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EXPLORING MATHEMATICS TEACHERS' DISPOSITION IN BELIEFS, ATTITUDE AND BEHAVIOUR (BAB) IN ICT MEDIATED LESSONS: A CASE STUDY OF FOUR MATHEMATICS TEACHERS.

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A Research Report submitted to the Faculty of Humanities, School of Education, University of the Witwatersrand, South Africa, In partial fulfilment of the requirements for the degree of Master by Dissertation of Mathematics Education.

November, 2020

DECLARATION

I declare that this Research Report is my own unaided work. It is being submitted for the Degree of Master of Education at the University of the Witwatersrand, Johannesburg. It has never been submitted in any form for any degree or diploma in any tertiary institution. It, therefore, represents my original work. Where use has been made of the work from other authors or organisations, it is duly acknowledged within the text or references chapter.

V. Chilengi

Signature of candidate

25th November 2020

Date

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Abstract

This study explored the primary teachers' beliefs, attitudes and behavioural intentions (BAB) to use information and communication technology (ICT) and how teachers' beliefs were enacted in the actual teaching of the concept of time. This was a qualitative case study on four primary school teachers from an international independent school in Johannesburg, South Africa when they were teaching the topic of time. The study was guided by the unified theory of acceptance and use of technology (UTAUT) model. Data were analysed thematically but some descriptive statistics were used to support the qualitative analysis. The major findings of the study indicated some positive teacher perceptions in the facile use of ICT and the pedagogical potential of ICT to improve teaching and learning mathematics. All participants felt the urge and showed motivation to integrate ICT in mathematics teaching and learning. However, the study showed that in general, they lack onsite technical support, encouragement from the school leadership, unreliable ICT infrastructure, and the lack of training and professional development in the pedagogical use of ICT. The study recommends that the school leadership should encourage teachers and be very explicit about the benefits of integrating ICT into mathematics teaching. It should provide onsite technical support, adequate ICT infrastructure as well as continued training and professional development to boost teachers' competencies in the pedagogical use of ICT in mathematics teaching and learning.

KEY WORDS

Information and Communication Technology, Beliefs Attitude and Behavour, Teaching and Learning Time, Grades 3, 4 and 5. Unified Theory of Acceptance and Use of Technology, Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Behavioral Intentions

ACRONYMS

BAB: Beliefs Attitude and Behavour

UTAUT: Unified Theory of Acceptance and Use of Technology.

TAM: Technology Acceptance Model

TrA: Theory of reasoned action

TPB: Theory of Planned Behaviour

MM: Motivational Model

MPCU: Model of PC utilization

SCT: Social cognitive theory

DoI: Diffusion of innovation theory

PE: Performance Expectancy

EE: Effort Expectancy

SI: Social Influence

FC: Facilitating Conditions

BI : Behavioral Intentions

MKT: Mathematics Knowledge for Teachers

PCK: Pedagogical Content Knowledge

MKO: More Knowledgeable other

ZPD: Zone of proximal development

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CHAPTER 1: BACKGROUND TO THE STUDY

1.1 INTRODUCTION

Globally, Information and Communication Technology (ICT) has developed substantially in various learning environments. The term ICT is widely utilized in the field of education to refer to the different collection of technological materials used to communicate, create, store and control information (Department of Basic Education, 2016; Naicker, 2010). These information and communication technologies (ICTs) comprises computers, SMART boards, the internet, telephones, broadcasting radio and television. Although ICT is an umbrella term for diverse technologies like telephones, televisions and data projectors, its meaning in the context of this study will be limited to the ICT tools that are used by teachers in mathematics teaching. For example, iPads, computers, air-played TV, over-head projectors and calculators.

Over the past two decades, ICT has been reported as an important mediating tool for mathematics teaching and learning (Ali, 2015; Association of Mathematics Teacher Educators, 2006). Yet studies reveal that a lot of mathematics educators tend to avoid the integration of ICT tools in their lesson delivery (Jacobsen, Clifford, & Friesen, 2002; Bakia, Mitchell &Yang, 2007). In cases where technology is integrated into mathematics lessons, the teacher's intention is primarily to cover the basics of how to perform simple computations, like using non-scientific calculators (Ndlovu & Lawrence, 2012; Ozgun-Koca, Meagher, & Edwards, 2010).

Despite the application of ICT tools being invaluable in mathematics classrooms the world over, teachers hold differing viewpoints on the use of technology in their teaching (Brun & Hinostroza, 2014). Studies by Archambault and Crippen (2009) in Sweden have served to shed a light on mathematics teachers' experiences and challenges with the integration of technology in their lessons and their resulting stance about the usage of such aids. The research indicates that while teachers assessed themselves as being capable in mathematical pedagogies, their capability and approaches towards the use of ICT tools in classroom instruction proved insufficient. Similarly, studies in Turkey revealed that mathematics teachers' dispositions and confidence vary in the use of technological appliances despite their expressed belief that integrating computers in the lesson can help teach mathematics (Dogan, 2012).

In African countries, for example, Ghana, despite the curriculum reforms placing a lot of emphasis on the use of technology for teaching of mathematics, the expected standards in terms of how mathematics should be presented are still not met (Agyei & Voogt, 2011). This has been reflected consistently in the instances of the country's poor mathematics achievement. For example, in the Trends in International Mathematics and Science Study (TIMSS) in 2003 and 2007, Ghana's grade eights came out 43rd out of 44 and 46th out of 47 nations that took part in the study in 2003 and 2007 respectively (Mullis, Martin, Foy, 2008; Mullis, Martin, Foy, Gonzalez, & Chrostowski, 2004).

The South African system of education is frequently adapting to the updated and revised requirements of the Department of education. The fact that ICT has become the most commonly used method of communication among the Global populace has had a spillover effect on the South African education system, where its applications are diversified, specialised and enhanced at a rapid pace (Department of Basic Education, 2016; Department of Basic Education, 2004). The 21st century has developed educational learning outcomes that permit teachers and learners to access and refer to digital information found in virtual classrooms which can be accessed in different settings and at individualised paces (Department of Education , 2002; Law & Chow, 2008). It has been noted that the teaching of mathematics as both a language and a skill is intricately connected to the development of higher-order thinking skills (Zhang, Fan, Cheung, Meng, Cai, 2017). Considering the unpleasant performance of South African learners in different learning areas including mathematics (Grosser & Nel, 2013), the ensuing deficit that arises in the development of these higher-order skills demands a certain reformation in mathematics teachers' perspective in using ICT skills for them to be able to effectively bridge specific pedagogical outcomes for the learners' meaningful and effective learning (Nieuwoudt, 2006).

1.2 Background to the Research Problem

The global debate on the application of ICTs in education, especially in mathematics teaching is ongoing. Studies, (Umugiraneza, Bansilal & North, 2018; Culp, Honey & Mandinach, 2005; Zhou, Brouwer, Nocente & Martin, 2005) indicated that ICTs can enhance conceptual understanding and problem-solving skills in the teaching of mathematics and science. With the expectation that ICTs can create possibilities that can enhance the quality of teaching and learning, the challenge arises of how such systems should be applied and regulated in the classroom context (Scott, 2002).

In South Africa, teachers, particularly in urban and private schools, face different challenges in their attempt to incorporate technology in their teaching routines (Steyn & Van Greunen, 2014). There are many possible reasons for these challenges. One reason is speculated to be connected to the fact that all learners are part of the digital generation but each learner's level of exposure to and interaction with the digital interface varies (Department of Basic Education, 2016). Prensky (2001) asserts that learners are digital natives, often having been exposed to brain-development games in infancy, and are thus fluent communicators in the computer language, iPads, video games, mobile phone applications, and other technological devices. Teachers born before the computer era are defined as digital migrants, as emerging technologies were forcibly thrust upon their lives and they were thus challenged with acquiring the skills to operate in and function in a world beyond ink, graphite, chalk, and paper (Pramana, 2018; Prensky, 2001). With this claim, Ndlovu and Lawrence (2012), and Bennet, Maton and Kervin (2008) note that there is an overwhelming challenge for many teachers to use technology efficiently to meet the expectations of the digital generation. Another reason for the need to integrate technology in education may be to meet the global transformation of individual and isolated countries to a vast, living, constantly-communicating network. Also Zuochen and Dragana (2008) assert that the numerous global advancements in ICT essentially demands teachers' thorough information of these technological devices and their impact on engagement and execution of the

learners.

The above reasons may give a background understanding of the South African Department of Education's calls for the use of technological tools in teaching (Department of Basic Education, 2016; Jaffer, 2010; Department of Education, 2004). For this reason, the objective was to have had every learner in the classroom technologically literate by 2013 (Wilson- Strydom, Thomson & Hodgkinson-Williams, 2005; Department of Education, 2004). Regardless of the idealism associated with the vision of digital learning interfaces, and the resulting opportunity for extended inter-activeness, ready access to vivid visual aids and communication in a language which requires no translation from one language to the next, Bansilal (2015) warns that the delivery of ICTs into the education system presents a challenge because there is still an imbalance in the provision of ICT resources. Furthermore, while the constitution of South Africa upholds the value of equality and the right to education for all, there is still an indication of acute disparities in the type of ICT support available in urban white private schools and schools in rural areas (Dzansi & Amedzo, 2014)

Another troubling phenomenon is that, in schools where ICTs are available, the use of these teaching aids tends to be relegated to lessons that are covering the basics of the subject content rather than the expected systematic integration of ICTs into each lesson (Umugiraneza, Bansilal & North, 2018; Mueller, Wood, Willoughby, Ross & Specht, 2008). In light of these research findings, we can conclude that these valuable tools remain undervalued and largely underutilized (Law & Chow, 2008). Given that the use of ICTs in mathematics education has been shown to be highly effective it is asserted that the expected standards in mathematics teaching continue to remain unmet due to the lack of implementation of ICTs by the teachers (Umugiraneza, Bansilal & North, 2018). The problem is that there is little research on how mathematics teachers' beliefs, attitudes, and behavior intentions influence their competence and effectiveness in the teaching of ICT mediated lessons. Attitudes and beliefs in other research have been addressed, but this study focuses on the primary teachers in Johannesburg. Therefore, it is important to note that besides the government's scant delivery of ICT resources in schools the core matter of concern is how mathematics teachers regard the use of technological tools in classroom settings when the devices are available at the school or institution. Research into this area may yield findings that could be used to drive the constructive change in their use of technology.

If mathematics teachers' dispositions concerning the use of ICT tools remain unassessed, their classroom practices may be negatively affected and this may ultimately impact the intended learning outcomes in mathematics education (Bowers & Stephens, 2011). Although there are some studies on the mathematics teachers' use of ICT tools, there are additional, albeit limited studies that have been undertaken locally that serve to expose primary teachers' underlying perspectives on the use of ICTs in mathematics teaching. These studies are explored in detail in the literature review.

1.3 Mathematics Teacher's professional dispositions in the use of ICTs

According to Tatto & Senk (2011), the professional disposition of a teacher comprises how teachers act out their pedagogical practices, subject mastery and their interactions with the learners. Drawing

from Bourdieu's (1974) notion of dispositions, he asserts that disposition is an established direction or position that aligns one`s thinking and acting contracted within a social context. Many mathematics teachers participate in professional development networks (PDN) to expand their professional knowledge and typically disposition themselves in the network platforms to share relevant teaching materials, digital resources and different websites (Trust, 2015). The disposition is accordingly within the context of ICT mediation in their teaching as technology is not expected to substitute the traditional methods, but to back up the improvement in teaching (Tishkovskaya & Lancaster, 2012). Hoadley and Ensor (2009) agree that as much as people's classification of dispositions around them are socially acquired, indications of these tendencies are noticeable within individuals and their practices. There are, however, many factors that may affect the teachers' disposition towards the use of ICT tools in mathematics teaching. To delineate and understand the role of mathematics teachers in ICT-integrated lessons, their dispositions, specifically their beliefs, attitudes, and behaviors towards technology were studied and expanded upon. Using the internet and ICT tools in teaching could be described as a positive and an influential aspect in the teachers' role and disposition as it gives accessibility to more content and resources for greater ability in keeping up with educational developments (Purcell, Heaps, Buchanan & Friedrich, 2013). Hew and Brush (2007) argue that a teachers' beliefs, attitude and behavior (herein referred to as BAB) towards the use of ICT could hamper integration.

1.4 Advantages of using ICT in teching Mathematics in South Africa

The coming of ICTs in education provides today's learners with many learning advantages over the past decades (Ojo & Adu, 2018). In South Africa, continuous advances in the development of modern technology have significantly advantaged the need to incorporate technology within teaching and learning (Department of Basic Education, 2016; Mlitwa, 2006). South African researchers support that using ICT in teaching and learning offers the potential to advance the learner knowledge and affect different learning abilities (Kaput, 2007).

The use of ICTs also encourages learners to change from the traditional learning illustrated by rot-memorisation of facts to a progression of knowledge construction (Kristianto, 2017; Naicker, 2010; UNESO, 2008). For example, the children at early age also benefit from ICT tools when they play different computer games as this helps with the development of sensory-motor and thinking skills. Furthermore, the field of educational psychology also suggests that the use of ICTs such as computer/internet games has immediate positive effects on academic performance and specific cognitive skills (Ojo & Adu, 2018; Subrahmanyam et al., 2002). Using ICTs in schools ultimately increases the mathematical attainment of children in lower and higher grades (Yelland, 2001). The use of ICTs within South African schools enables learners to access learning and exchange ideas, and teachers to engage in communication with different professionals around the globe (Department of Basic Education, 2016; Mfum-Mensah, 2003).

These benefits are also extended to the administrative sectors as it makes the processes of timetabling and the drawing up of curricular faster and efficient (Nonyane & Mlitwa, 2007). Besides, ICTs in schools contribute to the value of the curricular and prepares learners for the workplace in society (Dede, 2009; Martinovic & Zhang, 2012). Miltwa (2006) contends that using computer-assisted eLearning not only contributes to an improved quality of learning, but also introduces the

South African learners to more technology based practices of post-school experiences.

1.5 Rationale of the study

Teachers in South Africa and many other developing countries face many technological challenges that relate to their mathematical content knowledge. The skills that are required to integrate ICT tools in the classroom are generally hampered by the lack of quality in the technological knowledge the teachers bring to the classroom (Vadachalam & Chimbo, 2017; Rowland & Ruthven, 2011). Although some studies in Southern and Eastern Africa (kaput, 2007) have mainly focussed on technology and the learners, little has been explored in understanding why and how the teachers use ICT facilities in the teaching and learning of mathematics. The effective incorporation of ICT in mathematics education in South African schools not only depends on knowledge, capability, and applications of ICTs, but also on an individual teacher's attitudes and perceptions regarding ICT tools.

According to the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) III study (2012), mathematics teachers in South Africa possess a limited understanding of ICT tools in the curriculum content as well as the knowledge adequate for effective teaching. Hence, it is against this background that this study explored the beliefs, attitudes and behavioral intentions of teachers' efforts to integrate and adopt the use of ICTs in the teaching of mathematics. The study focused on the primary school teachers' beliefs, attitudes and behavioural intentions towards ICT tools.

Notwithstanding the availability of ICT tools in the schools, interestingly many studies show that in many South African schools, ICTs are generally confined to administration and personal use. Furthermore, despite government putting in place polices to integrate ICT in the education sector, several gaps and challenges still prevail with respect to ICT insertion in mathematics education. This clearly demonstrates the vulnerability of the current teaching and learning practices, readiness, skills, competence, beliefs, knowledge and attitude of various educational stakeholders specifically on teachers' perspectives regarding the use of ICTs in schools.

From the above, it could be justified that for mathematics teachers to incorporate ICT tools effectively in teaching, they need to implement ICT mediated lessons (Vadachalam & Chimbo, 2017). Tubin and Edri (2004) contend that lack of proficiency in technological knowledge has been posited as one of the reasons for the modest use of ICT in learning environments. The teachers' stance to integrate effective ICT mediated lessons ought to be a combination of positive belief, attitude and behaviour (BAB) towards technology (Hew and Brush, 2007).

Based on these grounds, that the mathematics teachers need a positive disposition in ICT mediated lessons, this study will address the significance of the primary teachers' disposition concerning their beliefs, attitude and behaviour in ICT mediated mathematics lessons to enhance learning. For example, if the teacher shows a positive disposition towards ICTs, the use of computers, calculators, online games and Dynamic Geometry Environments may facilitate good lessons and conceptual understanding. Therefore, teachers must implement the use of ICT tools in effectively achieving

the desired learning outcomes. Moreover, a positive disposition in the integration of ICT tools not only leads to a successful lesson but also enables the teacher to confidently manage effective classroom activities.

1.6 Problem Statement

While the continuous development of modern technology in schools has significantly led to a neccessity for teachers to implement and integrate technology in teaching and learning (Department of Basic Education, 2016; Kramarski & Michalsky, 2010), numerous research studies also support the consensus that many mathematics teachers still lack the confidence to implement ICT mediated lessons when teaching mathematics (Vadachalam & Chimbo, 2017; Montgomerie & Irvine, 2001). In particular, Rogers (1995) avers that the rate of diffusion of technology by a group of practitioners ranges widely from innovators to laggards (see Chapter 2). Innovators are the first to use technology whereas laggards are the very last to embrace it.

Law and Chow (2008) contend that, despite a large number of mathematics teachers acknowledging the importance of ICT in teaching and learning, the pedagogical use of ICT tools in South African schools remains bleakly limited. As the issue of ICT in mathematics teaching and learning in South Africa remains debatable (Prew, 2013), the Department of education and the role players should rather go beyond just the ICT provision in the schools (Ndlovu & Lawrence, 2012), and consider the mathematics teacher's beliefs, attitude and behaviour (BAB) towards the use of these ICT tools. If teachers' dispositions which encompass beliefs, attitude and behaviour (BAB) towards the use of ICT tools remain ununderstood, by those in authority, their teaching may continue to be negatively affected and ultimately impact on the learners understanding (Bowers & Stephens, 2011).

Other reasons for failing to implement ICT mediated lessons could, of course, be the teacher's resistance to change due to the pressure expected to come with technology (Rogers, 1962), lack of accessibility and fear due to technical failures that the learners are more knowledgeable than the teachers. In this regard, there is a gap in the literature that focuses on teachers' dispositions regarding beliefs, attitude, and behaviour (BAB), and teachers' pedagogy in implementing ICT tools in mathematics learning environments (Pierce & Stacey, 2010; Freidhoff, 2008). Hence this study looks to uncover the primary teachers' beliefs, attitude and behavior (BAB) intentions in mathematics ICT mediated lessons.

1.7 Aims and objectives of the study

The aim of this study was to explore the primary mathematics teachers' disposition towards the use of ICTs to teach the concept of time. By having a clear understanding of BAB, appropriate interventions can be recommended.

Objectives

- to explore the teachers' beliefs, attitudes and behavioral intentions in applying of ICT tools in mathematics teaching.
- to find out how the teachers' beliefs, attitudes and behavioral intentions in using ICT tools are enacted in the actual teaching of the concept of time.

- to propose how the mathematics teachers' disposition towards ICT mediated lessons can be explained.

1.8 Research questions

This study was guided by two research questions to understand the mathematics teachers' beliefs, attitude and behavioral intentions in using ICT tools:

1. What are the teachers' beliefs, attitude and behaviour (BAB) intentions in using ICT tools in mathematics teaching?
2. How are the teachers' beliefs, attitudes and behavioral intentions in using ICT tools enacted in the actual teaching of the concept of time?

1.9 Significance of the study

The teaching of ICT mediated mathematics lessons occurs socially within the classroom. In this context, the teacher has the obligation to use ICT tools to mediate the learning. The purpose of this case study was to explore the teachers' beliefs, attitude and behaviour (BAB) intentions in ICT mediated lessons in mathematics teaching. To understand the mathematics teachers' BAB, this study sought to use the UTAUT model to discover the beliefs, attitude and, behaviour (BAB) of the mathematics teachers in ICT mediated lessons.

This study will, therefore, contribute to the policymakers' pool of mathematical knowledge, teachers, principals, academicians in teacher training institutions and the extension of the literature regarding mathematics teachers' beliefs, attitudes and behavioural factors in the implementation of ICT mediating tools in teaching. The results of this study will provide new knowledge for understanding the mathematics teachers' beliefs, attitudes and, behavioural intentions to integrate ICT tools in teaching.

1.10 Conclusion

There is a shortfall of the use of ICT tools by mathematics teachers in South Africa. This chapter has problematised the beliefs, attitudes, and behaviours (BAB) of the mathematics teachers towards ICT mediated mathematics lessons. There is an indication that South African teachers do not utilize ICT tools to mediate their lessons despite their beliefs of teaching with technology. This shortfall, however, results from the challenges in the teachers' BAB in the use of ICT tools, hence there is a gap in this area. This has been documented as a concern locally and not much has been done to address the problem. This study sought to explore the mathematics teachers' belief, attitude and behaviour (BAB) in ICT mediated lessons. The next chapter reviews the literature of the theoretical and conceptual framework for this study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Learning is a process of development in which information is absorbed, processed and returned (Skinner, 1987). Fletcher (2016) charcterised the process of learning by a shift in behaviour as a result of a certain stimuli or experience. Constructivists like Piaget (1964) see learning as a procedure of meaning-making, where new information is integrated along with the preceding knowledge that a learner has. From another perspective, Vygotsky (1978) saw learning as a mediated activity where historical-cultural knowledge is passed on to learners through socially mediated activities. These ideas were further explicated in this chapter as they together with Rogers (1962) rate of Diffusion of Innovative theory (DOI) and Davis (1989) Technology Acceptance Model (TAM) in the Unified Theory of Acceptance and Use of Technology (UTAUT) form the theoretical framework of the study.

Three frameworks were also referred to in this research, these are: Mathematics Knowledge for Teaching (MKT) (Ball, Bass & Hill, 2004) which identifies the phases of the teacher's mathematics teaching, the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003), which include the Technology Acceptance Model (TAM) (Davis, 1989), the Diffusion of Innovation Theory (DOI) (Rogers,1962) and other models on the use of ICTs in teaching and learning. The UTAUT identified and explained the teachers' behaviour and attitude in the use of ICTs, while the sociocultural conceptual framework (Vygotsky, 1978) explained how the learning was conceptualised by the mediation of ICTs in the sociocultural context of teaching mathematics.

Therefore, the literature review firstly extended the discussion of the teachers' beliefs, attitude and behaviour towards ICT tools as these are the key concepts or variables of the study.
Secondly, it discussed empirical studies in different places relation to teachers' BAB in ICT mediated teachin. This was linked the review of the MKT, what it entails and its impact on the importance of the teacher's instructional information of teaching. Thirdly, it attempted to create and identify a link between the UTAUT framework's four components and the teachers' belief, attitude and behaviour (BAB) in the implimentation ICTs in the teaching of mathematics. The UTAUT model's four components are Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI) and Facilitating Conditions (FC) in mathematics teaching and learning with technology. Lastly, it explained the stages of the Vygotskian theory of learning and linked it with the classroom social context of the teacher and the learners' use of ICT tools.

