourced schools, there still remains an urgent need to address the lack of ICT hardware and software in schools.

5.4 Limitations of this study

Although this study was not gender based, the five female participants and one male participant did not offer a true reflection of the views of men in teaching. The participants comprised a sample of only six teachers in the Tshwane region. Thus, generalizations cannot be made in relation to other cities. The results of this study also only depicted ICT usage by Grade 5 mathematics teachers in private schools.

5.5 Final reflections

It is certain that change in the education environment is necessary, although it must be undertaken carefully. ICT can contribute positively to the teaching and learning of mathematics; however, the process is never easy and there are barriers that exist. Therefore, after conducting the research it is evident that although private schools are independent organisations; the mathematics teachers in this study are not necessarily equipped with effective digital skills to apply ICT into their lessons. It is evident from this research that even though the schools in this study were well-resourced schools, they also lack sufficient

resources and showed a lack of support needed by the teachers. Therefore, bridging this gap between education and technology requires continuous research. It is also not just about having the necessary tools available in the classroom, but also about having specific tools that can be used effectively to improve teaching and learning. Therefore, using ICT in the classroom is dependent on the teacher, but with the motivation and encouragement of the whole school network.

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7. Addendums

7.1 Addendum A: Letters of permission and assent

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Education

Ms. N. Abdul-Razak
Science, Mathematics and Technology Education
Groenkloof campus
University of Pretoria
Nasreenar111@gmail.com
Cell: 076 9237032

06 February 2019

Dear Sir/Madam

Letter of consent to the Mathematics Teacher

I am currently enrolled for a Master's degree at the University of Pretoria. Part of the requirements for the awarding of this degree is the successful completion of a significant research project within the field of education.

You are invited to participate in my study entitled, **"Teachers' experiences of ICT use in Grade 5 mathematics classrooms"**. The instruments used during the data collection process are a questionnaire and a semi-structured interview. You will be required to complete a questionnaire that will take approximately 30 minutes of your time. After a week you will be contacted to arrange for a convenient time to conduct an individual interview. I would like to audio record the interview to ensure that I capture accurate information of our conversation. This interview will take no more than 60 minutes of your time.

Should you declare yourself willing to participate in this study, you will be one of six teachers that form part of my research project. There are no risks involved in this study, your participation is absolutely voluntary and you have the rigtht to withdraw from this study at any time. If you at any time make a decision to withdraw from this study will not result in any penalties. Confidentiality and anonymity in this study will be guaranteed at all times. This will be done by allocating pseudonyms to you and the school during all phases of the research process. Only my supervisors and I will have access to the audio recordings that will be password protected. The study will be conducted in English and there will be no incentives for the participating schools or teachers.

If you are willing to participate in this research study, please sign this letter as a declaration of your consent, i.e. that you participate willingly and that you understand that you may withdraw at any time.

Yours sincerely

Researcher: Ms N. Abdul-Razak — Date: 12/02/2019

Supervisor: Dr JJ Botha — Date: 12/2/2019

E-mail: hanlie.botha@up.ac.za

Co-supervisor: Dr. K Moodley — Date: 8/2/2019

I hereby grant consent to Ms N Abdul-Razak to collect data from me for her Master's degree research study by completing a questionnaire and taking part in an interview. I also grant permission to Ms N Abdul-Razak to audio record the interview.

Teacher's name: _____

Teacher's signature: _____

Date: _____

E-mail address: _____

Contact number: _____

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
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Faculty of Education

Ms. N. Abdul-Razak
Science, Mathematics and Technology Education
Groenkloof campus
University of Pretoria
Nasreenar111@gmail.com
Cell: 076 9237032

06 February 2019

Dear Sir/Madam

Letter of consent to the Principal

I am currently enrolled for a Master's degree at the University of Pretoria. Part of the requirements for the awarding of this degree is the successful completion of a significant research project within the field of education. The title of my approved study is, **"Teachers' experiences of ICT use in Grade 5 mathematics classrooms"**. I hereby request permission to conduct research at your school. I would like to invite two Grade 5 Mathematics teachers to participate in my study.

The instruments used during the data collection process are a questionnaire and a semi-structured interview. I will give each teacher a questionnaire to complete which will require approximately 30 minutes of their time. Once the teachers' have completed the questionnaires, they will be contacted and an interview will be individually scheduled. Both the questionnaire and interview will be conducted after hours at the school at a convenient time that the participant suggests. All interviews will be audio recorded to ensure that I capture accurate information of the conversation. The time allocation for the interview will not exceed 60 minutes.