2.2. Teachers' belief about the use of ICT in mathematics

Beliefs are acquired convictions that are both societal and individual that serve as consensus explanations for phenomena that are either unexplained or are not possible to explain. Beliefs may also be understood as arising from intuition, which is loosely defined as knowing without knowing how and tend to be communal which serves to reinforce peer associations and familial bonds (Smit & Cronje, 2002). Jankvist (2015) contends that beliefs about mathematics as a subject are different from

what literature refers to as beliefs about mathematics as a taught subject in schools.

The question as to whether or not modern teachers tend to believe in the use of ICT tools in mathematics teaching remains under-investigated. However, a press release from the Public Broadcasting Corporation (PBC) in the United States reports that 76% of in-service teachers currently implement technology in their teaching (Balanskat, 2009). Studies by Buabeng-Andoh (2012), report that modern mathematics teachers believe that using technology in their teaching increases their confidence in the content. Another survey conducted on American teachers by MetLife reveals that over 62% of teachers polled use ICT tools such as computers, smartphones, and iPads to access the internet to view and share different teaching ideas (Markow & Cooper, 2008). The teacher's incorporation of ICT tools like computers, mobile devices, calculators, etc. and their use in the mathematics classroom is believed to rely on the teachers' technological knowledge (Thomas & Palmer, 2014). Goos, (2014), attest that the teachers' methodological beliefs about the use of digital technologies, is one of the influencing factors to teach with ICTs.

Umugiraneza, Bansilal and North (2018) asserts that in South African, teachers who used the National Curriculum Statement (NCS) in teaching believed that using technology positively influenced the teaching, learning, and understanding of mathematics. Studies by Ali (2015), showed a substantial affiliation between mathematics teachers' beliefs towards ICTs and the classroom instructions in using technology. Despite 93% of the teachers agreeing with the statement that "Digital resources such as classroom technology and Web-based programs bolster learners' academic achievement" (Kovacs, 2010). Studies have unfortunately revealed that many teachers find it challenging to implement ICT tools in the lesson-structure (Mueller et al, 2008).

To maintain the upward trend in using technological tools, such as iPads, computers and alike, teachers' values and beliefs about teaching are being challenged. While the technological extensions may offer the mathematics teacher exciting possibilities for technological enhancement of mathematical pedagogies, it is equally important to bring to shed light on how teachers' beliefs and challenges about using ICT may hamper the processes of learning. For instance, Bowers and Stephens (2011) bemoan that lack of transparency as to what kind of technological device is the most effective in mathematics education gives way to learners adopting informal learning strategies and peer-teaching.

Another potential hurdle may be that the potential incorporation of ICT tools in the mathematics teaching requires an educator to connect the divide between the mathematics curriculum content knowledge and the technological skills teachers are required to possess for teaching purposes to implement such technology in the classroom setting (Buabeng-Andoh, 2012; Scott, 2002). This implies that teachers who do not have adequate training in the use of ICT will be limited in the scope and effectiveness of their teaching, resulting in an overall shortfall of ICT as a useful mathematical skill (Liu & Kleinsasser, 2015).

2.3 The mathematics teacher's attitudes towards ICT

Attitude significantly has an effect on the teaching and the learning of mathematics in general (Ali & Dawkins, 2010). Attitude is indirectly observable and can **be** defined as a combination of beliefs, feeling, and behavioural predispositions regarding socially significant objects, classes, events or symbols (Triandis, 1971). In mathematics ICT-mediated lessons, are many facets which can effect a teacher's attitude and proficiency, for example, self-rated efficacy, confidence, motivation, and anxiety (Mahdum, Hadriana, & Safriyanti, 2019; Ali & Dawkins, 2010).

In Australia, Sydney, a study on teachers' attitudes regarding the integration of ICT tools ndicated that e-learning was understood as an added mission on the already full capacity responsibility, and the unavailability of time was the reason presented for not implementing it (Neyland, 2011). Another study by Dhakal (2018) in Nepal reported that the teacher's positive attitude combined with the need for ICT proficiency for teachers motivated and increased learners' performance.

In South Africa, statistics show that despite having access to the internet, many mathematics teachers often show a reluctant attitude towards the use of available ICTs to advance the quality of instructional goals (Bansilal, 2015). In the same light, Bialobrzeska and Cohen (2005) noted that many teachers in South African schools, want the skills required to integrate technology into instructional activities because they exude a reluctance and unwillingness towards the usage of technology in their lessons. Unwin (2005) proposes that in many developing countries, including South Africa, many mathematics teachers lack technological skills needed for effective integration of ICT tools in their teaching practice despite the availability of technology resources. This often results in computers only being used on special occasions or treat days. Ultimately, technological devices linger as objects of novelty, uncertainty, anxiety and mystery instead of a powerful mediating tool (Pelgrum, 2001; Unwin, 2005; Hew & Brush, 2007; Organisation for Economic Co-operation Development (OECD), 2015)

Yet reports from Dunham (2000) and Jankvist (2015) have shown that a teacher's interest, willingness and apparent enthusiasm for advanced digital technologies are intricately linked to the resulting efficacy of these aids in the classroom setting. There is evidence to suggest that a teacher's positive assessment and resulting attitude towards ICTs such as graphing and Computer Algebra Systems (CAS) and digital calculators **can** unlock their enhancing capabilities (Thompson & Senk, 2001). Furthermore, studies conducted in teacher education institutions, for example, the American Council of Education (1999), the National Council of Teachers of Mathematics (2000) and the National Mathematics Advisory Panel (2008) has accorded that an educator's proficiency and skill in the use of ICT tools is equally as important as their subject content knowledge.

2.4 The Teacher's behaviour towards the use of Technology

Behaviour can be how one acts or conducts oneself, especially towards others. The teacher's behaviour, stemming from his or her attitude is another factor to consider when gauging the scope and frequency of using of ICT tools in mathematics teaching. As inferred in some studies, a teacher's belief, and attitude plays an essential role in their perception of ICTs mediated lessons (Mwendwa, 2017; Ertmer, 2005). It is imperative to mention that beliefs and attitudes are solely responsible for the resulting behaviours that teachers display towards the integration of technology in the the learning

environment. Hence teachers' beliefs, attitude and behaviour (BAB) are closely inter-related and are considered to have a combined effect.

Teachers of mathematics vary in their different teaching and learning methods, as such their behaviour in ICT mediated tools differs accordingly. Positivity in ICT influences the learners to participate in a large number of ICT activities such as conducting research, online learning, and communication. The success in ICT mediated lessons depends on the teacher's behaviour (Amuko, Miheso & Ndeuthi, 2015). Johnson, Smith, Willis, Levine and Haywood (2011) also indicates that education trends in mathematics teachers' positive behaviour show a high demand in the use of ICT tools, e.g. internet through iPads and smartphones. Therefore, if teachers are expected to perform and teach mathematics with ICT tools, their beliefs, attitude, and behaviour (BAB) towards the integration of ICT need to be appealing.

2.5. Empirical Studies in relation with teachers' BAB in ICT mediated lessons

Worldwide use of ICT tools in teaching and leaning has developed significantly in various learning environments (Naicker, 2010). Many Studies highlight the importance of ICTs in improving the conceptual understanding of mathematics and science skills (Umugiraneza, Bansilal & North, 2018; Culp, Honey & Mandinach, 2005; Zhou, Brouwer, Nocente & Martin, 2005). It is expectated that ICTs can fashion opportunities that can motivate and influence the teachers' beliefs, attitude and behaviour to enhance the eminence of teaching and learning, however the challenge arises of how such structures should be functional and strategised in the classroom situation (Scott, 2002).

A study in Australia, on teachers'beliefs and attitude towards the use of ICT tools show that technology was taken to be an extra task on the already expected obligation of teaching, and the unavailability of time was the reason presented for not implementing it (Neyland, 2011). In the same light, Dhakal (2018) reported in his study that, in Nepal, the teacher's positive attitude combined with the need for ICT proficiency for teachers motivated and increased learners' performance.

In African countries, for example Ghana pioneered in the technological curriculum reforms program with a significance importance of the use of technology in teaching and learning of mathematics, yet the expected teachers' beliefs and values in relation with ICT tools in mathematics education are still not met (Agyei & Voogt, 2011). Studies conducted in Zambia also show that in spite of the government putting in place policies to integrate ICT in the education sector, there are still some gaps and challenges that prevail with respect to the teachers'positivity towards ICT integration in mathematics education (Mulenga & Prieto, 2018). This implies that although the accessibility of ICT tools in some schools, mostly in urban areas, there has been inadequate ICT usage in the teaching and learning of mathematics. This shows that careful investigation of the current teaching and learning practices, readiness, skills, competence, beliefs, knowledge and attitude of various educational stakeholders specifically on teachers' perspectives regarding the use of ICTs in schools is inevitable (Mulenga & Prieto, 2018) .

Statistics in South Africa show that although many schools have access to the internet, various mathematics teachers often show a reluctant attitude towards the use of the available ICTs to improve the quality of teaching goals (Bansilal, 2015). Bialobrzeska and Cohen (2005) also noted that in many

South African schools, teachers lack the skills required to integrate technology into teaching activities because they display a reluctance and unwillingness towards the usage of technology in their lessons.

With the above noted teachers'sentiments towards ICTs in mathematics education, the teaching and learning of mathematics can also be affected by the teachers' Mathematical Knowledge for Teaching (MKT) as discussed below.

2.6. Mathematics Knowledge for Teaching (MKT)

From Shulman's (1986) very widely used Pedagogical Content Knowledge (PCK) theory, Ball, Thames, and Phelps (2008) argue that PCK lacks clarity in its description and its potentailcapacity has not yet been fully realized in mathematics teaching (Schneider & Plasman, 2011). The attempts to improve on the concept of PCK paved way for Hill et al.'s (2008) construct of Mathematical Knowledge for Teaching (MKT). This has been designated by Depaepe, Verschaffel, and Kelchtermans (2013) as the utmost significant reformation of teachers' PCK within mathematics education. Depaepe et al. (2013) mention three strong qualities of MKT: that were founded on experimental research based off the information teachers require in order to teach mathematics; that MKT appropriated Shulman's (1986) practical aspect of PCK and curved it into an effective measurement of teachers' mathematical knowledge for teaching; and lastly, that it offers an observed evidence of a confident relationship between student learning and teachers' PCK.

The theory of Mathematics Knowledge for Teaching (MKT) (Ball, Bass & Hill, 2004) is defined as the knowledge that entails how effective the teacher teaches mathematics to deliver the needed knowledge to the learners (Karagoz-Akar, 2016). The effectiveness of the teacher's MKT is affected by the willingness and confidence (beliefs and attitude) of the teacher, which ultimately may lead to gains in learners' achievement (Pournara, Hodgen, Adler, & Pillay, 2015).

For Adler and Davis (2006), MKT is the pedagogic practice that teachers recognize the 'what' to teach and the 'how' to teach in their practice. They argue that the importance of MKT does not only enable the teacher to have a wide range of mathematical representations of ICT tools and the explanation, but it also avails the social interaction of the learners' conceptual understanding with different examples of critical classroom events (Adler & Davis, 2006).

MKT can be linked with the teacher's BAB from the fact that it offers observed evidence of a confident relationship between the teacher and the learner. The teacher's beliefs and attitude affect confidence. This implies that as learning takes place in the sociocultural context (Vygotsky, 1978), the teacher needs to have the confidence to use ICT mediated tools and this confidence is boosted by believing that the learner will understand. This belief then may bring about the right attitude and ultimately good behaviour towards ICT mediation.

2.7. The teacher's belief, attitude and behaviour for the MKT, and the use of ICT

Debate on the needed MKT in integrating ICT knowledge and the different views on how wide and deep the teachers' mathematical education should be, has been ongoing (Ball & Bass, 2003; Deng,

2007). Karagoza-Akar (2016) deposits that improvement of the teacher's MKT may result in better performance of the teacher and enhance learner understanding. Mathematics educators are, however, compelled to agree that "teachers must know in detail and from a more advanced perspective the mathematical content they are responsible for teaching. Both prior to and beyond the level they are assigned to teach" (National Mathematics Advisory Panel, 2008, p. 37). This may help the teacher to understand his or her locus of control within the MKT in ICT mediated lessons.

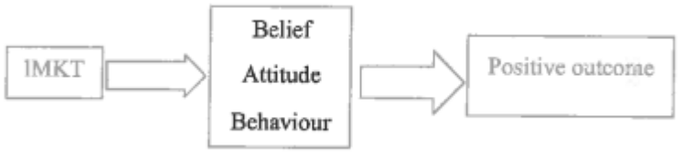


Figure 1: Internal locus of control

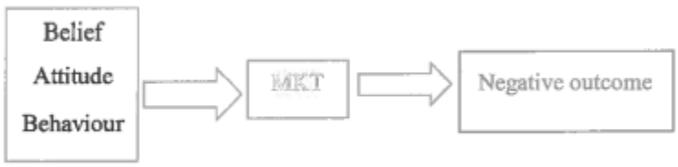


Figure 2: External locus of control

The term "Locus of control" was brought to light by Rotter (1954) and it explains when an individual believes that he or she can influence an event and its outcome either internally or externally. For example, a person with an internal locus of control behaves and attributes positive results to the effort put into his or her work. In other words, that person's success is a direct result of his or her hard work. Regarding ICT mediated lessons, a mathematics teacher with an internal locus control will believe in using technology to enhance understanding and conceptualisation. On the other hand, one with an external locus of control might influence success with external or environmental causes such as fate. The belief of external forces like the learner's prior technical knowledge can help them understand better than what the teacher believes (Figures 1 and 2). Relating this to the teacher, MKT can be explained that the teachers' belief, attitude and, behaviour in ICT mediated lessons may influence the learning outcome of the learners either positively or negatively. If the teacher has an external locus control, he or she may lack the needed MKT to enhance the learners' conceptual understanding. This is illustrated below.

Furthermore, Mewborn (2003) and National Council of Teachers of Mathematics (2000) have shown that not only does the lack of MKT or the teacher's inability to explain hard concepts mathematics hinders learners conceptual understanding, but also the lack of proper technological skills to implement ICT mediated lessons. This aspect is also an important feature of the technological knowledge as it enables the creative flexibility with available ICT tools needed for precisely pedagogical purposes (Harris, 2008). For if mathematics teachers possess adequate knowledge in both content and technology, the lesson would be pedagogically implemented with ICT tools to accommodate the needs of all the learners. As the South African education constantly transforms, the 21st century requires the development of learning outcomes to facilitate learners (Department of

Basic Education, 2016; Department of Education, 2002; Law & Chow, 2008). In this, the teaching of mathematics (MKT and the teacher's BAB in the sociocultural context) plays a significant role in the expansion of higher-order thinking skills (Karagoza-Akar, 2016). For example, the accomplishment of detailed tasks needed for pertinent academic outcomes, conceptulisation, conceptualisation, problem solving, generalisation and knowledge processing (Nieuwoudt, 2006). The mathematics curriculum's outcomes and objectives can be achieved by the integration of many ICT mediated learning activities to compute accurate mathematics calculations, from the foundation phase of describing patterns and relationships to the complex algebra laws and meanings of exponents in the senior phases (Department of Basic Education, 2016; Department of Education, 2002; McDonald, 1988).

The incorporation of ICT mediated tools does not only refer to computers merely being placed in a learning environment, nor using technology as a support to traditional ways of teaching (Du Plessis and Webb, 2012). Mediation of ITC rather suggests the strength of technology as teaching a tool for teachers to facilitate teaching and learning. Wilson-Strydom et al. (2005) deposit that mediation advocates learning with or through ICTs, which they described in two different ways; the first is related with ICT acceptance and the second is related to the use of ICT.

2.8. Type of ICT tools

In the same line, Hokanson and Hooper (2000) describe two types of ICT tools to use, as learning about computers (or representational use) and also learning with or through computers (or generative use). For Hokanson and Hooper (2000), generative use inspires learners to generate knowledge and exercise new skills as ICTs are intertwined into curricula. Representational use stresses on knowing the skills through learning how to use technological devices such as computers (Hokanson & Hooper, 2000; Wilson-Strydom & Thomson, 2005; Maholwana-Sotashe, 2007). Despite representational use being crucial in providing learners with basic computer skills, generative use, however, allows learners to learn effectively and independently (Song, Hannafin & Hill, 2007; Naicker, 2010). To better understand the behaviour aspect of the mathematics teacher in the technology-rich environment, the UTAUT model by Venkatesh, et al (2003) was used in this regard.

2.9. Theoretical Framework

2.9.1. Technology Acceptance Model (TAM)

There are many different models developed to observe an individual's acceptance and intention to use technologies. For example, in his most widely used "Technology Acceptance Model (TAM)", Davis (1989) tried to determine what causes people to accept or reject technology. The theoretical basis of TAM explains the impact of external factors on an individual's internal beliefs, behavioural intentions and attitude towards the use of training and computer self-efficacy (Ibrahim, Khalil & Jaafar, 2011). On a wide variety of technologies, TAM has been tested and validated.

2.9.2. Diffusion of Innovation theory (DOI)

Another old theory in social sciences is the Diffusion of Innovation theory (DOI) (Rogers, 1962). The DOI model was originally used in communication to explain how an idea or a product momentarily diffuses through a specific population. As part of a social system, people adopt a new idea, behaviour or product. Adoption in this diffusion implies that something different is done or

innovated from what was previously done. Unfortunately, this adoption of new behaviour, idea or product does not happen simultaneously but rather a process where some people are pertinent to adoption than others. The early people to adopt an innovation have different characteristics than those who adopt it later.

Rogers (1962) established five categories in this diffusion, with the majority in the middle categories: The innovators, the early adopters, the early majority, the late majority and finally the laggards. Innovators are the first people to try innovation. They are risk-takers and often the first to develop or use the new idea or product. The early adopters are those in leadership roles and they embrace and enjoy the opportunities of change. The Early Majority may not be in the leadership, but they jump at the opportunity of innovation before an average person and usually have success stories. The Late Majority is the group of people with skepticism and will only adopt after the innovation has been successfully adopted by many. Finally, the laggards are the staunch tradition and very conservative. These are the hardest group to bring on board. Figure 3 below illustrates the Diffusion of Innovation theory (Rodgers, 1962).

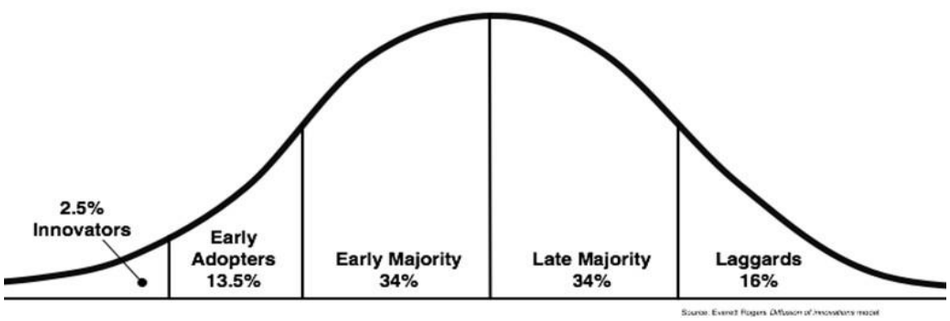


Figure 3 The Diffusion of Innovation Theory

Although his theory may also apply to this study because of the ICT mediated tools, where technology is seen as an innovation in the field of mathematics teaching, the researcher linked this study to a more comprehensive and quite recent model of technology acceptance, a variant of TAM known as the Unified Theory of Acceptance and Use of Technology (UTAUT).

2.10. Unified Theory of Acceptance and Use of Technology (UTAUT)

Pioneered by Venkatesh, Morris, and Davis (2003), the Unified Theory of Acceptance and Use of Technology (UTAUT) was proposed and validated to provide a unified theoretical base for the facilitation of research on the use of technology option and diffusion. The understanding of the UTAUT as an acceptance model was formed after comprehensively assessing and synthesizing the eight prominent models of user acceptance of technology named in Table 1 below.

Table 1. Models of user acceptance of technology

Model	Author and year
The technology acceptance model (TAM)	Davis (1986)
The theory of reasoned action (TrA)	Fishbein and Ajzen (1975).
The theory of planned behaviour (TPB)	Ajzen (1991).
A model combining TAM and TPB (C-TAM-TPB)	Taylor and Todd (1995a10 and 1995b11).
The motivational model (MM)	Davis, Bagozzi, and Warshaw (1992).
The model of PC utilization (MPCU)	Thompson, Higgins, and Howell (1991).
Social cognitive theory (SCT)	Bandura (1986).
The diffusion of innovation theory (DoI)	Rogers (1962).

The above theories and models have been effectively used by many previous studies of both technology and other innovation of information system disciplines including social psychology, education, marketing, and administration. The validation of UTAUT was motivated and argued on the grounds of many constructs of existing technology theories which are similar, therefore, it was reasonable to map and integrate them to produce a unified theoretical basis (Venkatesh et al., 2003). By so doing, designers of the UTAUT wanted forthcoming researches not to search, organize and incorporate constructs from various models but instead apply the UTAUT to achieve the knowledge of a variety of challenges related to technology acceptance and diffusion.

The UTAUT model recognizes four major elements of behaviour intention and use of technology: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI) and Facilitating Conditions (FC) as direct elements of behavioural intention. In addition to these variables, the theory assumes that age, gender, experience and being voluntary are identified as a direct effect on the usage of technology (Venkatesh et al, 2003).

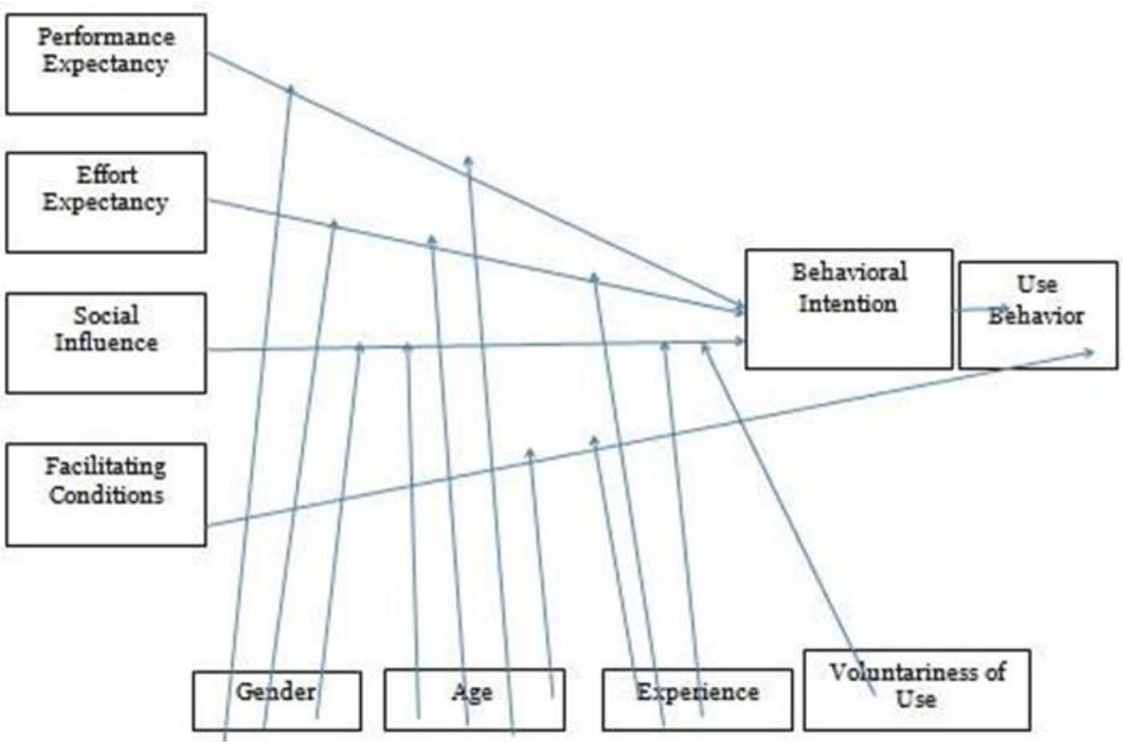


Figure 4. The unified theory of acceptance and use of technology (UTAUT) model (adapted by Venkatesh et al., 2003)

Performance Expectancy: For Venkatesh et al. (2003), Performance Expectancy (PE) is the extent to which a person believes technology assist to improve job performance. About the other five constructs from various underlying models, PE is relatively considered as perceived usefulness, job-fit, extrinsic motivation, relative benefit, and outcome prospects. Taylor and Todd (1995) deposit that perceived usefulness is the belief that using technology will intensify performance.

Likewise, Davis (1989) and Davis, Bagozzi, and Warshaw (1989) explain perceived usefulness as the degree to which an individual believes that using a specific technological system within an organisational context will improve job performance (Sykes, 2015). Extrinsic motivation involves the inspirational influence behind behaviour like utilizing technological devices for the classroom purpose due to the confidence that the user will be assisted to gain from this behaviour (Sykes, Venkatesh & Johnson, 2014). Relative benefit is described as the degree to which a new concept is believed to be clearer than its forerunner (Moore & Benbasat, 1991). Finally, outcome expectations insightfully describe the tendency of an individual's desire to have a behavioural perception that effects positive outcomes rather than behaviour that is believed to be unbeneficial in the enhancement of the job performance (Sykes, 2015; Venkatesh et al., 2003).

In this study, Performance Expectancy was viewed as the degree to which (or how much) a mathematics teacher believes that using ICT mediating tools will assist in improving the standards of education to advance learning gains and enhance conceptual understanding.

Effort Expectancy (EE) deals with an individual's perceived comfort to use technology (Venkatesh et al., 2003). EE is related with three constructs namely: perceived ease of use, complexity, and ease of use (Venkatesh et al., 2003). Perceived ease of use is the degree to which an individual believes that

using a specific technological system will be effortless (Davis et al., 1989). Venkatesh and Davis (2000), lament that perceived ease of use influences perceived usefulness because performance can be improved by technological systems that necessitate little effort to use. On another hand, Rogers (1995) contrasts the ease of use and defines complexity as "the extent to which an invention is perceived as relatively difficult to comprehend and use". In this research, EE discusses how the mathematics teacher perceives ease of use when using ICT materials to advance teaching and learning. In another way, what effort does mathematics teacher make when using ICT tools to relate with the learners and enhance learning with understanding?

Social Influence (SI) refers to an individual's understanding of what significant others contemplate about his/her use of technology (Venkatesh et al., 2003; Sykes, 2015). Likewise, the three constructs concerning SI notions are subjective norm, social factors, and image (Venkatesh et al., 2003). Fishbein and Ajzen, (cited in Venkatesh et al., 2003, p.428) define subjective norm as a "person's perception that most people who are important to him think he should or should not perform the behaviour in question". Comparably, Ajzen (1991) describes subjective norm as an individual's insight of social pressure for carrying out certain behaviour or not. On the same note, Taylor and Todd (1995) denote to subjective norm as social influence.

Moore and Benbasat (1991) identify SI as the image that implies social approval and can be defined as the extent to which the use of new technology is perceived as promoting an individual's standards in his/her social circle. In comparing different models, Venkatesh et al. (2003) indicate that social influence is a predictor of the intentional use of technology only when the use is not voluntary.
In this study, Social influence refers to the mathematics teacher's individual opinion about technology and the attitude towards ICT use by significant or influential people around (such as heads of department, principals and colleagues, school governing body). Put differently, do mathematics teachers earn approval in their effort to use ICT tools for teaching and learning ?

Facilitating Conditions (FC) are explained as the level of an individual's view that organisational and conducive technical structure exists to provide the use of technology (Venkatesh et al., 2003). Facilitating Conditions are three constructs from fundamental theories namely; perceived behavioural control, facilitating conditions, and compatibility. Ajzen (1991) lament that perceived behavioural control is the perceived ease or difficulty associated with an individual's carrying out of one kind of behaviour (Sykes, 2015). A positive connection exists between perceived behavioural control and specific behaviour when an individual believes that he/she is capable to execute a certain behaviour (Ajzen, 1991). Taylor and Todd (1995) deposit that perceived behavioural control can influence behavioural intention, which further, will in turn impact the actual behaviour that arises. In their argument, they also state that, in settings of computer utilisation, user support is an example of a facilitating condition that can affect computer use. Compatibility denotes the extent to which new technology is perceived as conforming with potential users' current values, needs and previous experiences (Moore & Benbasat, 1991).

In this study, Facilitating Conditions (FC) are therefore delineated as the level of the mathematics teachers' perceptions about the ICT tools that the school has facilitated or put in place for use. These are knowledge/skills, technical resources, and computer labs. FC responds to the questions, How does the teacher perceive technological systems as the sociocultural education environment? How is a culture (ICT) of education enhanced in such environments?

Behavioural Intention**:** The UTAUT model's first four concepts (i.e. performance expectancy, effort expectancy, social influence, and facilitating conditions) suggests an individual's behavioural intention (Venkatesh et al., 2003). In this study, behavioural intention means the Mathematics teachers' intent to use or integrate technological materials as mediation to enhance understanding. Behavioural Intention responds to the question, What intention or attitude regarding the usage of ICT tools does the mathematics teacher come with to the class.

It is, however, important to note that Facilitation Conditions and Behavioural Intention will explain the actual usage of ICTs in the learning situation. Although the UTAUT model refers to general users' purpose to use technological devices without precisely referring to teachers' use of ICT tools, I will apply the model to my study to attempt to comprehend the behavioural aspects of the mathematics teachers when they use or integrate technological devices (ICTs) to mediate the teaching of mathematics to enhance learning gains.

The other determinants of the UTAUT model namely gender, age, experience and voluntariness of technology use might not be differently considered in this study, given that the four participants are all experienced teachers and are of different age groups. Using the UTAUT was pertinent for this study because not only did it reflect the possible influence of the four mathematics teachers in ICT mediated lessons, but it also developed alongside an orientation for ICT mediation to other teachers and administrators such as the principal and office staff.

From its progress, the UTAUT has been successfully utilized in a multiplicity of contexts. For example, UTAUT was used by Avdic and Eklund (2010) in their study to help find out why Swedish students did or did not use library databases. Saravani and Haddow (2011) also used UTAUT to look at the technology training needs of Australian and New Zealand librarians using a qualitative variation. In Iran, Khalili and Singh (2012) used UTAUT in their study to find the acceptance of open access journals. These studies validate that UTAUT has the possibility to help enlighten technology adoption and acceptance. At this time, no one has explored the mathematics teachers' beliefs, attitude and behaviour (BAB) in ICT mediated lessons through the lens of UTAUT.

2.11. Conceptual Framework

The Conceptual framework for a study is an argument or a series of reasoned ideas for what the study is about and why it matters (Osanloo & Grant, 2016). The conceptual framework of the study should shape the design and direction of the study through the understanding of the research topic, methodologies, data collection and presentation of findings. Maxwell (2012) defines a conceptual

framework as the arrangement of perceptions, assumptions, expectations, beliefs, and theories that support and inform the research. Marshall and Rossman (2006) offer a different view by suggesting two primary research elements the conceptual framework must support. Firstly, the argument for the study's significance and secondly, the conceptual framework must reflect the important intellectual traditions that guide the study (Marshall & Rossman, 2006). Conceptual frameworks in education are explained in theories of teaching and learning. For example, Piaget's (1952) constructivist theory, Skinner's (1987) behaviourist learning theory, Lave's (1991) situated learning theory and the famous Vygotsky's (1978) social cultural learning theory.

2.11.1 Constructivist theory

Constructivists explain how individual knowledge is cognitively represented internally and how such internal representations are acquired (Piaget, 1964). This implies that our thinking is based on our own experience and understanding, not rote learning. Piaget (1964) recognises four cognitive developing stages namely; Sensory phase (birth–2 years), pre-operational stage (2-7 years), concrete operation stage (7-11 years) and formal (11- upwards). Furthermore, Piaget has three key ideas of fundamental learning processes called assimilation, accommodation, and equilibration.

2.11.2 Behaviourist learning theory

Behaviourists believe solely on observable behaviour and define learning by the outward expression of new behaviours (Skinner, 1987). Behaviourist believes that a child is not born with some form of knowledge, but learn by responding to a stimulus. The outcome of the response to the stimulus can be positive or negative (reinforcement or punishment). Unlike cognitivists who believe in the development of the child through his own experience, behaviourists on the other hand focus on the teacher being responsible for the learning of the child.

2.11.3 Situated learning theory

On the other hand, Lave (1986) in his situated learning theory believes that knowledge is maintained in an external social world. This theory of learning usually comes in with demerits of academic knowledge linked to a non-academic context which implies that academic knowledge is not genuine (Lave,1988). For example, the competence of school taught mathematics does not contribute much or correlate to one's job performance. In other words, knowledge is grounded in the learning situation where it occurs (Lave, 1988).

2.11.4 Sociocultural Theory

The Sociocultural theory of learning pioneered by Vygotsky (1978) is the process through which the development of cognitive competences results from interactions in the social-cultural context. For Vygotsky (1978), these competencies of teaching and learning come from the interaction between novices and more skilled members of the society who act as tutors or mentors. Although Vygotsky's (1978) theory is mainly known for learning, the teaching process is equally important because learners interact with a more skilled member. In the teaching of mathematics, knowledge is mediated through the culture of meaningful teaching and learning. Meaningful teaching and learning are the social active engagement in the apprenticeship of the teacher and the learner. The ultimate goal for this apprenticeship is to provide the instruction and support through the mediation of tools and to acquire the knowledge and competencies that are appreciated by the culture.

Vygotsky (1978) identifies the following keynotes in the teaching and learning procedures. Mediating tools (signs and symbols), artifacts, language, a Zone of Proximal Development (ZPD), More Knowledgeable Other (MKO), scaffolding, mental plane (intra-psychological) and social plane (inter-psychological/personal). This study, however, is only linked with the keynotes that relate to the actual teaching as it puts emphasis on exploring the teachers' dispositions towards the use of ICT tools. The teaching keynotes are the artifacts, language, ZPD, MKO, and scaffolding. Below is the conceptual map that links the concepts to the mathematics teaching of this study.

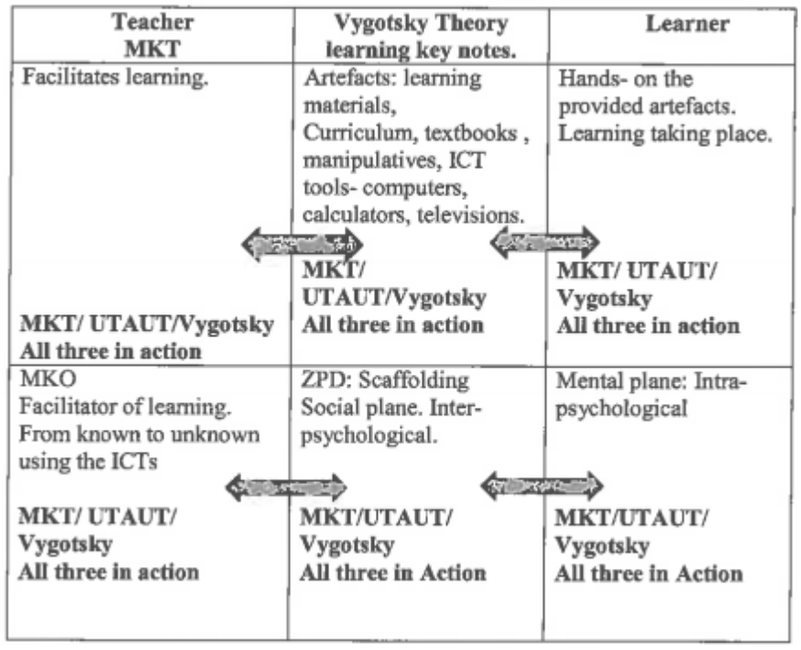


Figure 5: The conceptual map that links mathematics teaching

2.12 Vygotsky's learning keynotes

I discuss Vygotsky's ideas below.

2.12.1. Language

Vygotsky (1978, 1987) believed that language is the most important learning tool in the sociocultural context as it provides a powerful means of communication and carries concepts. It is seen to be a tool of tools. For example, language can be used to say to a person "run" and the person will run at that command. It is a tool in itself and auto-works on itself. Language is the biggest sign and tool in which we accept teaching and learning (Vygotsky, 1987). With this, we can say that language is a mediating artifact of learning like the midwife mediates the birth of the child.

2.12.2 Artifacts

What is an artifact? Moyer-Packenham and Suh (2012) asserts that an artifact or manipulative are objects designed to represent the explicit and tangible mathematical ideas that are abstract. An articifact has the capacity to manipulate the visual representation as well as object connects the user with real thinking and learning. The influence of manipulative tools is thus the opportunity to make meaning and see the links resulted from one's action (Moyer-Packenham & Suh, 2012).

Vygotsky's (1978) theory of activity, states that a learner usually works on an activity with an intermediate auxiliary, a tool. This auxiliary may execute an illustration internalized by the learner depending on the learner and their surrounding environment (Vygotsky, 1978). Drawing from my personal experience as a mathematics teacher, I am more influenced to define artifacts as the particular tools that teachers can use to assist in teaching so that learners understand and comprehend certain concepts. In the teaching of mathematics, language is used to strengthen the understanding of theories for the learners to be able to effectively and efficiently work through given tasks at a given time, therefore it is part of an artifact.

Universally, a specific language used in social interaction provides a powerful means of learning (Vygotsky, 1987). However, other than language, there are other artifacts used for learning. Some are material like written words in the textbooks, the school curriculum and the syllabus to follow are also learning artifacts. They set boundaries for where learning should start and stop. Some are concrete in the form of board games, wall charts and technological devices which are all linked to specific themes. ICTs are also a form of artifacts that help for mediating teaching and learning. In the teaching of mathematics, ICTs like calculators, computers, and iPads are used to help the learners relate and understand different concepts.

Artifacts differ in various ways, but despite that, they all exist in aiding the same purpose of making learning fun and enjoyable. It is, however, insightful to note that, if the learners are actively engaged within the learning process propelled by an artifact, it then becomes easy for the learners to understand and further build on the skills behind that artifact to its full potential. Irrespective of the format of the artifact, learners can simultaneously develop problem-solving skills while having fun throughout the teaching process if an instructional artifact is well-designed (Harris 2008).

2.13. Linking ICT to the sociocultural theory

I link the teaching and learning of mathethematics with the social cultural teory using the Vygotsky (1978) learning keynotes.

2.13.1 Zone of Proximal Development (ZPD)

Vygotsky (1978) discusses the zone of proximal development (ZPD) as the zone where learners can do things only with the help of more knowledgeable other (MKO) which otherwise they cannot do by themselves. The ZPD is an area of developing cognitive functions where the mentor as an MKO draws the learner in learning ranges. That is why an MKO is important in any learning development, to help the learners perform the task which they cannot do alone. There are three capabilities; 1) Things that learners can do by themselves or on their own (prior knowledge), 2) Things that learners can do with an MKO (from known to unknown), and 3) Things that learners cannot do even with an MKO. For example, trying to teach calculus to a grade one child. There is so much knowledge between what a child knows and what he is required to know. It is impossible for the child to learn this concept by himself.

It is insightful to note that the MKO uses the artifacts to help the learner develop cognitive knowledge from what they already know (prior knowledge) to what they do not know (known to unknown). In mathematics teaching, ICT artifacts like computers, calculators, and iPads are tools used by the teacher to help to learn in that context. This is called scaffolding.

2.13.2 Scaffolding in ICT mediated Mathematics Lessons

Scaffolding is another key aspect of sociocultural theory. Vygotsky (1978) deposits that scaffolding is the provided mediation of assisted performance by a mentor. It reveals a learner's ZPD and possibly enables the cognitive development of higher functions. Scaffolding can be in various ways of verbal and non-verbal. The notion of scaffolding in mathematics teaching and learning implies that the MKO interacts with the learner when teaching the knowledge.

In this study, ICTs were taken as mediating artifacts that helped mathematics teacher participants to teach the concept of time better. This mediation is called scaffolding because as Vygotsky (1978) says, once the learners have achieved or have learned the needed skill, the scaffolding is withdrawn. Implying that the learners are now knowledgeable and therefore the scaffolding cannot be continued.

Once given the directions and instructions by the teacher, the learners can be left to learn by themselves so that learning becomes permanent. In South Africa, Marais (2009) contend that ICT provides scaffolding not only for the teaching and learning environments but also for the development of the socio-economic needed skills in all sectors of industrialisation.

Other aspects of Vygotsky`s theory talk about where, when and how learning occurs. Vygotsky (1978) asserts that learning occurs in two planes, the social and mental planes.

2.14. ICT as regulative discourse

Regulative discourse is drawn from Bernstein's (1986) theory of pedagogic discourse. Regulative discourse implies the use of ICT to communicate instructions from the teacher or school

administrators to the learners or to the parents. For example, the classroom rules like respect the teacher, do the homework, no noise and so on. Learning cannot occur where there is noise. In regulative discourse, the order of what comes first does not matter if all work is systematically done.

For example, in mathematics teaching, regulative discourse can be seen in algebraic expressions:

$2x - y \times y + 4 =$

In the above expression, 2 is the coefficient of x, y is a variable and 4 is a constant. The answer can be found by any order. Either by first multiplying the '2 ys', or by first adding the constant and the 2x. Regulative discourse applies in every subject and no learning can occur without it. It is an orderly discourse. Implementing ICTs in mathematics teaching can help the teachers in their regular discourse of teaching. For example, the work can be put on the iPad, or marks can be posted online to the student portal. Using YouTube for some lessons like simultaneous equations can also be a regulative discourse.

2.14 Constitutive discourse

While regulative discourse is concerned with school communication, constitutive discourse, on the other hand, gives some restrictions (Bernstein, 1986). For example, in mathematical issues, a quadratic equation with the second power can only come in issues of knowledge systems that relate to mathematics, or the learning of geometrical progression. It is a concern that many mathematics teachers tend to use ICT for peripheral use only. For example, sending emails for communication purposes but not for actual teaching and learning mathematics. Yet many online mathematical lessons can be optimised as they benefit both the teachers and the learners. Like processed puppet helps to do the factorising, ICTs also provide the videos that show the learners how to solve certain problems and the learners can do it anytime and from anywhere.

However, while ICTs are continuously acknowledged as mediating artifacts in blending the technological world and the traditional /normal teaching methods, it is insightful to take note of its disadvantages to teaching and learning if not taken good care of. For example, sometimes teachers do not encourage learners to do mental mathematics computations without using technology. This makes them lazy to even try on their own in the absence of ICT mediation. For example, simple mathematical calculations are always computed on the calculator.

2.15 How the three conceptual theories speak to each other

With the above explanations, this research ties together the three theoretical frameworks in that the MKT features as the pedagogical knowledge needed for the effective teaching of mathematics. Such knowledge is required for effective mathematics teaching. This teaching avails in the social aspect through the interaction between the teacher and the learners. Therefore,Vygotsky`s learning theory is critical with teachers being more knowledgeable others through mediating scientific knowledge to learners. In that, MKT is important. In the process of teaching with ICT, the teachers' beliefs, attitude and behaviour (BAB) towards ICT tools may influence how they use it. The UTAUT model helps the researcher to understand this process. The diagram below shows how the three theoretical frameworks are linked to each other in this research.

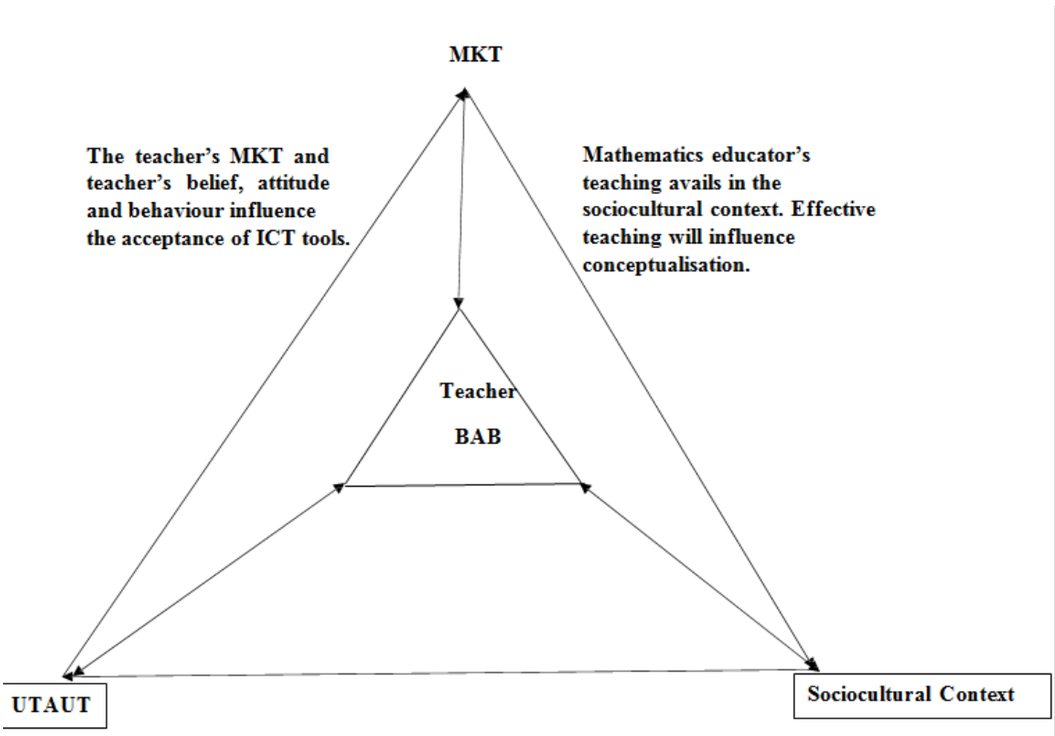


Figure 6: The three theoretical frameworks speak to one another.

2.16. Conclusion

Learning theories, as earlier stated, refers to the process of human development in which information is absorbed, processed and returned (Skinner, 1987) There are many cognitive learning theories in education, however, the four most known are constructivist, behaviourist, situated learning, and sociocultural theory. The UTAUT framework and the sociocultural theory has been explained how they both speak into the mathematics teachers' beliefs, attitude and behaviour in ICT mediated lessons. With the documented evidence that many mathematics teachers' beliefs, attitudes and behaviour (BAB) still need to improve, researchers agree that there is a need for mathematics teachers to improve in their BAB for the quality of teaching and learning mathematics. Although not much has been done to ascertain the importance of the mathematics teachers' BAB in ICT mediated lessons, this study seeks to explore and understand how effective this can be in their teaching.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter presents the methodology which was used to explore mathematics teachers' beliefs, attitude and behaviour (BAB) in ICT mediated lessons. Philosophical assumptions underpinning the focus of this study was reviewed. Research procedures and design for the study including approaches, tools, data collection and analysis methods is also discussed.