All participation is absolutely voluntary and participants have the right to withdraw from the study at any time. If the participant refuses to continue in sharing information and makes a decision to withdraw will not result in any penalties. Confidentiality and anonymity are guaranteed at all times by using pseudonyms for the school and the teachers. The school and the teachers will therefore not be identifiable during the research study or in the findings of my research. However, only my supervisors and I will have access to the digital audio recordings that will be password protected. The study will be conducted in English and there will be no incentives for the participating schools or teachers.

After the successful completion of my Master's degree, I will give feedback to the school in the form of a written report and if the school is willing, I would like to do a presentation of my findings to all mathematics teachers at your school.

For any questions before or during the research, please feel free to contact me. If you allow me to conduct this study in your school, please sign this letter as a declaration of your consent.

Yours sincerely

Razak

Researcher: Ms N. Abdul-Razak — Date: 12/02/2019

Supervisor: Dr JJ Botha — Date: 12/2/2019
E-mail: hanlie.botha@up.ac.za

Co-supervisor: Dr K Moodley — Date: 8/2/2019.

I hereby grant consent to Ms N. Abdul-Razak to conduct her research in this school for her Master's degree. I also grant permission to Ms N. Abdul-Razak to conduct a questionnaire and an interview with each participating teacher. I also grant consent to Ms. N. Abdul-Razak to audio record the interviews with the teachers.

Principal's name: _____

Principal's signature: _____

Date: _____

E-mail address: _____

Contact number: _____

School Stamp

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Education

Ms. N. Abdul-Razak
Science, Mathematics and Technology Education
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Nasreenar111@gmail.com
Cell: 076 9237032

06 February 2019

Dear Sir/Madam

Letter of consent to the Regional Head of School

I am currently enrolled for a Master's degree at the University of Pretoria. Part of the requirements for the awarding of this degree is the successful completion of a significant research project within the field of education. The title of my approved study is, **"Teachers' experiences of ICT use in Grade 5 mathematics classrooms"**. I hereby request permission to conduct a research study at your school. I would like to invite **two** Grade 5 mathematics teachers to participate in my study.

The instruments used during the data collection process are a questionnaire and a semi-structured interview. I hereby request permission to allow the respective teachers to complete a 3-page questionnaire that will not exceed 30 minutes and take part in an interview which will not exceed 60 minutes. All participation is absolutely voluntary and the participants have the right to withdraw from the study at any time. Confidentiality and anonymity will be guaranteed at all times by using pseudonyms for the three schools and six teachers involved in this study. The schools and the teachers will therefore not be identifiable in the findings of my research and only my supervisors and I will have access to the audio recordings that will be password protected. The data collected will only be used for academic purposes. The study will be conducted in English and there will be no incentives for the participating schools or teachers.

After the successful completion of my Master's degree, I will give feedback to the school in the form of a written report and if the school is willing, I would like to do a presentation of my findings to all mathematics teachers at that school.

For any questions before or during the research, please feel free to contact me. If you are willing to allow members of your school to participate in this study, please sign this letter as a declaration of your consent.

Yours sincerely

Researcher: Ms N Abdul-Razak — Date: 12/02/2019

Supervisor: Dr JJ Botha — Date: 12/2/2019

Co-supervisor: Dr K Moodley — Date: 08/2/2019

I, the undersigned, hereby grant consent to Ms N. Abdul-Razak to conduct her research at this school for her Master's study. I, the undersigned, hereby also grant permission to Ms N. Abdul-Razak to allow two Grade 5 Mathematics teachers from this school to partake in a questionnaire and an interview. I grant the researcher permission to audio-tape the interviews with the teachers.

Name of School: _____

Regional Head of School's name: _____

Regional Head of School's signature: _____

Date: _____

E-mail address: _____

Contact number: _____

Institution stamp

7.2 Addendum B: Questionnaire for Grade 5 mathematics teachers

In this questionnaire you will be asked questions about your experiences of using Information and Communication Technology (ICT). The term ICT refers to the use of the communication technologies which are:

1. **Hardware** – Computers, Laptops, Tablets, iPads, Cell phones, Data projectors, Smart boards, Calculators
2. **Software** – Computer applications (Microsoft Word processor, Excel), Internet, PowerPoint presentations, YouTube videos

---

Date: _____ School: #_____ Teacher: #_____

Section A: Demographic information

Please tick ☑ the correct block below:

1. Gender: Male: ☐ Female: ☐

2. Age: 18-35 years ☐ 36-55 years ☐ 55 years and over ☐

3. Educational qualifications:

_____

_____

_____.

4. Number of years of teaching experience in Mathematics:

☐ Less than 1 year ☐ 1-5 years ☐ 6-10 years ☐ 11-15 years

☐ 16-20 years ☐ 21 +

5. How often do you use a computer or laptop at school for teaching and learning mathematics?

☐ Never ☐ 1-3 lessons ☐ 4-6 lessons ☐ Every lesson

6. Tick ☑the ICT tools you use in your Mathematics lesson:

ICT tool	Always	Sometimes	Never
Computer			
Laptop			
Tablet			
iPad			
Cell phone			

Calculators			
Data projectors			
Smart boards			
Internet			
Computer Applications			
PowerPoint presentations			
YouTube videos			
Other (list): _____			

7. Circle the appropriate choice below:

	The following people positively influence my use of ICT:	**1 Strongly Agree**	**2 Agree**	**3 Neutral**	**4 Disagree**	**5 Strongly disagree**
a.	Principal	1	2	3	4	5
b.	Head of Department	1	2	3	4	5
c.	Colleague(s)	1	2	3	4	5
d.	Learners' parent(s)	1	2	3	4	5
e.	Learners	1	2	3	4	5

Section B: Technology Acceptance Model (TAM)

Circle the most appropriate choices below.

1) What are the barriers that are hindering teachers' abilities to make use of these resources?

1.1) Perceived external barriers (EV1)

	The following external barriers will hinder me from teaching with ICT:	**1 Strongly Agree**	**2 Agree**	**3 Neutral**	**4 Disagree**	**5 Strongly disagree**
a.	Lack of resources (educational software)	1	2	3	4	5
b.	Lack of professional development opportunities on using ICT in teaching	1	2	3	4	5

c.	Lack of access to the internet	1	2	3	4	5
d.	Lack of time in class to implement ICT tools	1	2	3	4	5
e.	Lack of technical support	1	2	3	4	5
f.	Lack of support from school administrators, parents, or other teachers	1	2	3	4	5
g.	Lack of leadership	1	2	3	4	5

2) In what way are the available technological resources used to enhance the teaching and learning of mathematics?

2.1) Perceived Ease of Use (PEOU)

		1 Strongly Agree	**2 Agree**	**3 Neutral**	**4 Disagree**	**5 Strongly disagree**
a.	Learning to use ICT in teaching is easy for me	1	2	3	4	5
b.	I find it easy to use ICT in teaching if I want to use it	1	2	3	4	5
c.	My interaction with ICT in teaching is understandable	1	2	3	4	5
d.	I find using ICT in teaching enables more flexible interaction with content	1	2	3	4	5
e.	It is easy for me to become skilful at using ICT in teaching	1	2	3	4	5

2.2) Perceived Usefulness (PU)

	Using ICT in my teaching,	**1 Strongly Agree**	**2 Agree**	**3 Neutral**	**4 Disagree**	**5 Strongly disagree**
a.	enables me to teach more quickly	1	2	3	4	5
b.	improves my teaching performance	1	2	3	4	5
c.	gives me greater control over my teaching	1	2	3	4	5
d.	makes lessons more motivating	1	2	3	4	5
e.	makes teaching and learning more interesting	1	2	3	4	5
f.	encourages more interaction between learners and content	1	2	3	4	5

g.	improves student learning as it allows students to assess learning content anywhere at anytime	1	2	3	4	5
h.	enhances/encourages my learners' self-directed learning	1	2	3	4	5

3) What are the views of Mathematics teachers regarding the use of ICT in the classroom?

3.1) Attitude towards use (ATU)

		1 Strongly Agree	**2 Agree**	**3 Neutral**	**4 Disagree**	**5 Strongly disagree**
a.	Using ICT makes teaching more enjoyable	1	2	3	4	5
b.	I like using technological tools in teaching	1	2	3	4	5
c.	ICT is beneficial in the classroom	1	2	3	4	5
d.	Using ICT helps improve Mathematics results	1	2	3	4	5
e.	I feel frustrated more often when I use ICT in my class than when I do not use it	1	2	3	4	5
f.	I have positive ICT experiences in my classroom	1	2	3	4	5
g.	I always have positive experiences with ICT previously	1	2	3	4	5
h.	I feel I am trained well enough to use a variety of ICT tools when teaching	1	2	3	4	5

3.2) External Variables (EV2)