3.2 Philosophical background

All research is founded on some important philosophical norms that constitute the expansion of knowledge and the paradigms of both social reality and social behaviour (Maturana, 1991). The word paradigm invented from the Greek expression "paradigm" meaning patterns. Kuhn (1962), the first to use the term paradigm expresses it as an combined collection of practical ideas, variables, and tools. Paradigm refers to an entire theoretical, methodological and evaluative context within which a study is directed (Kuhn, 1970), in other words, it is a set of views, assumptions, and values that the research culture has in common (Kuhn, 1977). Olsen, Lodwick, and Dunlop (1992) assert that a paradigm is a design, structure and outline or system of logical and theoretical ideas, ethics and norms. A paradigm in research describes the frame of reference through which an investigator understands the world and the problem. The three kinds of paradigms are positivism, the interpretive views of post-positivism and the critical theory. Generally, research in education has observed either the traditional views of the positivist paradigm, because of their staunch reality belief, or the interpretive views of the post-positivism paradigm, or even both. These views, however, have underpinning assumptions of ontology, epistemology, and axiology as explained below.

3.2.1 Positivism

The positivist paradigm of societal reality is grounded on the ethical belief that the goal of life is simply to describe the originalities of the knowledge that we experience. This philosophical belief is known as ontology. In general, ontology is the philosophical conceptualisation of nature and its being. The positivists' ontology is of the assumption that the reality of knowledge is objective, exists and it is independent of human belief (Krauss, 2005). Reflection and reasoning are the best means of understanding human behaviour (Kuhn, 1996). They also adapt scientific quantifiable methods that systematize the knowledge generation processes. The positivists' concern is to reveal the reality and present it by pragmatic means. For instance, in a class of mathematics, the reality of any concept is the same and when learners come to the class, they learn the same reality regardless of their background. Mathematical knowledge a reality and is to be understood as it is in any context. For example, when a grade nine learner understands a mathematical concept "The Pythagoras Theory", the learner can apply the concept in any right-angled triangle and even be able to build on other concepts like trigonometry ratios.

According to Glaser and Strauss (1967), epistemology is of the assumption that people cannot separate themselves from what they know. How we appreciate the world around us is a vital share of how we recognize ourselves and the world (Guba & Lincoln, 1998). The positivists' epistemological belief addresses issues of knowledge in social reality. Krauss (2005) deposits that knowledge is hard, objective and tangible, therefore it can be acquired through observations or measurement of peoples' perceptions. It is the philosophical awareness of how we come to know. The objective of the study is independent of the researcher and is founded on the certainty that publics' perceptions and speeches are factual or erroneous, right or wrong.

Although not often mentioned in research paradigms, the axiology assumption is the entire structure that is fundamental to the positivists' model and without which it could malfunction. More than anything else, positivists value honesty and personal integrity (Kuhn, 1996). This results from the value purpose of fashioning an atmosphere of trust: That what is read in research journals matches reality. Positivist scholars also value preciseness and demanding logic. McCullagh (1984) denotes that preciseness is of importance in research due to the credence that reality can be calculated only by measurement. While not only appreciated by the users of scientific methods, rigorous logic is essential in calculation and thinking (McCullagh, 1984). The positivist paradigm, however, does not fit well with this study because it does not take into consideration how different cultures influence the interpretation and how empirically people make meanings (Stahl & Gibbons, 2004). This is study is empirical in that it features human activity in a social context of learning, which entails a different scenario from positivism altogether.

3.2.2 Interpretivism

Contrary to positivism, Interpretivism objects the belief that reality is the same. Rather, reality is primary, and the mind is independent (Creswell, 2012). This implies that interpretivists believe that reality is socially influenced by human interaction. The ontology of the interpretivist paradigm views reality as only knowable through the human mind and socially constructed meanings. Interpretivism moves from positivism in that it considers the individual human ability to interpret immediate social experiences. Reality is only imperfect and problematic. Willis (1995) posits that there is neither a correct route nor process to gain information. For example, in mathematics teaching, learners come to school with different realities of their lived experiences. Based on their socio-cultural background, some learners come to school with more acquired knowledge than others, hence we cannot assume that learners have equal knowledge when we teach them. "One size fits all does not work in this context."

Furthermore, Walsham (1995) argues that interpretivists have neither correct nor incorrect theories. The interpretation of theories depends on how interesting the researcher and those involved find it. This is reinforced by reflection and understanding. Implying that to

reflect is to gather data about the procedures and to understand is to make meaningful and draw inferences of the information.

The epistemological aspect of interpretivisim views knowledge as established through meanings attached to the study. Interpretivists see knowledge as personal, unique and subjective. They epistemologically argue that any claim about knowledge must be justified based on how the claim was arrived at. The researcher normally interacts with the study to acquire data and the greatest way to appreciate any wonder is to understand and experience it in its setting.

The axiology of the interpretivists entails that values are shared through social interaction (Pandey & Pandey, 2015). Values keep changing as one interacts with different people. Values are not constant, they keep changing and shifting relatively (Agyei & Voogt, 2011). Hence this study assumes that human beings have multiple realities and because of these multiple reactions, they have different interpretations of what they value. This study gives room for those voices to be brought out. The researcher is also for the assumption that values, beliefs, attitude, and behaviour are socially constructed, therefore this study would like to understand and explain ideologies and morals that mathematics educators come with to ICT mediated lessons. This study assumes that teachers behave differently in the way they react with other people and learners.

To this study, the interpretivists' assumptions of ontology, epistemology, and axiology would refer to how socially the teachers interact in the learning environment. With their different realities of lived experiences, their behaviours, attitude, and values can be observed and interpreted differently.

From the above discussion, assumptions in ontology, epistemology, and axiology views ultimately call for different research methods (Pandey & Pandey, 2015). In this regard, this study was drawn from an interpretive view as the emphasis was on understanding and explaining the beliefs and attitudes of four individual teachers (cases) rather than a generalisation (Creswell, 2012).

3.3 Qualitative study

Myers (2019) proclaims that a research technique is an approach of inquiry from the basic conventions to the research plan, and then data gathering. Despite the availability of different research methods, the most commonly used are quantitative, qualitative and mixed methods. Depending on the epistemological differences, eventually, these methods refer to how data are gathered, analysed and how it can be generalized. While positivist (quantitative) research methods were developed for the study of phenomena in the natural sciences, post positivist (qualitative) was also developed in the social sciences to study social phenomena (Foot, Life, & Heep, 2012).

The quantitative method is positivist by nature. Based on the need to explain why something occurs, the researcher identifies the research problem and aims to establish the overall responses from the participant (Foot, Life, & Heep, 2012). Quantitative studies relatively quantify the changeable characteristics on a sample of the subject being studied to correlate large-scale population or diversity**.** Positivist research usually uses inquiry form, surveys, and experimentations to collect data. The investigator is mandated to make a hypothesis before the commencement of the research. The collected data are then later reviewed and arranged numerically to be statistically analysed (Hittleman & Simon, 1997). Given this description, the quantitative approach will however not be of use in this study as the focus is not to quantitatively measure the variables but to have in-depth understanding of the mathematics teachers' belief, attitude and behaviour (BAB) in ICT mediated lessons.

Qualitative research is interpretive by nature. It naturally attempts to study and interpret the daily lives of diverse clusters of people and communities in their usual settings (Creswell, 2012). Qualitative researches are usually outlined with inductive conceptual representations and models (Merriam,1998). Despite the inductive method, most post-positivists studies fundamentally either molds or changes already current theories because; (a) information is usually analysed and understood in line with conceptual framework or hypothetical alignments, and (b) the results are relatively deliberated on according to the already existing knowledge or philosophy with the goal of indicating in what way the study will contribute to the increaseing knowledge base (Merriam, 1998).

Cresswell (2014) condend that social research is intended to help investigators to explore and appreciate people in their natural settings. In social research, diverse forms of knowledge, investigation techniques, and data gathering methods and analysis are utilised (Creswell, 2003)**.** The data bases in the qualitative approach include observation, interviews, and questionnaires (Myers, 2019). Information is obtained from direct reflection of behaviours, from face to face dialogue, from diaries or journals, or even public documents (Sprinthall, Schmutte, & Surois, 1991). Printed imageries of people, opinions, procedures, attitudes, and settings, or a combination of these can also be sources data sources.

Since qualitative approaches, as earlier explained, are founded on the interpretivists' belief that reality is socially built through individual experiences, relationships with other people, negotiations within cultures and social settings (Angen, 2000), the researcher feels that interpretive approach fits well with this study as it tries to understand or interpret particular issues and the views of people (Denzin & Lincoln, 2003). In this case, the qualitative approach speaks to the constructs of UTAUT theoretical framework to address the teachers' belief, attitude and behaviour (BAB) in ICT mediated lessons. The Interpretive approach will also assist the researcher to have dialogue and conversations with the participants through interviews and questionnaires.

Following the Vygotsky's (1978) sociocultural learning theory, Halliday and Hasan (1985**)** assert **t**hat education occurs through a interactive process of the teacher and learner, and between the learners themselves with a more knowledgeable other (MKO) as mentioned earlier in section 2.6. This research is socially investigative and interpretative in that it seeks to explore, appreciate and explain the competences of the mathematics teachers' belief, attitude and behaviour (BAB) in ICT mediated lessons. This again falls in place with the post-postivist approach as it claims that it is the "research that attempts to understand the meaning or nature of experiences" (Strauss & Corbin, 1990).

Many scholars (for example, Denzin and Lincoln, 2003; Domegan and Fleming, 2007; Henning, Van Rensburg, and Smit, 2004) claim that human paticipants can best be studied is by qualitatively. In choosing a study procedure, Guba and Lincolin (1998) proposes that "it is proper to select that paradigm whose assumptions are best met by the phenomenon being investigated". The present research focuses mathematics teachers' beliefs, attitudes, and behaviour (BAB) in ICT mediated lessons. Generally, it is known that social research is focusses on procedures rather than products. Hence social research techniques are being widely applied and more suitable than natural sciences designs to offer the insights essential to appreciate the participants' role in the research.

With the typicality of the processes to be utilised, social research approaches can better explain the teachers' beliefs, attitudes, and behaviour. These processes essentially include observation, questionnaires, and interviews. These approaches influenced and allowed for a detailed interpretation of the teacher's BAB in ICT mediated lessons.

Therefore, to explore and explain the mathematics teacher's belief, attitude and behaviour (BAB) in ICT mediated lessons, an interpretive case study strategy was used under the framework of Unified Theory of Acceptance and Use of Technology (UTAUT). The researcher's justification for using a case study was driven by its strong relationship with the interpretive world view as they focus on real-life situations to provide a thorough explanation of the public situation (Opie & Sikes, 2004).

3.4 Research design: Case study

A research design is a guide for all the phases of the way the study should be directed. Research plan can also be said to be an outline of the events that optimise the legitimacy of information in a study setting. Mouton (1996, p. 175) states that the study design serves to "plan, structure and execute the research to maximise the validity of the findings". It offers guide lines from the primary theoretical expectations to research plan and information gathering. Furthermore, Yin (2003) adds that "colloquially, a research is an action plan for getting from here to there, where 'here' may be defined as the initial set of questions to be answered and 'there' is some set of answers (conclusions)" (p. 19).

The research plan for this research was explorative and interpretive. Meaning that it explored and got an understanding of the mathematics teachers' belief, attitudes and behaviour (BAB) in ICT mediated lessons that enhanced the learners' conceptualisation. In South Africa, Nieuwenhuis (2007), note that most distinctive utilization of social research techniques is seemingly that of a case study because researchers get to understand the participants` behaviour and attitudes.

A case study is one of the many ways of researching in social sciences as it aims to appreciate participants in a social setting and interpret their activities as a unit, event or community. Gillham (2000) asserts that a case study is an inquiry to respond to given questions that may require a variety of diverse pieces of evidences from specific cultural settings. Yin (1994) posits that a case study is a scientific investigation that explores individuality within the context of its natural settings.

An exploratory case study is typically a predecessor to a prescribed, extensive study and its aim is usually to attest for a more research (Cohen, Manion, & Morrison, 2007). For example, an explorative case study on the behaviour of learners or teachers towards a certain subject or topic could be done in education. The researcher could develop a large-scale project to determine what is likely to influence the teachers or learners to behave in that particular fashion . Exploratory case studies often allow researchers to explore new ideas or theories.

Multiple-case studies or collective studies are formulated by using information from different past studies. This allows for additional information without the need for extra time and money. For example, in a school study on the learners and the teachers' behaviour towards a phenomenon, the researcher could use case studies from different studies within the school and then provide a standard sample of the variables that are likely to influence learners` and teachers' behaviour.

The research design that suits this study was an explorative case study as it explored the mathematics teachers' belief, attitude and behaviour (BAB) in ICT mediated lessons. Cohen, Manion, and Morrison (2007) maintain that an explorative case study is also bounded by a set of temporary, geographical, organizational, and other factors. In this study, the boundaries lie within the four teachers' BAB in the use of technological tools in their lessons. Given the explorative and interpretive stance that this study adopted, and the type of the study questions, the researcher considers the case study design to be the most suitable approach to utilise as it offers a orderly way to gather data, break it down it and describe the findings.

3.5 Research site

This study was conducted at a private International School in the Gauteng Province, South Africa. Located in the northern suburbs of Johannesburg, the school is very popular amongst the affluent communities, and the immigrants from all around the globe. These are mostly expatriates and diplomats for different embassies and consular. This has resulted in a cross-cultural and diversity of a learning environment with English as the medium of instruction. The school has an enrolment of plus /minus 1000 learners from Early years to high school and it also offers distance learning for Advanced levels . It has three venues in total: (i) a preparatory school accommodating Grade R to Grade Seven learners with two classes in each stream, (ii) a high school accommodating Grade 8 to Grade 12 learners and (iii) an Advanced levels facility accommodating learners aged between 17 and 19.

The classrooms usually have approximately 20 learners in each. The school has a strong culture in the teaching and learning of mathematics and sciences. Most learners are usually competitive and are encouraged to excel from the lower to the higher grades. This is a motivating factor as many students proceed to do their Advanced levels which gives them a head start into tertiary and paves their way to study either in local universities or abroad in institutions of their choice. Also, the distance learning for Advanced levels from all around Africa advantages international students to be exceptionally accepted in the South African Universities as it aggregates them double points for the needed university entrance points. The four teachers employed at this school are all qualified with a minimum qualification of a bachelors' degree in education or equivalent. The school has rich technological infrastructure to support ICT mediation during teaching and learning.

3.6 The role Of the researcher

The role of the researcher was that of a non participant observer, in order to avoid interfering with the teaching and learning phenomenon. Dey (2003), argues that the danger significantly lies not in having assumptions but in being unaware of them In addition, the researcher interviewed the participant to gain in-depth understanding of their beliefs and attitudes towards the use of ICTs. He ensured that the interviews were conducted after school and in a conducive environment that guaranteed the confidentiality of information . The researcher also ensured that the questionnaires were completed and the "raw" data collected from the audio interviews were transcribed verbatim and interpreted accordingly. Thereafter reduction and analysis processes begun.

3.7 Participants in the study

The participants in this study were four mathematics teachers from an international school in Johannesburg. Two were Foundation Phase teachers teaching grade three, and the other two were Intermediate Phase teachers teaching grade four and five. . The

proportion was one male to three females. There was only one male mathematics teacher in the school.Tthe focus of this study was the intermediate phase, the two phases (foundation and intermediate) were chosen because grade three is a transitional period from the foundation phase to the intermediate phase. Transitionality is very critical because learners are moving from the concrete stage to an abstract stage for their conceptual development (Piaget, 1964). As such the researcher wished to see how teachers handled the learners in ICT mediated lessons as they move from foundation to intermediate phase.

The participants were selected using a purposive sampling strategy. Purposeful sampling according to Patton (2002) is a non-random method of sampling but where the researcher selects "information-rich" cases for an in-depth study. Purposeful sampling usually takes place when the researcher selects a sample from which most can be learned (Merriam, 1998). It was mostly used in qualitative research because, from the qualitative perspective, the sample size, however small, was acceptable to deliver an understanding of a specific concept. Purposeful sampling involved the researcher making conscious decisions about which individual would provide the desired information (Burns & Grove, 2007). The idea of purposeful sampling was beneficial as any common patterns that might have developed from great differences could be of interest and value in capturing the core experience and central shared dimensions of setting (Patton, 2002).

The approach of choosing individual participants to do an in-depth study has also been employed by other studies before. For example, Randall (2009) conducted an in-depth study to explain one teacher's technological pedagogical content knowledge. The sample size was able to generate quality data to provide answers to the research questions.

In this study, the researcher purposefully chose the four participants from the foundation phase and the intermediate phase at her school. This was because the school had three strands for each grade, so the researcher chose two teachers from grade three, one from grade four and one teacher from grade five. Besides these teachers being the researcher's colleagues, they were convenient as participants of the study and were within reach. Bertram and Christiansen (2014) describe purposeful sampling as an easy and practical sample within the researcher's reach. The researcher purposefully chose the participants based on the following criteria:

a) The participants were required to have a Bachelor of Education degree (Bed) in teaching intermediate and senior phase school levels. This was to ensure that the participants had capabilities of addressing the teaching and learning pedagogies in mathematics that involved ICT mediation. The participants were to teaching at the same school as the researcher.

b) The participants were to have more than three years of teaching experience at the time of the research. It was assumed that such teaching experience would have enabled the incumbent to develop the needed content knowledge for ICT mediation in the lessons.

c) The participants were to be using ICT in their teaching and and willimg to take part in this study.

d) The participants were to have a good track record of achievement with a class average of + 65% and a pass average of >85% for the last three years.

3.8 Data Collection Methods

Data were collected in three methods: Semi-structured interviews of the teachers, questionnaires, and observation of the lessons. This enabled me to get an in-depth interpretation of the teachers` BAB in ICT mediated mathematics lessons. The topic that was taught by all four teachers was "The concept of Time" in grades 3, 4 and 5. The ICT tools used were the iPad for YouTube videos, TV for airplay and computers.

3.8.1 Semi-structured interviews

Interviews are a method of gathering information through an oral quiz using a set of pre-planned core questions. Shneiderman and Plaisant (2005) contend that interviews can be very productive as the interviewer can pursue specific issues of concern that may lead to focused and productive suggestions. They denote that the main benefits of collecting data through the interview methods are that: (a) direct contact with the users often leads to specific, constructive suggestions; (b) they are good at obtaining detailed information; (c) few participants are needed to gather rich and detailed data.

To evaluate the UTAUT model, for the teachers' beliefs, attitudes and behaviour (BAB), this study used the semi-structured interview method to interview each one of the four teachers after school hours as this was more convenient. The semi-structured interviews were designed to address the research questions and featured both structured and unstructured questions or both closed and open questions. For the interviewer to be consistent with all the participants there was a set of pre-planned central questions that guided the interviewer. While the interview was in progress, the interviewee had the liberty to elaborate and give more information that could be of relevance if so wished. The interviews were done after each participant had taught the three ICT mediated lessons. Each interview took a minimum of 20 minutes depending on the interviewee's elaboration. The three lessons were taught because the topic in the text-book was divided into three lessons of an hour each. The interview was audio recorded to allow the researcher to get the in-depth data and to allow for verbatim transcription.

3.8.2 Questionnaires

Questionnaire as a method of data collection has an advantage over interviews as it addresses each aspect of the conceptual framework (Creswell, 2012). It assures confidentiality as it can be completed anonymously, however, unlike other data collection methods, it is difficult to customise the questionnaire items to suit each research participant.

In this study, the questionnaire was developed by using the components of the UTAUT model: PE, EE, SI, FC and the behavioural intention (appendix 1) to address the first research question; what are the teachers' beliefs, attitude and behaviour (BAB) intentions in using ICT tools in mathematics teaching? This was done as a baseline questionnaire to find out the stance of each participant's BAB in the use of ICT tools before the actual teaching.

3.8.3 The lesson observation

Lesson observation as a data collection technique means that the researcher observes a specific situation or type of situation given in a conceptual framework. In the present study, the research observed how teachers' beliefs, attitudes and behaviour (BAB) were enacted in ICT mediated mathematics, using a list of specified traits informed by the four major constructs of the UTAUT model. This helped to address the second research question: How are the teachers' beliefs, attitudes and behavioral intentions in using ICT tools enacted in the actual teaching of the concept of time?

Quoting the highly honored American philosopher Yogi Berra, "You can observe a lot just by watching." By watching the teachers mediating their lessons using ICT tools, the researcher collected important information which complimented and sometimes contradicted the information teachers shared in the questionnaires. . Although learners were in the classroom when their teachers were observed teaching, , the focus of the study was on the teachers alone.

Observation as a technique had some advantages. It allowed for flexibility and the depth of data being reached. The researcher observed the language in use and how ICT tools such as computers, iPads, calculators were used in mathematics teaching and learning. This method, however, had a disadvantage in that it was time consuming and the teachers might have changes their BAB when the researcher was observing them.

3.9 Data Analysis

In a qualitative case study, researchers attempt to derive their data through direct interaction with the phenomenon being studied. Direct interpretation of what was observed could be an important aspect of data analysis in a qualitative case study. In their definition, Bogdan and Biklen (2003) assert that data analysis is a process of working with the data, organising and breaking them into manageable units, coding them, synthesising

them, and searching for patterns. The analysis of qualitative data aims to discover patterns, concepts, themes, and meanings.

Yin (2003) discusses the necessity for searching the data for "patterns" which may explain or identify causal links in the database. In the process of analysing the data, the researcher first concentrates on the whole data and then attemptes to split it apart and then re constructs it again in a more meaningful manner.

In the current study, data from the semi-structured interviews were categorised and organized to help the researcher compare patterns, to reflect on certain patterns, to then make sense of them. Similar patterns were then grouped into themes and categories that were informed by the constructs of the UTAUT model. Strauss and Corbin (1990) call this process "open coding".

Data from the questionnaire was analysed by use of descriptive statistics, particularly frequency and histograms to demonstrate how teachers responded to each of the Likert scale statements. Some qualitative data from the interviews and observations were used to strengthen the statistical analysis.

3.10 Measures of Trustworthiness

Scientific and experimental studies use the traditional criteria of objectivity, reliability, and validity to ensure the credibility of research as they are often based on standardized instruments and can be assessed in a relatively straight forward manner. In contrast, qualitative research studies are usually smaller with non-random samples and the interest of the researcher is more in questioning and understanding the meaning and interpretation of the phenomena (Merriam, 1998). To be able to assess the correctness of qualitative findings, there are criteria to be used to enhance the measures of trustworthiness. Trustworthiness is the measure of the quality of research, the extent to which the data and data analysis are believed to be trustworthy (Creswell, 2014). In this study, the results were therefore created from the interpretation of the data collected from the questionnaire, lesson observations and interviews, thus trustworthiness was of the utmost importance. Bertram and Christiansen (2014) suggest that trustworthiness is a better indicator of validity for qualitative data as there are no measurements. Therefore the credibility of qualitative research is strengthened by detailed descriptions of the data and by the conformability of the findings. Guba and Lincoln (1998) and Creswell (2012) identify three measures of trustworthiness that apply to qualitative research. These are credibility, dependability (reliability) and confirmability.

3.10.1 Credibility

Credibility (validity and Reliability) in this study refers to the researcher's accountability for the preparation and the carrying out of the research process; from data

collection to data analysis and discussion of findings. Throughout this research, the concepts of credibility have been taken into consideration to ensure that the risks linked to the study are reduced. Credibility in qualitative research matches validity and is defined as the degree to which the findings are believable and trustworthy (Creswell, 2012). Cohen, Manion and Morrison (2007) suggest that validity focuses on the depth and richness of the data and the objectivity of the person conducting the research. In other words, the extent to which, if the study was to be repeated with the same methods and same participants, similar findings would be obtained. Reliability was ensured by using the participants who were more informed in the use of technology in the classroom, and willing to share the information freely. To ensure validity and reliability of this study, the following steps were taken

1. After constructing the questionnaire, it was sent to my supervisor so that he could scrutinise it for approval.
2. The questionnaire was also tested with a group of teachers with similar characteristics like those I used for the main study. This pilot study helped me check if the questions were going to be straight forward or confusing? Or if the participants understood the questions to allow me gather the data I wanted.
3. The Interviews, were audio-recorded and later transcribed the data collected.
4. Lesson observations were done by member checking.

In addition, the study was located in a natural setting of learning for a data-rich context. Lesson observations were done by member checking (Appendix 2) and the interviews (Appendix 3) were audio- recorded and coded to allow for rigorious data analysis and interpretation. Therefore, including feedback on the data, interpretations, and conclusions from the participant have some credibility (Guba & Lincoln, 1998).

3.10.2 Consistency

Triangulation is another way to ensure consistency. In social sciences, triangulation involves the use of multiple methods and techniques to overcome biases and to ensure the validity of the findings (Sandura & Williams, 2000). Yin (2003) deposits that triangulation can be achieved by the use of multiple sources of data. This study used semi-structured interviews, questionnaire and participant lesson observations for the researcher to gather multiple data on teachers' beliefs, attitudea and behaviour (BAB). Triangulation was used to relate data and see if it corroborated (Creswell, 2003; Patton, 2002), and thus, to validate research findings. Qualitative research findings use triangulation as the most important way to improve the trustworthiness.

3.10.3 Confirmability of the findings

Confirmability measures in qualitative research are applied to prevent the researcher's bias and it is similar to objectivity. It entails the extent to which a researcher is aware of or accounts for individual subjectivity or bias (Seale, 1999). In this study, I collected data in

well organised retrievable forms, of questionnaire, lesson observations and interviews. The findings of the study were also presented at in different research seminars and the input from the audience helped to refine the data analysis and interpretation. The final report was also sent to an editor.

3.11 Ethical Consideration

In the present qualitative study, the researcher interacted deeply with the four participants to gain access to their beliefs, individual strengths, weaknesses, and behavior . Silverman (2000) cautions researchers that they should always remember that, as they research, they are entering the private spaces of the participants. Justifiably, this raises some ethical issues that should be addressed during, and after the research has been conducted. Ethical measures bellow were followed to ensure that this research did not infringe the rights of the participants:

I sought and obtained permission from the Dean of International school to conduct the study in the school premises. I also sought and obtained the research clearance from the Wits School of Education. This was to ensure that my research followed the right ethical protocols.

Participation in the study was voluntary. Participants were given the information sheets that explained what the study was trying to achieve and how their participation was going to help the study. Consent forms were provided for the participants to give or decline their participation in the study. The privacy, confidentiality, and anonymity of the participants were taken into consideration by using pseudonyms intead of their real names. They were informed that they were free to withdraw from the study at any time if they so wished. After completion of the present research process, raw data will go to the supervisor. It will then be destroyed within 3 to 5 years.

3.12 Conclusion

All research is principled on some fundamental ontological, epistemological and methodological assumptions. These assumptions define what constituted a ‘binding’ research problem and which research methods are most appropriate to tackle the problem. Two broad conceptions of social reality were discussed in this chapter and their philosophical assumptions revealed. The positivist paradigm form the basis for quantitative research methods, while the anti-positivist or interpretivist paradigm lies in qualitative research designs. This chapter described the research design that was adopted for this study, which is a qualitative approach.

CHAPTER 4: DATA PRESENTATION AND ANALYSIS

4.1 Introduction

The introduction of technology in teaching and learning environment represents a change but teachers must first accept and use the technology in their teaching practices for such change to be successful. Teachers are in charge of whatever happens in the classroom. They can accept or resist the technology depending on how they perceive the value of technology in teaching and learning practices. The thrust of the study was to explore mathematics teachers' acceptance and use of technology, focussing on their beliefs, attitude and behavioural intentions (BAB) to use ICT tools in the mathematics curriculum. It was a case study of four teachers. The previous chapter discussed the research design and methodology, which includes sampling, methods of data collection and data analysis. Data was collected from a private school located in Johannesburg, Gauteng Province, South Africa. In this chapter, I engage with data presentation and analysis. Data presentation is guided by two research questions:

1. What are the teachers' beliefs, attitudes and behavioural intentions to use ICT tools in mathematics teaching?
2. How are teachers' beliefs, attitudes and behavioural intentions to use ICT tools enacted in the actual teaching of the concept of time?

Data analysis is guided by the UTAUT model from which four themes emerged:

1. Performance expectancy (PE)
2. Effort expectancy (EE)
3. Facilitating conditions(FC)
4. Social influence(SE)
5. Teachers' behavioural intentions to use ICT(BI)

The purpose of data analysis is to change raw data into final meaningful patterns (Tracy, 2010; Pelto, 2017, p. 241). Data were analysed qualitatively using thematic data analysis techniques and quantitative data analysis was used sparingly to heighten qualitative analysis.

4.2 Participants' background information

The participants in this study were four mathematics teachers from an international school in the north of Johannesburg. Three were female teachers and one was a male teacher. Two female teachers taught grade three, and one taught grade four. The male teacher taught grade five. Teachers were known as Alice, Betty, Charlene, and David.

Alice is an elderly female aged 70. She has over 40 years of working experience as a primary school teacher in the southern region of Africa. She has taught in Zimbabwe,

Botswana and South Africa. Because of her international exposure, she has some considerate level of diversity and has a good approach to both traditional and modern teaching methods. Technology has recently been introduced in her teaching career and she is still learning to teach with ICT tools.

Betty is a young female teacher in her late twenties. She obtained her teaching degree recently and has been teaching for four years. She was exposed to the use of ICT tools while at primary school. She gained a better insight into technology during her tertiary years of study. This enables her to be dynamic in handling different ICT tools which are available in the school.

Charlene is a female teacher in her early forties and this is her first school to teach. She has been teaching for four years. Before joining the teaching career, she worked in the corporate sector as an ICT specialist. With the technology background, she embraces the modern teaching methods and has a better know-how of ICT tools in her teaching.

David is a 40 years old male teacher. He has been teaching for 10 years. Although he partially used technology in his school years, he never had a good understanding of it until he went to varsity where he since has been exposed to technology and now has good experience in teaching with ICT tools. Prior to his present school, David taught in a technologically well-resourced school in Zimbabwe. He has experienced both the traditional teaching method and the modern method of teaching with technology.

4.3 Analysis of the questionnaire and Interview

I present the data emerging from the questionnaire for the teachers' ICT perceptions, Performance Expectancy (PE), Effort Expectancy (EE), Social Influence(SI)**,** Facilitating conditions (FC**)**, and Behavioural intentions (BI). All the teachers answered one questionnaire, which was categorised in themes: PE, EE, SI, FC and BI on a Likert Scale (see appendix 1). Furthermore, I strengthen the questionnaire data with teachers' voices through direct quotations from their interviews (see appendix 2 and 3).

4.3.1 Performance expectancy (PE)

In this study, PE is viewed as the degree to which mathematics teacher participants believe that using ICT tools will assist in improving teaching and learning practices, to advance learning gains and enhance conceptual understanding by learners. To have a clear understanding of the teachers' PE, teachers responded to four statements on a Likert scale system; a) Using ICT would enable me to achieve the instructional goals more quickly. b) Using ICT would help improve the presentation of materials in my lessons. c) Using ICT would significantly increase learners' engagement in my lesson. D) Overall, I would find using ICT to be advantageous to my teaching.

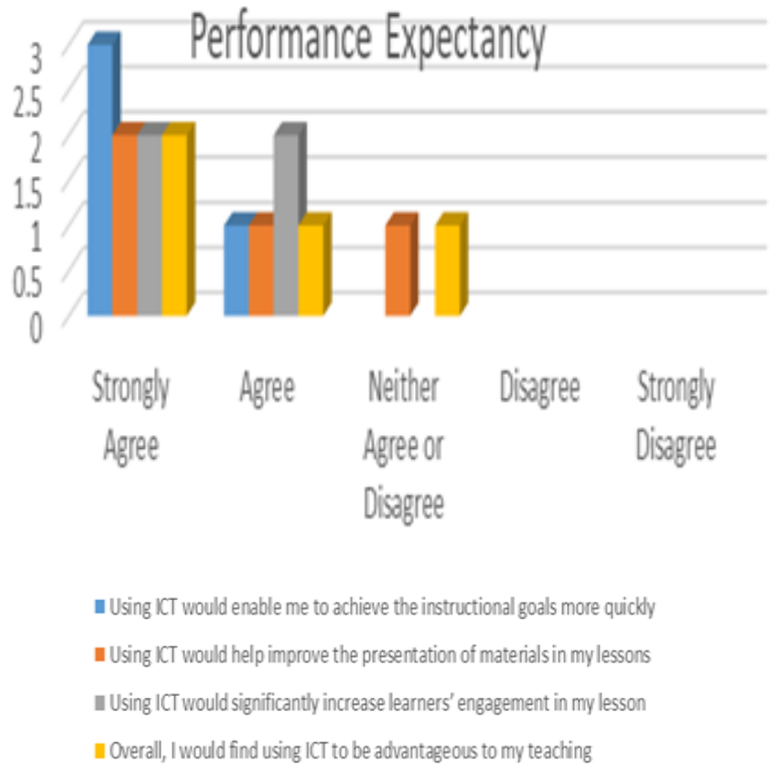


Figure 7: Overall teachers' responses in respect to Performance Expectancy

As in Figure 7 above, the majority of participating teachers believe in the potential of ICT tools to enhance their teaching performance. Betty, Charlene, and David strongly believe that ICT enabled them to achieve the instructional goals. Alice however just believes that ICT would enable her to achieve the instructional goals more quickly. An open-ended question was asked for teachers to elaborate on how ICT helps or would help to achieve the instructional goals more quickly. Some of the responses were as follows.

> Alice said: ICT helps to make things clearer to some of the children. It is set out in an "a b c" way (A logical order which is easy to follow). It is visual, so it makes things easier for the children to grasp.
>
> David retorted: There are different sites where you can find information on the topic. There is only so much that I can tell my children, and sometimes children need to learn from different people, different ways. So bringing ICT gives learners a plethora of other voices to explain to them, and can understand better.

The comments above suggest that ICT helps to achieve instructional goals more quickly by providing tools to teach learners in meaningful ways. It provides access to multimedia resources to visualise abstract concepts and access to multiple perspectives for learners to construct the deep meaning of the concepts taught.

> Alice said: It is quite an easy teaching method. Children of this age tend to know it better. We need to teach using something that relates to them. Therefore, I feel ICT tools are quite useful for mathematical education.
>
> Charlene uttered: We have various teaching methods that we were using in the old days. However, at this moment, we need to open up to new methods of teaching which are appropriate for the current generation of learners.

For Alice and Charlene, ICT helps to achieve instructional goals more quickly by enabling to integrate teaching practices that are relevant to the current generation of learners. Their comments suggest that current learners are plugged into technology, so teachers should teach mathematics with tools, technology in particular, learners are

familiar with in their everyday experience.

On the second statement "Using ICT would help improve the presentation of materials in my lessons", Charlene and David strongly agree, Alice just agrees, and Betty is neutral. It should be noted that Betty is a newly qualified teacher, and therefore a less experienced teacher. She is still experiencing with different teaching methods. She is not yet sure whether ICT would transcend other teaching methods for improving the presentation of materials in her lessons.

> Betty retorted: It is valuable, I have grown up using technology and it makes life easy for me. When I was at varsity, I used ICT for my college work and assignments. Now as a teacher, I do not use it every day because I am still experimenting with different teaching methods to find which method works better.

The above extract from Betty confirms that, although she has the technical knowledge to handle ICT tools, she still lacks the technological pedagogical knowledge. ICT becomes an integral part of teaching and learning when the teacher has a well-developed pedagogical content knowledge. Her sentiments in the interview are contrary to the position she took on the first statement of PE on the questionnaire. Charlene and David's strong agreement with the statement may be linked to their teaching backgrounds as already elaborated above.

The third sub-theme: "Using ICT would significantly increase learners' engagement in my lesson". While Charlene and David strongly agreed to this statement, Alice and Betty on the other hand just agreed.

The significance of this statement could be connected to active learning, which the school emphasises. Being modern teachers, Charlene and David seem to have a deeper understanding of the value of technology to engage learners in the lesson and how actively involved children learn better in the technological environment. This is what they both had to say in the following interview extracts when asked about the significance of ICT tools in engaging learners in the teaching and learning process.

> Charlene said: ICT is very useful in my teaching. Some websites have interactive lessons that can be played for children, t enabling them to use their iPads to learn . For example, when using educational Mathematics apps, the app tells them whether they are wrong or right, thus giving them instant feedback on mathematics actions. It is a hands-on experience.

> David retorted: It is a quicker method of teaching than the traditional method because children are engaged in learning either by doing the work online or following instructions from what is being projected. This enhances teaching and the children's conceptualisation. Besides, children of this age are more inclined to technological devices even from their homes. So I feel ICT tools are quite useful towards learner engagement in mathematics education

Alice is not sure as to whether ICT would engage learners in the teaching and learning process. She claims there is no internet connectivity in the classroom for her to engage learners using ICT tools. The following is an extract from her interview about whether using ICT tools significantly increase learner participation:

> Alice uttered: Not so often because sometimes there is no network connection at the school. Even if I feel like using ICT, I am just discouraged. Therefore, the significance of learner engagement is difficult to tell.

Indeed internet connectivity could help to engage learners with mathematics but the school's iPad devices are loaded with educational apps, which could engage learners while offline. Therefore, it could be that Alice does not have the desired technological pedagogical knowledge to integrate educational apps, which are available despite her belief in the potential of ICT to improve teaching and learning.

In the last sub-theme "Overall, I would find using ICT to be advantageous to my teaching", Charlene and David strongly agree, Alice agrees and Betty takes a neutral stand. Having been an IT specialist may be the reason why Charlene considers ICT tools to be of a huge advantage in her teaching. She knows how to manipulate and make the most out of it. For David, his considerable exposure in modern teaching possibly helped her to develop a strong belief in the pedagogical potential of ICT. Both teachers indicated during the interview that, using ICT tools promotes peer teaching while motivating learners to engage with the teaching materials independently and collaboratively, and as a result they learn.

> Charlene: There are many advantages in using ICT tools because some children may not know how to write answers down in their books when given individual tasks. However, when working as a group and as part of a team with an ICT tool like an iPad, they perform and come out better at the task.
>
> David: ICT tools save time and are accurate. They motivate children and allow them to learn on their own.

It was important to note that Alice agreed to all statements. This can be explained by her teaching background. As stated previously, she has diverse experience in teaching in multi-cultural setups. Due to this exposure, one can understand that Alice has come to evaluate and to appreciate that technology provides new teaching and learning avenues that transcend the possibilities of traditional teaching. Her statement clearly explains it.

> Alice claimed with enthusiasm: ICTs are a handy tool in teaching the concept of time. They are visual and tangible, helping learners see how the long and short hands of the clock face are counting seconds, minutes and hours. This helps to make things clearer to some learners who might have missed a point. Hence it is worth-while to use ICT tools and it is always a motivating tool in my teaching.

Alice furthermore explained that her learners tend to understand more clearly and can conceptualise what they have learned when she uses ICT. She can always see happy and smiley faces in front of her when she uses ICT in her teaching.

On another note, Alice said that although ICT tools were a motivating factor in her teaching, she at times found it easy and necessary to teach without technology depending on what she is teaching. She believes some topics are well taught with ICT and those that are taught well without ICT. This means she has well developed pedagogical content knowledge to know when a certain teaching method is appropriate or not appropriate.

Betty's response to PE shows some uncertainty in her use of ICT. Although she strongly agrees that using ICT would enable her to achieve the instructional goals more quickly, she is neutral as to whether using ICT would help improve the presentation of materials in her lesson and whether ICT tools would be advantageous in her teaching. As mentioned

earlier, this can be explained to her background. Even though Betty is a digital native with a good understanding of technological devices (ICT), she does not have a long teaching experience . She does not seem to know what teaching without technology is like.

Charlene's response to PE shows that she strongly agrees to all PE statements. In her interview response, Charlene indicated that ICTs are valuable tools to use in teaching. They are visual and influential. She uses them to enhance active learning.

> Charlene explained:Using ICT tools has an influencing effect on children's learning because they are normally visual. The children can see on the screen and hear what is being said. ICTs promote active learning because sometimes children are required to work on the devices or follow instructions to execute learning. This, in turn, helps them to work in collaboration with their peers.

The above concurs with what David said in the interview. When asked whether and how ICT tools affect his teaching, David stated that ICT tools accommodate his learners' learning styles, specifically; they provide visuals for learners to link the new information to tools in their world of experience.

> David said: ICT's are quite an efficient way to teach with, especially when teaching young ones. They provide visual tools to minimise the chances of children forgetting.

4.3.2 Effort Expectancy (EE)

In this study, EE refers to how teachers believe using ICT resources in teaching and learning will be easy and effortless. To understand how each teacher perceives EE, teachers responded to four statements on a Likert scale system; a) Teaching with ICT is easy. b) I find my interaction with ICT tools clear and understandable. c) I think learning to teach with ICT is easy. d) It is easy to prepare a lesson, which integrates ICT.

Effort Expectancy

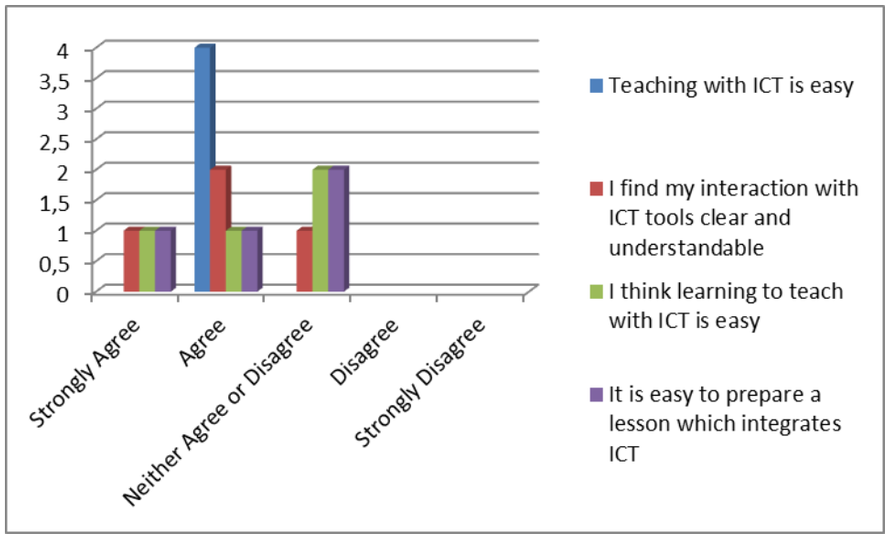


Figure 8: Effort Expectancy

As in Figure 8 above, it is clear that teachers believe in the ease of use of ICT devices in their teaching. It is also important to note that all teachers do not strongly agree with the first statement that "Teaching with ICT is easy". This means, they consider teaching with ICT as a progressive learning process. Alice, Charlene, and David just agree. Betty, however, takes a neutral ground. As mentioned earlier, she is still experimenting with different teaching approaches, predominantly, traditional. This could be the reason why she is neutral as to whether teaching with ICT is easy. Although she is not certain about the ease of use, she feels that it takes time to prepare a lesson that integrates ICT. An open-ended question was posed for teachers to give a narrative explanation of what drives them to be willing to use the ICT tools. In their response, this is what they had to say:

> Alice said: I am driven to use ICT tools because it is almost effortless. When I am at home, I might download something on YouTube to use in the classroom and this works for me.
>
> Charlene: For me, it is effortless because I find it easy to access online work for my class. Also, every time the learners enjoy what is on the screen and they have fun watching or doing what the video tells them to do.
>
> David added: It is always easy to prepare a lesson using ICT. It allows learners to see, hear and even sometimes do. There is a minimal chance for one to forget.

In their statements above, teachers are referring to the use of ICT to access online resources and to download videos. This suggests that they are still at the adoption stage of ICT integration. At this stage, the use of technology is just for mere drill and practice and for accessing online resources. This is a lower use of technology and does not affect existing classroom practices. At this stage, traditional teaching remains unchanged despite the use of technology. This could be the reason why teacher participants believe teaching with ICT is effortless. They still do not know what it takes to use ICT for learner-centered pedagogy and for teaching higher cognitive domains. They might have trouble as they move from the adoption stage to the invention stage where the use of ICT is for creation, investigation, and design.

On the second statement, “I find my interaction with ICT tools clear and understandable”, Charlene strongly agrees, Alice and Betty just agree. This means Charlene, Alice and Betty have high self-efficacy. With a high self-efficacy, they have a strong belief in their abilities to handle ICT tools despite the effort it might take to become skillful in the pedagogical use of technology in teaching practices (Freidhoff, 2008). The lesson observations will reveal the enactment of their self-efficacy in actual teaching.

David was neutral. Although he has been using ICT in his teaching for long , he confessed that he sometimes finds it difficult to find online resources or teaching materials that are appropriate for the age group he teaches. This may suggest that he needs to be developed in this specific area.

> David explained: Sometimes it is difficult to find appropriate online material for a particular lesson. You need to be clear and precise in what you are doing to be able to deliver what is necessary for the learners.

For the third sub-theme, “I think learning to teach with ICT is easy”, Charlene strongly agree, David just agree and both Alice and Betty are neutral. This statement signifies the aspect of training teachers to be able to teach with ICT. Although Alice uses ICT tools in her teaching, she has never attended any training on the use of ICT tools in the curriculum. This means she may not even be sure whether she uses it in a sound pedagogical way. Betty would not be in a position to take sides. She has ICT skills but she does not know how to pedagogically use it in her teaching. She did not receive any formal training from either the university or the school on how to use ICT in the classroom to enhance teaching practices.

> Alice explained: ICT was not a thing in the early days. I have taught for so long and learning to use it now in my teaching is out of my reach. I do not even know it well but just the basics I have picked up here and there. I usually download videos from different websites and later airplay them.

> Betty said: I used computers from an early age. I wonder how people who never learned how to use it are coping in their teaching. There has never been any training at school to train us on how to use ICT.