		1 Strongly Agree	**2 Agree**	**3 Neutral**	**4 Disagree**	**5 Strongly disagree**
a.	I feel comfortable using a laptop or computer to do my tasks	1	2	3	4	5
b.	I can easily learn ICT skills if I see someone else doing it	1	2	3	4	5
c.	I feel insecure about my ability to use ICT	1	2	3	4	5
d.	I need someone to show me	1	2	3	4	5

	the best way to use ICT in my teaching					
e.	I use ICT only for administrative tasks such as attendance and maintaining grades	1	2	3	4	5
f.	I use my computer, laptop or cell phone for calls, messaging and emails	1	2	3	4	5

3.3) Behavioural Intention (BI)

		1 Strongly Agree	**2 Agree**	**3 Neutral**	**4 Disagree**	**5 Strongly disagree**
a.	I intend to use ICT in teaching when I am equipped with the skills	1	2	3	4	5
b.	I intend to use ICT in teaching Mathematics as often as possible	1	2	3	4	5
c.	I intend to recommend strongly to others to use ICT in teaching	1	2	3	4	5

4) What technical training and support did you receive to integrate ICT in the Mathematics classroom?

4.1) Professional Development

		1 Strongly Agree	**2 Agree**	**3 Neutral**	**4 Disagree**	**5 Strongly disagree**
a.	The training I received could be easily applied in my lessons	1	2	3	4	5
b.	I feel adequately trained in the skills needed to use ICT tools	1	2	3	4	5
c.	The training I received on ICT enhances my professional capacity to complete relevant tasks	1	2	3	4	5
d.	The training I received is internal and within the school system	1	2	3	4	5

e.	I have access to ICT technical support when I need it	1	2	3	4	5

7.3 Addendum C: Semi-structured interview

In this interview you will be asked questions about your experiences of using Information and Communication Technology (ICT). The term ICT refers to the use of the communication technologies which are:

3. **Hardware** – Computers, Laptops, Tablets, iPads, Cell phones, Data projectors, Smart boards, Calculators
4. **Software**- Computer applications (Microsoft Word processor, excel), Internet, PowerPoint presentations, YouTube videos

Remember that you have read and signed the terms of this research. If you do not wish to continue at any stage, you are welcome to stop the interview. Thank you for agreeing to participate in this interview.

Date: _____ School: # _____ Teacher: # ___

Guided questions based on the TAM model:

1) What are the barriers that are hindering teachers' abilities to make use of these resources?

Perceived external barriers (EV1)

a) What prevents you from using technology in the classroom?
b) What, in your opinion, is the barriers in the use of technology for teaching?
c) In what ways have you experienced the lack of resources in your school to complete technical tasks?

2) In what way are the available technological resources used to enhance the teaching and learning in Mathematics?

Perceived ease of use in mathematics (PEOU)

a) Do you feel you have the necessary skills to integrate ICTs in your daily teaching responsibilities? Motivate your answer.
b) How has ICT made teaching mathematics easier for you?
c) What kind of assistance do you provide to your learners if they encounter problems with technology use?

Perceived usefulness in mathematics (PU)

a) Do you believe that ICT is making a difference on learner performances of Mathematics in your classroom? Motivate your answer
b) How is ICT improving your teaching performance in the classroom?
c) Does the use of ICT make your Mathematics lessons more interesting? How?

3) What are the views of Mathematics teachers regarding the use of ICT in the classroom?

Attitude towards use (ATU)

a) Do you think you can use ICT for teaching and learning?
b) Comment in general, what are your concerns of teaching with technology in the mathematics class?
c) Describe your experiences of ICT in your mathematics classroom?

Behavioural Intention (BI)

a) Do you intend to use ICT on daily basis in Mathematics in the future?
b) Do you recommend others to use ICT in their teaching and learning?

External Variables (EV2)

a) Do you experience any form of anxiety when using ICT in teaching?
b) What is your teaching philosophy of using ICT in the classroom?
c) How does the usage of ICT benefit you when teaching Mathematics?

4) What technical training and support did the teachers receive to integrate ICT in the Mathematics classroom?

Professional Development

a) What is your observation of technology acceptance of your colleagues? Has it affected or influenced the way you use ICT tools in your classroom?
b) What training and development strategies will maximise ICT use in teaching and learning?
c) Which external and/or internal training did you do to support your development in the implementation of ICTs in your teaching activities? What was the value/impact of this training?

d) What would you still like to do/ learn with regard to teaching with technology?

Any other comments regarding the use of ICT?

_____

_____

_____