From the above comments, one would realize that even though both Alice and Betty are of different digital generations, they have the same pedagogical challenges about the use of ICT in pedagogical practices. Alice is a digital immigrant and she had to make an effort on her own to be able to get the ICT basics to fit in the modern teaching environment. Betty is a digital native with relevant ICT skills. However, they both expressed the need to learn how to use ICT in pedagogical practices (Prestridge, 2010). The school should have taken the initiative to train teachers in how to teach with ICT tools if it has to maintain and raise the bar in modern teaching with ICT tools

The last sub-theme of EE stated, “It is easy to prepare a lesson which integrates ICT?” While Betty and David are neutral, Charlene strongly agrees, Alice just agrees. When asked during the interview if it was easy to prepare an ICT integrated lesson, teachers had various responses. Betty and David took a neutral stand and said…

> Betty answered: Sometimes it becomes hard to prepare an ICT lesson due to various

> circumstances. First, you need to know what exactly you are looking for online and what ICT tools you can use. You cannot take this for granted. Then if there is no internet or the computer crashes, it becomes another challenge in your ICT lesson preparation.
>
> David said: Yeah, it can be easy to prepare a lesson that integrates ICT if you are certain of the network. We talk of internet issues because everything lies around it.

Again, teachers are referring to the internet connectivity as a major challenge affecting the preparation of an ICT integrated lesson. This means, for Alice and David use of ICT in teaching mathematics is all about using online videos and web resources. They still do know that they could be using excel, SPSS and other mathematics educational apps to enhance the understanding of mathematics concepts. Alice and David, as well as their colleagues, need to be informed about the affordances of technology they could use to enhance learners' understanding of mathematics concepts.

4.3.3 Social Influence (SI)

Teachers do not work in isolation; rather they work in a socially organised teaching and learning environment where they relate with other members of the school community. The norms of the school community may be important in a teacher's decision to accept or reject technology. Hence the theme of SI in this study refers to teachers' perceptions of how the school norms, policies and power structures such as heads of department, principals, colleagues, and school governing body affect their beliefs towards acceptance and use of technology. To have a clear understanding of each teacher's perceptions about SI, teachers responded to four statements on a Likert scale system: a) People who are more important to me will expect me to teach with ICT. b) Most people who are important to me would find using ICT in the classroom beneficial. c) Most of my colleagues believe using ICT is a wise decision d) I cannot divorce from using technology; technology is part of our daily life. Their responses were plotted on the bar graph in figure 3.

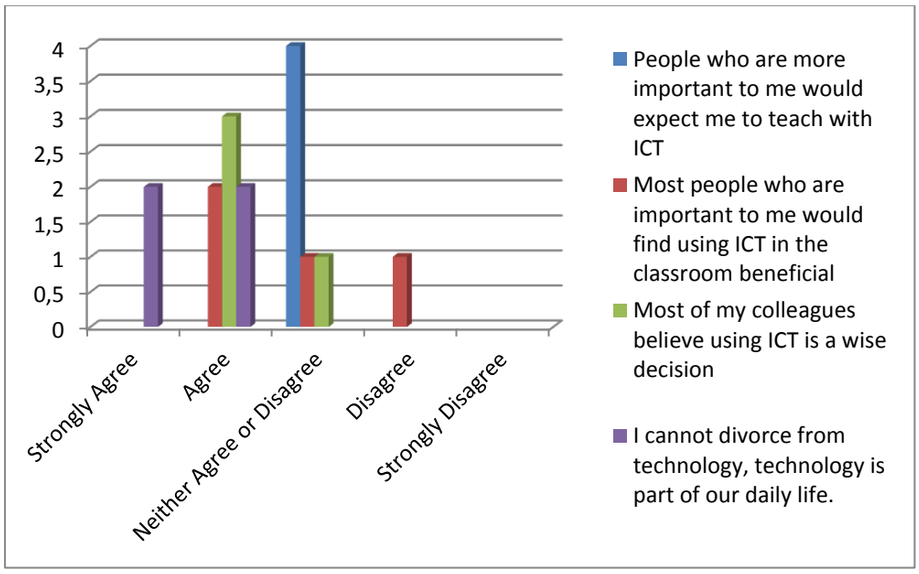


Figure 9: Social Influence

From figure 9 above, all the teachers demonstrated a neutral position to the first statement: "People who are more important to me will expect me to teach with ICT". This means, although the school has provided teachers with ICT tools, the school principal and the

school governing body have left it to teachers' discretion to use or not to use ICTs in their teaching. A possible explanation for this could be that private schools have a tradition of employing teachers who are strong in the content and pedagogy. They also encourage independent and freethinking among the teaching staff. Therefore, the school management may have confidence that the teaching staff would know when to use and not to use ICT in their teaching. The following statements make it clear.

> Alice said: The school management expects me to help learners understand mathematics. It does not matter whether I use ICT or not. It is entirely up to me if I want to use ICT or not.
>
> Betty said: The school management does not care much about using ICT although we are given the devices. I use ICT tools in my teaching not because I have to. I will not be reprimanded if I do not. I use it because it is the method that I find easy to use.
>
> Charlene: I think they do not care much, others do not teach with ICTs despite being in this private school for some years. It is not an issue if you use it or not.
>
> David: We are expected to use it because they provide us with ICT devices, but they do not check on us.

For the second statement "Most people who are important to me would find using ICT in the classroom beneficial", Betty and Charlene agree, Alice is neutral while David disagrees. The variability of teachers' responses to this statement may be linked to previous responses on the first statement, where they indicated that the school has left it to their discretion to use or not to use ICT. It could be that the school's power structures see it beneficial to use ICTs, and that may be the reason why they provided teachers with ICT tools. However, it does not affect the working relationship if teachers do not use ICTs in their practices.

> Betty confidently said: Having grown up in an ICT environment, obviously, the school management, which includes the principle and Head of Divisions (HOD) and my fellow teachers, would expect me to use ICT.
>
> Alice doubted: I am not sure, but maybe they do. They could not have provided us with ICT tools if they did not see it beneficial.

From the above extracts, there is a certain level of uncertainty as to whether important others like the school management would find the use of ICT beneficial. This may suggest that, although the school has provided the technology, it did not make the benefits of technology explicit. The school management must not only provide technologies but must also show its support to the use of ICT and make the benefits of technology felt by the teaching staff. This reiterates the importance of school management in the successful integration of technology in the school.

For the third sub-theme statement for SI, "Most of my colleagues believe using ICT is a wise decision", Alice, Charlene, and David agree while Betty is neutral. The three teachers based their statement on what they hear from their colleagues during the school meetings, and the way their colleagues use ICT tools in their classes.

> Alice said: Since all the teachers are given iPads to use and every class has the TV for air-play, we encourage each otherto use the devvices for certain topics.

> Charlene explained: I and my colleagues always share different apps for teaching different topics. For example, for teaching the concept of time. We find it useful to share online materials. I think ICT tools make teaching easier for most of my colleagues.
>
> David said: I believe my colleagues find using ICT tools valuable as well because when we cannot access the internet, we all complain..

Betty' s decision to be neutral can be supported by the following comment, which was extracted from her interview.

> Betty said: No, I am not sure about that because I have seen some of my colleagues not using ICT tools.

The fourth sub-theme statement: "I cannot divorce from technology; technology is part of our daily life", Charlene and David strongly agree and it is reflected in their comments below.

> Charlene: It cannot afford not to use technology in my teaching because it helps to prepare learners for life after school. If they go to colleges and university the computer will not be the elephant in the room.
>
> David:I always try to use ICTs in my teaching. If teachers nowadays can all be trained to use ICTs daily, we will have a better world.

Alice and Betty are neutral. For Alice, this could be a challenging statement because of her age. She has already been teaching for forty years, thus, regarded as a digital immigrant. It is not clear why Betty is neutral because she belongs to the digital native generation. Her position can probably be associated with the fact that she still faces pedagogical challenges when using ICT tools to enhance her teaching. Technology is yet to be an integral part of her classroom practices.

4.3.4 Facilitating Conditions (FC)

In this study, the theme of facilitating conditions relates to teachers' perceptions about the quality of the technical and school support to influence the behavioural intention to use technology use. To be able to understand how teachers perceive the facilitating conditions the school has in place, teachers had to respond to four sub-theme statements on a Likert scale system. a) The school has compatible technological infrastructure to support teaching with ICT. b) The school has an ICT integration policy. c) Onsite support is available. d) Ongoing professional development program on ICT integration is available

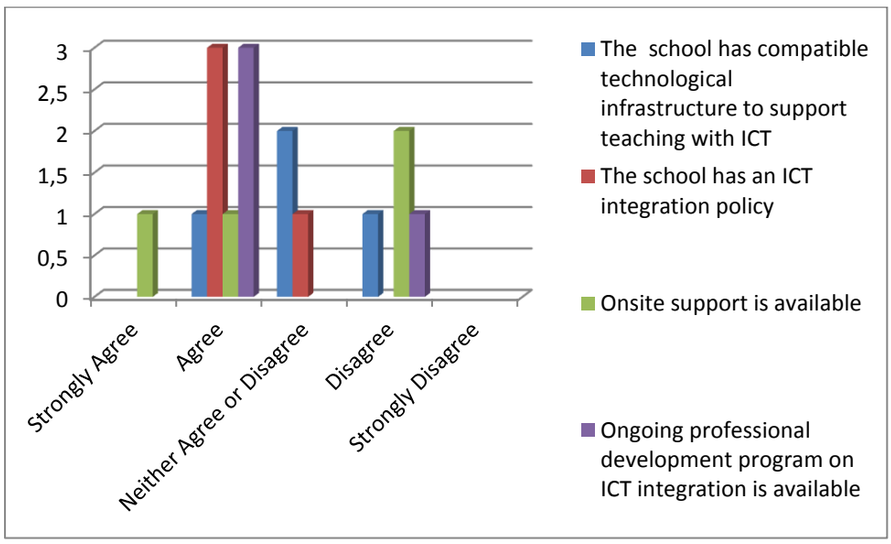


Figure 10: Facilitating Conditions

For the first sub-theme, "the school has the compatible technological infrastructure to support teaching with ICT", Charlene agrees, Betty and David are neutral and Alice disagrees. Overall, the teachers' responses indicate that they are not happy with the school's technological infrastructure. Their responses concur with their comments in the previous sections where they complained about unreliable internet connectivity in the school.

Given Charlene's stance on ICT, her agreement to this statement may be related to her experience in working with ICTs. She can easily manage to have an ICT mediated lesson with the devices the school provides. Betty and David's responses imply that they would like the school to provide each learner with a technological device to use whenever the need arises. Since there are just the basic devices provided (computer-laboratory, teachers' iPads, televisions), they do not feel that the school supports them fully. When asked about how they felt with the school ICT support system, this is what they both had to say.

> Betty said: I feel like the school does not fully support us with different technological equipments. We only have the teacher's iPad, the TV in the classrooms, and the computer lab. No smart boards and other fancy technological structures.

> David explained: ICT support system appears to be a problem to to an extent that one have to prepare an ICT mediated lesson with an iPad only. Sometimes there is the need for expensive technological equipment, to run an ICT based education system.

Alice disagreed with the school having compatible technological infrastructure because she feels the facilities available do not encourage the daily use of technology in the classroom.

> Alice said: The school support is not much. The school management only gives us the iPad and the TV in the classrooms for air-play, and nothing else. So if the lesson does not need what you have, then there is nothing else to use.

For the second sub-theme, "The school has an ICT integration policy" Betty, Charlene, and David agree to the statement but Alice is neutral. An effort was made to access the policy document to analyse its content. Surprisingly, the school leadership revealed that the school does not have a written ICT document. The school is still in the planning process to develop it. This means teachers who agreed to the statement wrongly assumed the school

had p an ICT integration policy in place.

The third sub-theme “onsite support is available” can be understood together with the fourth sub-theme on the availability of ongoing professional development programs on ICT integration. Betty, Charlene, and David agree while Alice disagrees. When asked if the school management offered any professional development programs (PDP) in support of ICT integration, teachers had to say the following.

> Alice said: There has never been any PDP on how to use ICT tools, but on other areas like team building, classroom management (disciplinary measures) and first aid. The school management expects us to be able to teach with ICT tools but they do not care how we do it.
>
> Betty explained: The school management offered training on how to log onto a Cambridge website and learn the Cambridge methods of teaching, but not how to use ICT tools. They have taken us for granted and expect us to know how to use ICT tools. I teach myself because I know how the computer works.
>
> Charlene said: Since I came to this school, we have had several online training programs but not on how we use ICT. And nobody cares if you use it or not.
>
> David retorted: We have never been trained to use ICT in our classrooms, but we are expected to use it in our teaching. Each teacher comes with the skill. No one checks on us though.

It is clear from the comments above that the school does not have a program to develop teachers’ competencies in the use of technology in the curriculum and assessment. Most of the teachers’ technological pedagogical knowledge is self-taught. In addition, the school not have an ICT policy. If teachers are to use technology in their teaching successfully, the school needs to have an ongoing teacher development program on the pedagogical use of ICT. It must also provide onsite support and adequate technological infrastructure.

4.3.5 Behavioural Intention to use technology (BI)

The previous section indicated that teachers believe in the pedagogical potential of technology to enhance their teaching practices. This section explores the extent to which teachers are intending to use ICT in their teaching. Teachers responded to four statements on a Likert scale system: a) I will frequently use ICT in my teaching because of its benefits b) I will recommend ICT to other teachers c) I will continue using ICT in my teaching because of its benefits. d) Given the chance, I want to use ICT in my teaching. The teachers’ responses to this theme are reflected in the bar graph below in figure 5.

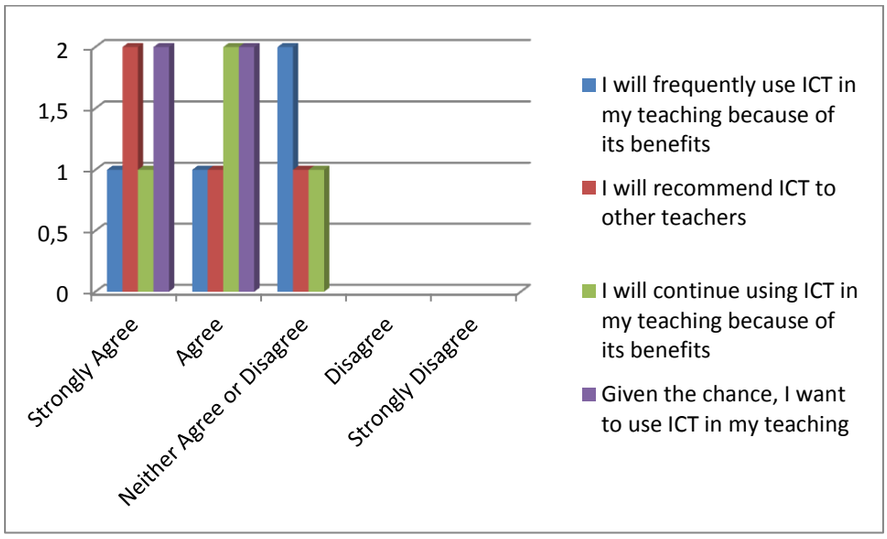


Figure 11: Bahavioural Intentions to use technology

Regarding the responses to the first statement: "I will frequently use ICT in my teaching because of its benefits", Charlene strongly agrees, Alice just agrees but Betty and David are neutral.

The above shows that has positive behavioural tendencies towards the use of ICT tools in her teaching. Alice is motivated to use technology frequently in her teaching due to the learning benefits it proved to learners.

The following was what the teachers said when asked how frequently they intend to use ICT tools in their teaching

> Charlene said: I intend to use it frequently because it helps the children to grasp the concepts taught easily. Children cheer up and are excited when they see that there is a video.

Betty and David are neutral. Their comments reveal that they are willing to use technology frequently if the internet was available in the school. This highlighted the need to take their technological pedagogical skills to a higher level where the use of technology is not limited to access to web resources only.

> Betty said: My intention to frequently use ICT tools in my teaching is not really because of its benefits, but because I usually depend on the integration of technology in my teaching.

> David explained: Since the internet is not easily accessible, it is hard to frequently use ICTs. Sometimes you may plan for an ICT mediated lesson, but if there is no access to the internet, it becomes a flop.

For the second statement: "I will recommend ICT to other teachers", Charlene and David strongly agree, Alice agrees and Betty is neutral. The responses from the interviews indicate that Charlene, David, and Betty would proudly advocate for the use of ICT due to ICT benefits they have experienced in their teaching.

> Charlene said: Yes, most definitely correct yes! It is quite an effective method that every teacher should use. If all of us could afford ICTs when teaching, it could be a good, teaching would not be difficult, and learning would be more enjoyable.

> David responded: For sure, Yes! I would recommend it but I think, it depends on online

accessibility. Yes! It's quite an effective method if it is well used. It could be effective if all of us could afford to have internet access.

Alice also said: Oh yes. I would recommend it because it is an advantage if you know how to use it and it helps with teaching.

The above comments are an indication of how ICT tools are seen to be useful in the teachers' teaching. If teachers are willing to recommend it to other teachers, then it is something they would like to embrace.

Betty remained neutral. Her comment suggests that she would only recommend it to teachers who have access to internet connectivity. This shows that she too does not understand different affordances of ICT and different ways of using ICTs in teaching and learning.

Betty shared: Yes, I will recommend only if the person can access online learning websites. I know there are online games that can be used as tests for the kids or even after a concept has been introduced. So ICT can be recommended to be used either at the beginning of a lesson or at the end of the lesson for revision as well.

The third sub-theme statement: "I will continue using ICT in my teaching because of its benefits" could be considered the same as the first sub-theme although the latter sounds more like a continuation of the first. However, the responses of the teachers were similar to the first sub-theme except for Betty who changed from neutral to agreeing. For Betty, she always uses ICT tools for teaching and non-teaching purposes. Her response shows her commitment to continuing learning how to use ICT for teaching. The previous section indicated that she is still exploring different teaching methods to see which one yields more learning gains.

The fourth sub-theme, "Given the chance, I want to use ICT in my teaching", Betty and Charlene strongly agree while Alice and Charlene just agree. Initially, this statement was meant for teachers who did not use ICT in their teaching for various reasons including lack of ICT devices and the relevant knowledge. All the research participants were using ICTs in their teaching, although some were still at the early stage of ICT integration. In other words, the last statement does not apply to the participants although some responded to it. It could be that they wanted to show the commitment to the use of ICTs.

4.3.6 Section Summary

In this section, I presented the analysis of the data that related to my first research question, "What are the teachers' beliefs, attitudes and behavioural intentions to use ICT tools in mathematics teaching? The data that emerged from the questionnaire was then complemented by teachers' voices from their interviews. The major insights that emerged from this analysis of data indicated that the majority of teachers were found to be inclined more to ICT usage in their performances. In considering the efforts that teachers may be expected to put in their use of ICT tools, it would imply that teacher participants were self-motivated and this subsequently has a positive effect on their behavioural intentions to use technology in their teaching.

4.4 Analysis of the Lesson Observations

The above section focused on what the teachers' beliefs, attitudes and behavioural intentions to use ICT tools in mathematics teaching are. In this section, I present the analysis of the lesson observations to address to the second research question: How are teachers' beliefs, attitudes and behavioural intentions to use ICT tools translated into actions in the actual teaching of the concept of time?

The lesson observation checklist (Appendix 2) was used to show how teachers' beliefs, attitudes and behaviour (BAB) were enacted in ICT mediated mathematics lessons. A list of specified traits informed by the four major constructs of the UTAUT model helped to address the second research question: How are the teachers' beliefs, attitudes and behavioural intentions in using ICT tools enacted in the actual teaching of the concept of time?

Performance Expectancy (PE) Observable influencing factors and their attributes in PE according to the checklist (Appendix 2) are: beliefs attributed by acceptance, trust and certainty. Enthusiasm with traits of interest, excitement/passion and desire. Motivation attributed by the desire to embrace ICT, determination and initiative to use ICT tools. Willingness attributed by the teacher's readiness and preparedness. It was taken to be PE when any of the attributes were observed by the researcher.

Effort Expectancy (EE) Observable influencing factors and attributes for EE according to the checklist are; Determination, attributed by the teacher's will power and purpose to use ICT tools. Energy attributed the teacher's liveness and dynamism when using ICT tools. Exertion, attributed by the teacher's action and forcefulness when handling ICT tools.

Social Influence (SI) The observable influencing factors and attributes for SI according to the checklist are; Image, with traits for the teacher's social approval when using ICT tools. Attitude, attributed by the teacher's beliefs/feelings for using ICT tools. Perception, attributed by the teacher's remarkable notice or distinction when using ICT tools.

Facilitating Conditions (FC) The observable influencing factors and attributes for FC according to the checklist are; Learning environment attributed by the setting or place of work. How it is situated. Is it an appealing atmosphere or not?

Each teacher taught three ICT mediated lessons and each lesson was an hour long.

4.4.1 Alice's First Lesson on Calculating time as a fraction of an hour

Alice was the oldest and the most experienced teacher among the participants. Although she did not have a solid foundation in the use of ICT tools, she still believed in their pedagogical potentials and made an effort to use technological devices in her teaching. She indicated in her interview that using ICT tools helps explaining abstract concepts.

There was 19 fourth grade learners in Alice's class (10 girls and 9 boys). These were seated in pairs, in three columns and there was enough space for the teacher to go round.

At the time of this lesson, the learners had not been given any technological devices to use. The teacher had an iPad on her table and there was an apple TV mounted on the back wall which was used for air-play.

Alice's first lesson was about calculating time as a fraction of an hour. Alice introduced the lesson with a mental exercise of multiplication and division by 5.

> **Alice**: Get your mental books out. Write the date and numbers 1 to 20. And get ready for mental work.

The learners did as instructed and in a short time, they were ready. Alice randomly called mixed multiplication and division of 5 questions one at a time, and the learners wrote the answers to each question as they were called. The learners swapped the books for marking and Alice read out the answers. After marking, she told the learners that they were going to learn how to calculate time in minutes as a fraction of an hour.

> **Alice**: We are going to watch a video about the time. I want you to turn around and face the TV. Please pay attention as you watch.

The ICT tools which were used in this lesson were the TV for airplay, and an iPad to source the video from the internet. Alice turned on her iPad and the TV, then connected the air-play to show a YouTube video about time. By now the learners were quiet, their faces looking at the TV and ready to watch. The virtual tutor in the video used a clock face to show the clockwise direction of long and shorthands of the clock. Numbers 1 to 12 and 5 minutes apart each number was indicated on the clock face. She explained the concept of time as a fraction of an hour.

The clock time 01:00 hrs (can be am or pm), the long hand on 12 and the shorthand on 1. She explained that when the long hand (minute hand) starts to move in the clockwise direction from 12, it counts 60 minutes to complete 1 whole hour. Then a clock face showed two equal parts where the long hand is on 6 and the shorthand between 1 and 2. The long hand moved 30 minutes from 12 (half of 60), this makes half-past the hour.

The clock face has the numbers 1 to 12, and there are 5 minutes between each number to make 60 minutes (an hour). From midnight 00:00hrs, 01:00hrs, 02:00hrs and so on until 12:00hrs. Then the half-past hour concept was also explained that when the minute hand of the clock goes clockwise from 12 to 6, it has moved 30 minutes after the hour. This is said as "half-past" the hour and the time is written as 00:30hrs, 01:30hrs, 02:30hrs as shown. Alice then paused the video to explain.

> **Alice:** (Using a plastic clock face to elaborate), the long hand has moved from 12 to 1, to 2, to 3, to 4, to 5 until 6. If you look at the face of the clock, it is in two equal parts (pointing at the right side "past" and the left side "to") and 6 is the half of 12. And 30 minutes is half of 60 minutes (1 hour) said as, "half past". 6X5=30.
>
> **Alice**: Is "half past"…clear to everyone?
>
> **Learners**: (in coral), Yes, ma 'am.

The video continued and now the concept of "quarter-to and quarter-past" the hour was explained. The virtual tutor then explained that from 12 to 3, counts 5 X 3=15 minutes

from 12, then together with the class, she counted 15 from 12 to 3, explaining that it is 15 minutes past 1. (Read as 01:15hrs or13:15hrs). So two quarters are equivalent to a half. Subsequently, she moved the long hand to 9, making 3 quarters by counting the minutes in 5s, 9 times (5X 9=45). This is read as 01:45hrs or 13:45hrs. 45 minutes is three- quarters of 60 minutes (1 hour). Eventually, she moved the long hand to12, counting 15 minutes more to make a clockwise round turn of 12 hours. That is 12 X 5minutes = 60 minutes (1 whole hour). With this, she explained that there are 4 right angles in 60 minutes. Therefore 15 minutes is a quarter of an hour. Or 60 divide by 4 = 15 minutes. She then explained that a third of an hour is 60 divided by 3 equals 20 minutes and so on with two third being 40 minutes because 2 X 20=40. This enlightened the learners to relate a face-clock of an hour (60 minutes) to a 1 whole. This can be represented by 12 X 5. This was an indirect recap on multiplication and division skills despite her not mentioning it to the children

The concept of "Time" is abstract, therefore, it can be difficult to teach it to children of this age group. The video helped to bring the lesson to life, because it was audio-visual, and the learners were able to follow step by step as the virtual tutor was explaining. Their minds were actively involved in constructing meanings of the fractions of the hour that were emerging from the lesson.

The use of the video also enhanced the learners' understanding of the concept because they eventually were able to apply the concept and subsequently answer the questions. The mediational role of the teacher was equally important. Whenever she sensed like she needed to explain further, she stopped the video to elaborate. For example, she used a plastic clock face in the classroom to elaborate on how the minute hand (long) and hour hand (short) move around the clock to make an hour. Alice's actions during the video presentation were pedagogically appropriate because she used her pedagogical and content knowledge (PCK) to be able to not only teach but with understanding. This was beneficial to the learners' understanding because they now had a plethora of voices and teaching materials from which to understand the concept. This could be the reason why they were able to respond correctly to all the questions in the class activity.

To further explain the other fractional terminologies such as a half of an hour, a third of an hour and a quarter of an hour, Alice, paused the video to elaborate on these terminologies. Using the clock face below to explain how time (in minutes) can be expressed as a fraction of an hour to 60 minutes (1 hour), and then be simplified in its simplest terms.

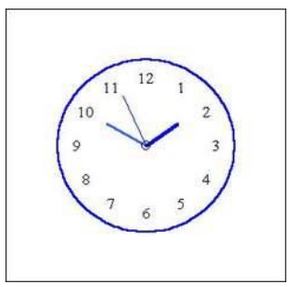


Figure 12: Shows the time: 13:50 hrs (1:50 pm) or 01: 50 am

Alice: For example, the above time is 01: 50hrs (morning) or afternoon as 13:50 hrs. This can be said as 10 minutes to 2, She explained that there are 10 minutes more to complete an hour from 1 to 2 (am or pm). Therefore, the fraction of 10 minutes before 2 (to complete an hour) can be expressed as 10/60= 1/6 of an hour.

The video further explained that the minutes after an hour can also be expressed similar to fractions. In this situation, it is 50 minutes after hour 1. Or 13:50hrs. This time elapse can be written as 50/60 = 5/6. She gave other examples like quarter past 4 (16:15hrs) can be expressed as a fraction as 15/60=1/4 of an hour. She then told learners to get into their groups for the class activity. The video ended and Alice told the learners to work in pairs to complete the tasks.

Alice: I want you to work in pairs and collaborate to figure out the fractions of an hour in the given times.

She then wrote the following questions on the whiteboard. What is the fraction of an hour when it is a) 20 minutes before and after 15:00 hrs b) 45 minutes before and after 09:00 hrs c) 10 minutes before and after 07:00 hrs d) 40minutes before and after 20:00hrs e)30 minutes before and after 13:00hrs.

The above shows that Alice's beliefs and attitude towards the use of ICT tools were translated into pedagogical actions in the actual classroom situation. In addition to her believing in the potential of technology, she also used it to invigorate her lesson. In anticipation, all learners paid full attention to her video and were able to perform the given tasks at the end. This suggests that the video helped with the learners' conceptualisation.

Although nothing looked complicated in the way she handled the technological devices, Alice at some point in her lesson appeared worried when she was not able to locate the video file on her iPad. It took her about five minutes to find it. This showed that her technological knowledge is still developing. She could just have typed the file name in the search bar for the video to appear. However, her commitment to the use of technology shows that with experience and proper training she can be able to use technology with less effort.

4. 4.2 Alice's Second Lesson on Telling analogue and digital time.

The purpose of the lesson was to tell analogue and digital time. It was a continuation of the previous lesson where time was presented as a fraction of an hour. The technological devices which were available to use in this lesson were the iPad for internet research and TV for air-play. Alice started the lesson with a quick recap of the fraction of an hour by asking mental questions like, how many minutes are in a third of an hour?, three-quarters after 14:00hrs?, What fraction of an hour has elapsed when it is15:40hrs? She then demanded the learners' attention.

Alice: Today we will learn how to tell analogue and digital time.So I want you to listen as you watch this video.

She turned on her iPad and the TV for an air-play. The virtual tutor in the video showed a clock face and explained that a day has 24 hours which comes in two sets of 12 hours and each hour is 60 minutes. At this point, Alice paused the video.

Alice: Do you remember from yesterday's work?

Learners: Yes, (replied in a choral form).

She continued the video show. It was how the 60 minutes in an hour can be counted digitally on the digital clock. It counted in seconds, then in minutes. 60 seconds = 1 minute. The virtual tutor in the video also explained that if you know your multiplication table five (X5) and the division by five (÷5), calculating the fraction of an hour digitally should be easy. The video also showed that night and day appeared at different times and different activities can be done during that time (am and pm). It also talked about the digital time of 24 hours when "am" starts at midnight (00:00).

Alice: (paused and pointed at the video). It is still dark till to the morning, till midday noon at 12: 00hrs. The afternoon "pm", however, starts a minute after midday at 12:01 to 23:59.

As the virtual tutor was counting (learners also counted with her), Alice would stop, pause and ask questions at any time. For example, the time shown in the figure below shows the analogue time as 12: 20 hrs. Or 10 minutes to 1. And the digital clock shows that it is 49 minutes after 10:00hrs.



Figure 13: Analog and digital watches

Alice: Now I want you to answer the questions which will be asked in the video. Take out your notebooks and pens and be ready.

The learners prepared their books. Alice moved around to check if they had ruled off and written the date correctly. Having been satisfied with that,

Alice: Now answer all the questions in your books as the video is going to ask.

She turned on the video. The learners were asked to listen to the time called on and to write it digitally. For example: If the time was quarter past 3 in the morning, the learners were expected to write: 03:15 am. 20 minutes to 5 in the afternoon would be 4:40 pm or 16: 40hrs. A total of 15 questions were asked and learners responded accordingly. Alice then collected the books to have them marked later as the period had ended.

The use of the technology in Alice's second lesson was of important value to the learners. It facilitated the lesson in a way that Alice did very little in terms of teaching. She only moved around to provided individual scaffolding. The video matched Alice's Performance Performancy by explaining some concepts which could have been otherwise difficult for her to explain. Her main role in the second lesson was to manage the classroom environment while learners watched the video. The use of the video corroborated the views she expressed in the interview that, when ICTs are used, difficult concepts are explained in a much clearer way to make the learners understand better. Her mediational role to further explain the movements of the clock hands whenever she paused the video helped to ensure that the learners did not miss important information from the video.

4.4.3 Alice's third lesson on Calendar Days, Weeks and Months.

The third lesson was taught to the same group of learners which Alice taught in the first and second lessons. In this lesson, she used her iPad to air-play a YouTube video on the TV. Before the start of the lesson, Alice asked the learners to recall the history of time and to explain why the calendar was introduced.

Alice: Why do we need the calendar ?

Learner-1: To help us know the days,

Learner-2: To see when we are going on holidays

Learner-3: So we can calculate the days.

Learner-4: To help us plan events.

She (with a happy smiling face) then told the class that they were going to look at time in another way, which was the calendar. The learners seemed to be happy too and excited as Alice turned on the iPad and connected it to the TV for air-play. She told the learners to listen carefully as they watched the video. The video explained the importance of the calendar and the planning of events. The video explained long a day is, a week, and how many weeks make a month. Later on, it explained how many months and weeks make a year. Alice would paused the video on different intervals to allow learners to look at the calendars projected on the screen. The months had pictures activities that are done in different seasons. For example, autumn season was indicated by the leaves falling off the trees, summer season by rains and people farming, winter season by people in winter coats, and spring season with colourful flowers in the gardens.

Learners were challenged to use the calendar to answer given tasks from the video. For example, what date is the 3rd Tuesday in August? How many Sundays in July? What day of the week is the 1st of June?

Alice: Now I want you to work in pairs to answer the following questions.
What date is the 2nd Thursday in February?
How many Saturdays in April?
What day of the week is the 1st of July?

It was an exciting lesson because learners worked in pairs when counting and their voices could easily be heard. She went around marking their work and the lesson was over.

Using ICT tools added some pedagogical value to the teaching and learning of calendar days. The bright pictures attached to each month depicted the activities done in that season. This eagerly excited the learners to concentrate even more, which ultimately was a positive influence on them. The different colourful seasonal pictures enriched her teaching because many learners could hardly have related the activities with the months without her initiative of using ICT tools.. Using technology in this lesson corresponds to Alice's PE that the learners were motivated and this had positive effect on both the teacher's performance and the learners' conceptualisation.

4.4.4 Summary of Alice's three lessons

Alice's enacted practice in three lessons concurs with the views she shared concerning PE, EE, SI, FC, and BI. Although her background was not so much grounded in technology, she was courageous to use technology to achieve her lesson objectives. The use technology in the three lessons helped Alice to be motivated and confident during the teaching.in respect to EE, Alice was quite energetic and her enthusiasm played a part in influencing the learners to psychologically be ready for the video. Although in the second lesson, she at one point acted worried when she could not locate the video she wanted to play, she exerted her emotions, and then she was able to find it. There are some pedagogical opportunities she missed though. She could have used iPad educational apps to engage learners with the content instead of relying on air-played videos only. It could be that she is not confident in her ability to use educational apps to teach mathematics concepts

With respect to SI and behavioural tendencies towards technological tools, she was motivated by her belief in the pedagogical potential of technology to support teaching and learning. It could be that she was also influenced by those around her because every teacher had technological devices in their classrooms not to mention the administration block. This meant that they were all expected to use devices. It was also clear that the school had unspoken social influence on its staff to use technology in their teaching. This is evidenced in the way the classrooms were facilitated with ICT tools.

In respect to FC, Alice's lessons were conducted in the classroom equipped with iPads and television but learners' were not used to engage learners with the content on their own, probably due to the lack of the technological pedagogical knowledge by the teacher.

4.4.5 Betty's First Lesson on Telling time (am and pm)

Betty was the youngest of the participants. She is a foundation phase teacher with three years of teaching experience. Being modern, she believed in ICT mediated lessons

because she grew up using technology. She teaches grade three and she was quite dynamic in her use of ICT tools. This was confirmed in an interview when she claimed to have grown up with computers and that she has used technology all her life. There were 20 grade three learners in her class (11 girls and 9 boys). These were seated in groups of fives, making two groups on each side of the classroom. There was enough room for Betty to move around the classroom. This section gives an account of three lessons about Time that were observed in her class. Each lesson was an hour- long.

Betty's first lesson was about telling time (am and pm). Before the lesson, Betty prepared her iPad and tested the air-play to make sure that the TV was working. She introduced the lesson with a quick mental activity.

> **Betty**: Today we are going to learn about time. I would like everyone to take out the mental work book and pencils.

All the learners knew what that meant and in a short time, they all got their A-5 sized notebooks, wrote the date and waited for the next instruction .

> **Betty:** Are we ready?
>
> **Learners:** Yes! (In a chorus)
>
> **Betty**: Right. Let us start. Remember I only want you to write the answers. I would like you to listen as I call out the time or an activity and you just write if that is in the morning, afternoon, evening or night.

Betty then started to read the ten random sentences that described the daily activities which are done at different times. For example, when do we wake up from bed at sunrise? Is it morning or afternoon? When do we have our first tea at school? When is it time to go home after school? When do you have golden time on Tuesdays? The learners wrote the expected answers to each question and afterwards, they swapped their books for marking. Betty called out the answers and the learners who got all the answers correct earned some points on the class merit chart.

> **Betty**: Today's lesson is about Telling Time; am and pm. Most of you already can tell time, but now I want everyone to turn to the TV, and watch the video. Listen carefully because you will be expected to answer the questions afterwards.

With high excitement, the learners turned their chairs to face the direction of the TV. Betty turned on her iPad and quickly connected the TV to air-play. The video (with a lady's voice explaining in the background) showed the clock face (hour hand, minute hand and second hand). The voice explained, " today's lesson is about Telling Time (am and pm). A new day starts at 00:00hrs. The first 12 hours of the day are known as 'am' hours and the second round of 12 hours as 'pm' hours." Together with the video show, the learners counted the first 12 hours, and as they counted, the video showed from dark, to dawn, to sunrise, and finally till noon. Betty intermittently stopped the video for an explanation.

> **Betty**: So "am" starts at 00:00hrs, that is when each day begins. It is dark until in the morning when the sun rises to 12:00hrs noon. Is this clear?

Leaners: Yes! Mum.

Betty: From 00:00 hrs to 05:30 hrs, it is dark (showed the dark pictures).



Figure 14: Picture from internet showing that there is no sun at night

The video continued with the concept of pm. The voice in the background explained that afternoon starts at 12:01hrs until sunset and then it is in the evening until 12:00hrs at mid night. This time is written with "pm" or digitally on a 24hour clock as 13:00hrs to24:00hrs. For example 1:00pm or 13:00hrs (12 + 1= 13:00 hrs). 2:00pm or 14:00hrs (12 + 2 = 14:00 hrs). The pm hours were shown from 1:00pm (13:00hrs) to 12:00 pm (24:00hrs).

Betty paused to explain (amid smiling and showing excitement)

Betty: Afternoon starts at 12:01hrs till about 18:00hrs or 6:00 pm when the evening starts. So pm is from 12:01 to 24:00hrs.

The video was paused at different intervals to explain and ask questions as she taught.

Betty: What is 3:00pm in 24hours time?

Learner: 15:00hrs.

Betty: How did you get the answer?

Learner: 3:00 +12: 00hrs = 15:00hrs.

Some learners were asked similar questions with different times and they gave the answers accordingly. Those who could not answer were helped by their friends. At this point, Betty quickly got onto her iPad, stopped the video and projected the chart below to help her elaborate on the am and pm concepts. She told the learners to look at the pictures to be able to tell the correct time. For example, what picture shows 07:00 pm? What picture shows 3:20 pm? What pictures show 05:35 am? The same process continued.

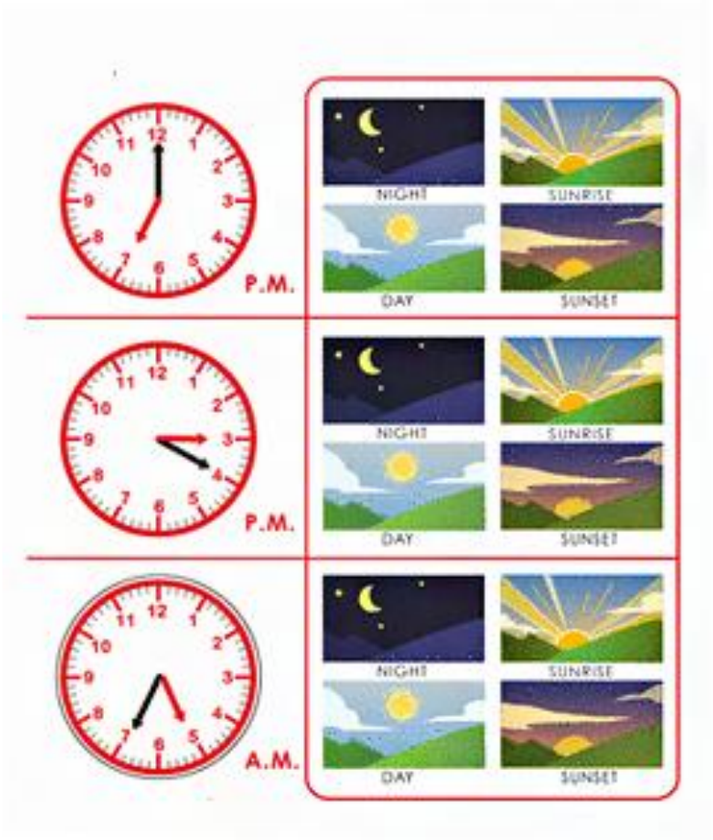


Figure 15: am and pm Time Chart from the internet

With the time chart still on the screen, Betty told the learners to face the whiteboard, then she explained how to convert from am or pm to a 24-hour format.

Betty: To convert am or pm time to the 24-hour time format, the following rules have to be used.

From midnight 0:00hrs to12:00 am, subtract 12 hours	From 12: 01 pm to midnight, add 12 hours
12:49 am = 0:49(12:49 – 12)	1: 49 pm = 13:49 (1: 49 + 12)

How to convert time from 24-hour clock to the 12-hour system

From 0:00 (midnight) to 00: 59, add 12 hours and use am	From 13:00 to 00:00, subtract 12 hours and use pm
0: 49 = 12: 49 am (0: 49 + 12)	13: 49 = 1: 49 pm (13:49 – 12)

With the chart, the learners were able to relate with what happens during the hours of the day and then did the exercise from their textbook on this concept. Betty went around correcting the work.

The use of ICT tools added some pedagogical value to this lesson in many ways. The video was able to explain the concept of "am" and "pm" using pictures. This, to an extent, helped learners to understand that a day has 24hours. The first 12 hours are in the morning

and the next12 hours for the afternoon and evening. By the use of technology, Betty was able to not only have the lesson done, but also to allow learners have a sense of relating to how the colour outside at a particular time meant different times. For example, the sun is seen during day time and not at night. So there is sunlight from sunrise to sunset.

Furthermore, Betty's questioning approach amid the video seemed to enrich the lesson as it elicited learners to have an idea of how they can differentiate or convert am to pm or vice-versa Through questioning, Betty was also able to assess her learners' logical thinking. For example, at 07:00 am, the sun should be coming out in the morning and logically the learners should be busy going to school. When it is 7:00 pm or 19:00hrs, the sun should be gone already, and logically they should be having their dinner. Betty's performance was amplified by the value that ICT tools added to her lesson, allowing learners to understand the concepts of am and pm with very little effort.

4.4.6 Betty's Second Lesson on Telling time (am and pm)

Lesson 2 was the continuation of telling analogue and digital time. Betty started her lesson with a different approach of a quick question and answer activity on multiplication table 5 (X5). She called out a question and randomly picked any learner to answer. Learners, however, raised their hands to give correct answers.

> **Betty:** Today, we will continue with analogue and digital time. Can we get ready for a video? (She turned on her iPad and did her connection to TV).
> Pay attention to the video.

The video was about telling time, telling how many minutes past the hour, and how many more minutes to the next hour. Different times were shown in both digital and analogue. The virtual tutor counted down the minutes from the past hour and then the minutes to the next hour. Betty paused the video to explain further whenever she felt it was necessary. She elaborated further as in Fgure 15.

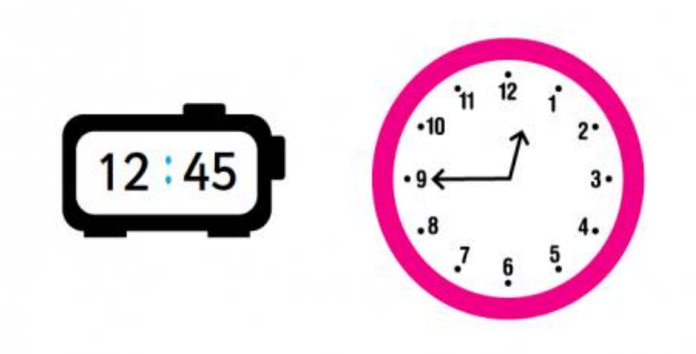


Figure 16: Digital and Analogue Times Betty used to explain

> **Betty**: What is the time? How many minutes after the past hour? How many more minutes to the next hour?
>
> **Learner:** The time is 12:45hrs. 45 minutes after 12:00hrs and 15 minutes before 1:00hrs (am or pm).

After several examples, the learners got into the rhythm and many of them could do their math mentally because they only worked with 60 and the elapsed minutes. Betty then gave the learners different tasks and asked them to tell what time it was, how many minutes past the hour and how many minutes to the next hour. Afterwards the learners completed the given tasks in their books and Betty went around marking.

Using ICT tools added value to Betty's second lesson. As they are both visual and audio resources, ICTs enhanced both teaching and learning. Learners were able to see and read with the video (digital and analogue time, counting seconds, minutes and hours). Learners were able to relate to what they saw on the videos with their eyes and counted together with the virtual tutor in the video. It can be said that ICT tools helped to bring the outside world into the classroom situation. This influenced the learners' conceptualisation ofTime. Although the technology was used to help the learners recap on their multiplication facts, especially table X5, only the clever ones seemed to enjoy it. The struggling learners never had their hands up. Betty would have involved them with slightly easier questions.

4.4.7 Betty's Third Lesson on Calendar

Lesson 3 was about the history of time and calendars, with a focus on how sand-dial and hour-glasses were used to tell time. She started the lesson by posing a question.

Betty: How did people tell time before the clocks?

Learner-A: By seeing when the sun is rising and when it is going down at sunset.

Learner-B By looking at shadows.

Betty: How? What difference does looking at the shadow make?

Learner-B: In the morning, the shadow is long, and as it goes in the afternoon it becomes shorter. From noon, it starts to be longer again until sunset.

Betty: Good. Who can give us another way of telling time that was in the past ?

Learner-C: They used hour-glasses.

Learner-D: Also sand glasses.

Betty: Very good.

Betty explained that before the watches were inverted in the olden days, it was difficult to measure time. In trying to come up with a standard measure of time different things were tried. For example-sand-dials, shadows and hourglasses. She asked the learners to look at the screen and air played the below pictures.

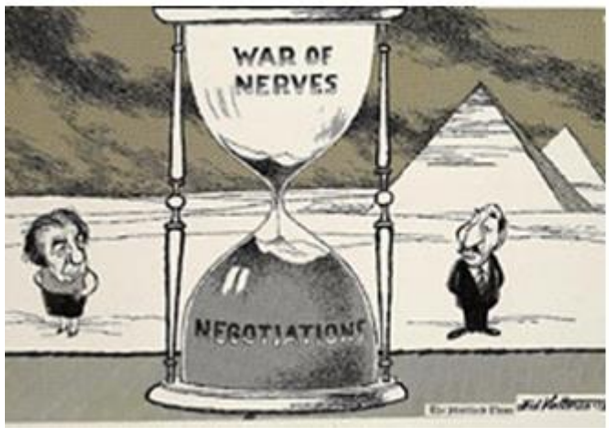




Figure 17: Hour-glasses sourced from the Cambridge Mathematics Teacher's Resources Book 3

Betty: Hourglasses are still used today to keep track of time. Where would you use them?

Learner-E: For playing games or even for cooking.

Betty: Good. While we understand how time was measured before the clocks, we should also remember that days, weeks, months, and years are also part of the concept of time. Our lesson today is about calendars. So take your mental book, write today's date and quickly answer the following questions on the screen. She then air played these questions: How many hours make a day? How many days make a week? How many weeks make a month? How many months make a year? What is the decade? How many years make a decade?
After 5 minutes, she asked the learners to swap their books so that they could correct each other. She air-played the answers and learners were able to correct themselves.

Betty: Can you please look at the calendar on the screen.

Apr 2019 printcal.net

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

Figure 18: An example of the calendar that was displayed

Betty: who has an idea what this is?

Learners: Calendar.

Betty: What does it tell us?

Learner: It is made up of days, weeks and months to make a year.

Betty: Good! There are 12 months in a year. Some months have 30 days and others have 31 days. February has 28 days and every four years it has 29 days. That is known as a leap year. There are four weeks and some days in a month. There are also seasons in a year. I would like you to watch the video that I am going to show now.

The learners faced the TV and Betty turned the video on. It was a 5 minutes show of the

months of the year and their seasons. What the temperature is and what activities are done in each season. Summer months were shown with some rains (people with umbrellas) and vegetation. Autumn showed the leaves of the trees turning yellow and starting to fall. Winter showed shed trees, and people in winter clothes. Spring showed the blossomed flowers and outside activities like picnics. Afterwards she asked general questions on how people dressed in each season. Learners gave answers accordingly. Using the calendar, she then asked the following questions.

Betty: What date is the second Tuesday in April?

Learner: 9th April 2019.

Betty: What day is the 15th of April?

Learner: Monday.

Betty: What date is the 3 days before the last Friday of the month?

Learner: 23rd April

Betty asked the learners to get into their groups and to work together to answer the class activity. They grouped themselves in twos and threes so that no learner worked alone. She instructed them to collaborate with their peers while doing the activity from the textbook.

The use of ICT tools intrinsically added value to this lesson in that, the video involved the activities done in different seasons of the year. For example, autumn season was indicated by the leaves falling off the trees, summer season by rains and people farming, winter season by people in winter coats and spring season with colourful flowers in the gardens. This was .an added advantage to her teaching. Betty's strategy of asking the learners to tell in which season each activity fitted motivated the learners to answer and to respond accordingly. She led the learners into acting scenarios of how people behaved in each weather condition. This clearly showed that both the teacher and the learners enjoyed the video that was used to deepen the understanding of the concept of time and seasons.

4.4.8 Summary of Betty's three lessons.

Some major insights emerged from Betty's three lessons concerning PE, EE, SI, FC and BI. She was confident in her use of the ICT tools. As a digital native, it was not surprising that she used the technology with ease. Using ICT tools not only enabled Betty to engage learners, but also elicited the learners to explore the digital or analogue times. In respect to EE, the ICT tools aided Betty in that she did not have to put in a lot of effort to explain. The video clearly explained how many seconds make a minute, and how many minutes make an hour. Children were able to see with their eyes and to count with the video and later were able to calculate the time (both am and pm) on their own. Her effort to combine different teaching materials for example the video and electronic charts with different times enabled the learners to relate with the outside world and this enabled Betty to also achieve her lesson objective. The topic is abstract therefore the teacher is challenged to explain using visuals to help learners conceptualise it**.** Notwithstanding with the way she used the technology in her lesson, it could have been more beneficial to learners' learning

if she had given each learner an iPad device to engage with the concept of time on their own instead of relying on the video. A close look at the school iPad devices showed that the devices embedded learner-centered educational apps on Time and seasons that Betty could have used. Despite her technological knowledge, Betty is still a novice teacher. It could be that she does not have the required pedagogical knowledge to integrate learner-centered educational apps.

4.4.9 Charlene's First Lesson on Telling time

Charlene is a female teacher in her early forties and this is her first school to teach. She has been teaching for four years. Before joining the teaching career, she worked in the corporate sector as an ICT specialist. She indicated in the interview that using ICT tools in schools today is the way forward for the modern child and with her technological skills, she believes that she cannot teach without ICT tools. This section will give an account of the three lessons that were observed in her third grade class of 20 learners. Each lesson was an hour- long.

Before the start of the first lesson, Charlene addressed the learners.

> **Charlene**: I want us to start with an activity. Can you all stand up and listen to the instruction. I want each one of you to tell me one activity that you do and what time of the day do you do it. For example, eating breakfast- morning time.

Learners went on mentioning different activities and which time of day these activities are carried out. . For example: sleeping- at night, coming to school- in the morning, having lunch- afternoon, and so on. Learners sat down as they mentioned each daily activity.

> **Charlene:** Our lesson today is about telling time. We are going to use Analogue and digital time. Why is time important?
>
> **Learner**: So that we know when to do things that we do
>
> **Charlene:** Things like what?
>
> **Learner:** Like coming to school, going to the mall, watching TV and eating.
>
> **Charlene:** OK. Good. I would like you to face the TV for a short video.

All the learners positioned themselves to watch as Charlene was busy connecting the iPad to air-play the video. The video was a cartoon about time and activities that are done during the day. Showing an analogue face clock, as the learners watched and listened quietly, the the background voice of the video explained:

> Time is told using both long and shorthands. A day starts at after midnight (00:00hrs). It is still at night then and people are still sleeping except for those who work at night. Waking up for the day's activity is at sunrise, any time between 05: 00hrs- 06:00hrs. Mid-day is at noon (12:00hrs) and dinner is normally in the evening after sunset (18:00hrs). Bed time is at night when it is dark. The 'am' time is from 00:00hrs to 12:00hrs, and the 'pm' time is from 12:01hrs to 24:00hrs.

The video then showed and explained how each hour is made of 60 minutes. The 12 numbers on the clock face are 5 minutes apart, making 60 minutes after one hour round or a complete turn. Starting at 12:00hrs the long hand (minute-hand) of the clock started to move clockwise, counting the minutes together with the learners in 5s until a complete turn. The background voice explained that after 60 minutes (1 hour) time is the time 01:

00hrs. Then the video showed different times like 03:30 hrs and 08:40 hrs, and asked how many minutes after the hour, and how many minutes to the next hour.?



Figure 19: Analogue and Digital time from the teachers' worksheet booklet

Charlene: (Paused the video and asked**)** we have to count from 12 to be able to find the answer.

Learners responded according to the time the video was showing.
03:30am = 30 minutes after 03, and 30 minutes to 04:00hrs.
08:40am = 40 minutes past 3 and 20 minutes to 9.

Now the video called the number of minutes and showed an hour, then the learners responded. When the video finished the learners were instructed to do an activity from their book.

Charlene then moved around checking the work.

As a mathematics teacher, I have noted that most learners find it difficult to recognise that numbers have different meanings in analogue clocks depending on which clock hand (long or short) points at the number, for example, 5 past 12 or one O'clock. They also find it hard to remember which side of the clock indicates "to" and which one indicates "past". For example: 5 to 5 and 5 past 5. Therefore, conceptualising analogue time for these learners is most likely difficult. However, in Charlene's class, ICT provided an opportunity to represent concepts of time in a manner that learners were able to understand. The video explained and showed pictures, counted the number of minutes "past" and "to" the hour, which could have been of help to the children and enhanced understanding. Also, Charlene approached this lesson strategically by putting the learners into groups. Through peer collaboration, the learners were able to interact and learn from each other. This brought confidence to shy learners when they were answering questions.

4.4.10 Charlene's second lesson on Time elapse

The second lesson was also about telling "Time elapse" but it was more challenging than the previous one. It required learners to think and give an answer within a given time. Before the beginning of the lesson, Charlene distributed iPads to the learners and instructed them to listen and to follow instructions.

Charlene: Do you remember what we did yesterday?

Learners: (one of them). Yes: we learnt how to tell time; minutes past and to the hour.

Charlene: Today, we are going to use an iPad to calculate the time elapse from an Analogue time, and write it digitally. So I want you to look at the TV and follow instructions from the example.

Charlene turned on the iPad and connected it to the TV for air-play. She showed a clock face telling time. And within a minute, she wrote the same time in digital form.

Charlene: Now focus on the analogue time on the screen, and then within a minute, write the time in digital on the iPad.

So she instructed them to turn on the iPads and get ready. When they were ready, Charlene started showing analogue times on the screen and within a minute, the learners wrote in digital and raised the iPad to show her. 10: 45hrs, 02:15hrs, and 02:07 hrs. It went on for about 10 minutes. Then Charlene explained to the learners that they should tell the time that has elapsed after the hour. When Charlene air-played the digital time on the TV, the learners told the time elapsed from the hour, and they put the time on the analogue clock face which they had on their tables. The video showed, for example, 12:15 hrs, and the learners were to say the time within 2 minutes and to show this on the analogue using a face clock.

Afterwards, the learners were given similar activities and they worked in groups of two and three.

The ICT value in this lesson was that, using individual iPads intrinsically motivated learners to participate in the lesson. They were interested whenever ICT tools are used regardless of the activity. The faster a child gave the correct time the more exciting it was for them. This, too helped the teacher to succeed in her lesson because every child seemed to be engaged in the lesson, even the less talented took part and found it interesting. It was a fun learning moment for all learners.

4.4.11 Charlene's third lesson on Calendars

The third lesson was about calendars. It was the same group of learners she taught in the previous lesson. Charlene started the lesson by asking the learners to shout their birthday months.

Charlene: Can we all stand. I will call the months of the year and when it is your birth month, you may shout hurray! Then sit down.

Charlene turned on a birthday song that mentioned all the months and the learners were excited as each shouted "hurray" when their birthday month was called. She then showed the calendar of a year for the learners to see.

Charlene: Today's lesson is about the calendar. What is the calendar made of?

Learners: Months.

Charlene: How many months in a calendar?

Learners: 12 months.

Charlene: Good. The 12 months make a year. Some months have 30 days and some have 31 days. Except for February which has 28 days and every 4 years it has 29 days.

Charlene: What is it called when it has 29 days?

Learners: Leap year.

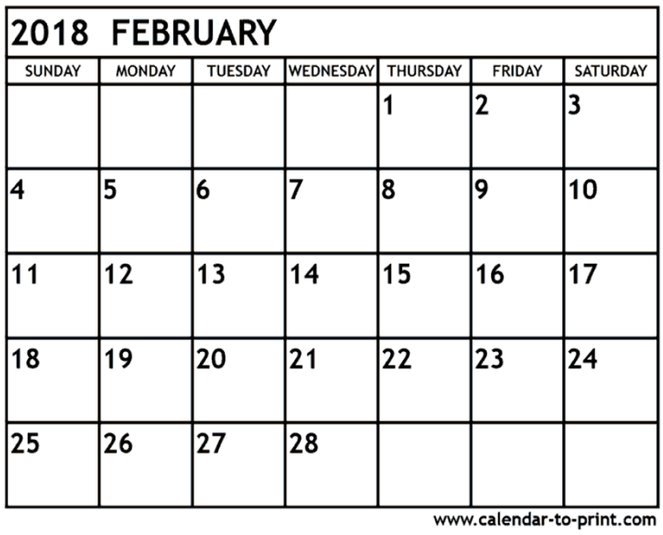
Charlene: Good. So how do we know which months have 30 days and those with 31days?

Learners: No one knew.

Charlene: OK, can we make a fist. I want you to look at the back of your fist and see the finger knuckles. The first knuckle stands for January, then the in-between space stands for February. The next knuckle stands for March, and the next space below for April. It goes on to the other hand. So all the months on the Knuckle have 31 days and the months in the spaces have 30 days except for February. She explained that the concept of days on calendars can be used in many ways in mathematics.

Charlene: We are going to use a calendar to solve mathematical problems.

She handed them a worksheet of a calendar, as in Figure 19 and asked them to work in groups to answer the questions that followed.



2018 FEBRUARY

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28			

www.calendar-to-print.com

Figure 2: A one month calendar

Questions that were asked:

1) What date was the first Monday?
2) What day was 2 days after the second Wednesday?
3) How many Thursdays were there in this month?
4) How many Fridays were there in this month?
5) If a leap year was 2 years ago, when is the next leap year?

The learners did their work in their notebooks as Charlene moved around the classroom and soon the lesson was over.

Pedagogically, the use of ICT tools added value to the lesson in that it started on a happier note. The birthday musical tune not only made the learners happy, but also elicited some sense of human appreciation of each one's birthday. Foundation phase learners are still in the formation age, so the combination of music and visuals was an exciting moment which highlighted their motivation to learn. Using a calendar simplified the lesson because it was easy to see the breakdown of the year into months, months into weeks, and weeks into days. This enhanced the logical understanding of the calendar concept and in turn, eased Charlene's task to explain this difficult concept.

4.4.12 Summary of Charlene's three Lessons

In respect to PE, Charlene enthusiastically motivated the learners by using ICT tools in the groups. This strategically helped her and the learners to have confidence and to be sure of

their answers. They discussed as a group while solving mathematics problems. The digital and analogue electronic game was also inspiring to the learners. It pedagogically facilitated and enhanced the teaching of hard concepts like "time elapse" which would have been otherwise difficult to achieve.

In respect to EE, Charlene was able to use iPads for collaborative learning. Every child had a turn to play and they were responsible for answers in their various groups. Technology enabled her to reach out to all the learners. Her use of ICT tools was encouraging and influential to the learners. This was seen in the way they socialised when answering the questions from the video.

4.4.13 David's first Lesson on Telling Time.

David was the fourth participant of the study. He is an intermediate teacher and has been teaching grade 5 mathematics for five years. He has been teaching in modern schools and has embraced the use of ICT tools in his teaching. He indicated in the interview that ICT's were valuable and credible tools in teaching especially when teaching young ones. He also acknowledged that ICTs are efficient and avail to different teaching methods which motivate both the teacher and the learner. He added that children are now familiar with different technological devices from their home environment, so using ICT tools makes it easy to teach them. There were 21 learners in his fifth grade class (11 boys and 10 girls). They were seated in pairs in four columns. There was enough room for easy movement. This section reports on the three lessons about "Time" which were observed in his class.

David approached the first lesson with a practical activity. Before the lesson, he collected some measuring equipment: a scale with different weights (50g, 100g, 200g, 500g and 1 kg), different containers for capacity (250ml, 500ml, 1l and 2l) and rulers and tape measures for length (m cm, and m).

> **David**: I have some equipment in front. Do we know what they are called?
>
> **Learners:** Yes! (Different answers) rulers, containers, tape measures.
>
> **David**: What are they used for?
>
> **Learners:** They are used for measuring.

He then asked four learners from the front row to sort them according to their categories. So the learners went and sorted them into their measuring categories: weights, rulers and tape measures and containers.

> **David**: Pointing at each group, what are these used for?
>
> **Learner: (**who the teacher pointed) Weights for mass, rulers and tape measures for lengths and containers for liquids.
>
> **David:** Good. What do you understand by the word measure?
>
> **Learners: (**whose hand was up) to know how heavy something is, to know the value of something, to understand the quantity, and so on.
>
> **David:** We call these, units of measures, g, mm, cm, m and l
> Did you know that time can also be measured? What do we use to measure time?
>
> **Learners:** Watches.
>
> **David**: Time can also be measured. Today, our lesson is "Units of measuring Time"; the conversion of time from seconds to minutes, and from minutes to hours.

He told them to get ready to watch a video. The video was about the units of time and how it is measured. The virtual tutor explained that time is measured in units of seconds, minutes, and hours. These add up to make days, weeks, months, years, and centuries.
60 seconds = 1 minute. 60 minutes =1 hour. 24 hours =1 day. Time tells you the duration, and when you can do something. So it is a measurement. The standard of measure is seconds.

> **David**: (paused the video and wrote on the board) 60 seconds=1 minute,
> 60 minutes = 1 hour =3600 seconds (60 x 60). He then gave another example that
> 2 hours in seconds will be 2 X 3600 = 7200 seconds.

The video continued as the virtual tutor explained that hours can be written in the units of minutes and also in seconds. The virtual tutor requested the learners to answer to following questions.

1) Write the following in seconds:
    a) 1hour 30 minutes
    b) 2hour 15 minutes
    c) 45 minutes
    d) Half an hour.
    e) 60 minutes

David guided the learners as they gave answers orally. Thereafter, they had to complete tasks from their textbooks. David went around checking and correcting.

This lesson allowed the learners to recap on the already known measuring terminologies. Mathematics is hierarchical, we learn from known to unknown knowledge. Starting with the known measuring terminologies laid the basis to new knowledge. This allowed learners to relate what they learnt to the real world as time is part of our daily life. The ICT tools pedagogically added value to this lesson because the learners were able to see and counted with the voice in the video how the 60 seconds make a minute. Although they did not count the actual 60 minutes to see how an hour is made, they saw how the long hand of the clock slowly moved forward in the clockwise direction. It was a logical understanding that it would make an hour after a complete turn.

4.4.14 David's second lesson on addition and subtraction of time

The second lesson started with a mental activity from the previous lesson.

> **David**: Do you remember what we did yesterday?
>
> **Learners:** Yes!
>
> **David**: I want you to take out your mental books, write the date and be ready.

All the learners did as they were told and in a very short time, they were ready for the mental test. David called out 10 questions on the previous days' work. Learners wrote the answers as the questions were called. Afterwards, the learners exchanged the books for marking. When David called the answers, there was excitement as there was a merit reward to those who attained 100%. There were four learners with 100% and each one ran to to put their names on the merit score chart.

David: Today, we will look at the addition and subtraction of time. Can you all face the TV and listen carefully to what you are going to learn.

The learners did as they were instructed and David made his air-play connection from his iPad. The video started with a recap on the previous lesson. The clock face was shown on the screen and the female teacher in the video explained the addition of time first, then later on subtraction. She explained that there are always to columns, hours (H) and minutes (m) when adding different times. She instructed to always start with the minutes' column because minutes can be more than 60 when added and it is easy to convert them to hours. As the video played, David paused on fixed intervals to explain the conversion process of addition and subtraction in different ways.

The video showed the conversion of minutes to hours and vice-versa when adding and subtracting. For example, adding five hours and forty-two minutes = ____ (5hrs:42 min + 3hrs: 38 min). Starting with the minutes, 42 +38= 80, so then we have 1 hour and 20 minutes in 80 minutes. We convert the minutes to hours by writing the 20 minutes and adding the 1 hour to the hours' column. It leads us to the total hours of 5 +3+1=9hours. So the answer is 9hrs:20min.

An example of subtracting time was also explained and how we take 60 minutes from an hour if the minutes being subtracted are more. For example: –Eight hours and twenty minutes minus three hours and forty minutes (8hrs: 20min – 3hrs: 40min). David paused the video to elaborate on this.

David: I would like you to listen. When we subtract, as usual, we start from the minutes because they are smaller units".20 minutes are less than 40 minutes, so we have to take 1 hour from the hours' column. Remember, 1hour = 60 minutes. So 60 minutes plus 20 minutes give us 80 minutes. Then we can easily say 80-40=40. So, that is the 40 in the minutes' column. 7 hours – 3 hours =4 hours. So, the answer to this subtraction is 4hrs: 40min.

He also emphasised the concept of "carrying over" of one hour when adding and the "taking off" of one hour when subtracting. Then he talked about using addition and subtraction in "time elapse", when calculating time spent in distances ("to from fro" a particular place to stipulate time). For example, in a race, the person with least time is the winner. Then he told the learners to do an activity from their textbooks on addition and subtraction.

The value of using ICT tools in this lesson was paramount in that it enabled the learners to understand why the concept of time can be added and subtracted like ordinal numbers. The conversion of hours to minutes and vice-versa when carried over was explained in a very simplified way by the virtual tutor. With the help of technology, David pedagogically managed to explain what could have been hard for him to teach. This ultimately supported learners' understanding although some learners still needed extra time to conceptualise.

4.4.15 David's third lesson on Time Management

The third lesson was about managing time using a scenario of a daily morning activity at a Bus station. Before the start of the lesson, David connected his ICT tools;the TV, the iPad, and the projector. After he greeted the learners, he announced the topic of the lesson.

David: How many of you have ever travelled by bus, train or aeroplane?

Learners: All the learners had their hands up.

David: Who can tell me what happens at the stations?

Learners: (Different answers) a lot of people walking in different directions. Buses coming and going, some shops around for people to buy food.

David: What else?

Patrick: A place (office) where people buy tickets.

David: Good. What do you find in that office?

Sibusiso: People who are selling the tickets.

David: What do they use to sell tickets?

Mary: Money.

David: Yes, but what influences people to pay money?

Mary: If the bus is there or not.

David: How to know whether the bus is there or not? What guides them?

John: The bus time-table.

David: Good. Today our lesson is about "Time Management". We are going to analyse a bus Time-table at a bus station. I would like you to watch the TV.

David air-played the pictures of a bus station, local bus time-table and the route taken to and fro through other cities at different departure times.

Stagecoach EAST MIDLANDS | FREE BUS SERVICE

Lincoln Bus Station	1015	1115	1215		1415	1515
Saxilby High St	1030	1130	1230		..	..
Sturton by Stow A1500	1035	1135	1235		..	..
Bransby Horses	1045	1145	1245		1435	1535
Bransby Horses	1045	1145		1345	1445	1545
Sturton by Stow A1500	..	..		1350	1450	1550
Saxilby High St	..	..		1400	1500	1600
Lincoln Bus Station	1105	1205		1415	1515	1615

Figure 3: Bus Time-table that was used during the lesson

Looking at the time table, David urged the learners to focus on departure times and see how long it took the bus to move from one place to another. He further explained that the time indicated against every bus stop showed the time of departure and not the time of arrival. This was a bus that commuted every hour from 10:15 hrs, and stopped at 3 different destinations before driving back to the starting point. As David explained and elaborated on the calculations of elapsed time, step by step, it helped the learners to have

an understanding of how time elapse practically happens, and the importance of time management, because other people could be left behind due to them being.

> **David:** How long did the bus take from its station in Lincoln to Sturton if it started at 10:15hrs?
>
> **Patrick:** 20 minutes, because it arrived at 10:35hrs.
>
> **David**: Good. We call that "time elapse". Time elapse means the time that has been taken for the bus to move from one place to another. Why do you think there is a bus every hour from 10:15hrs? Why is there a two-hours gap from12:15 to 14:15hrs.
>
> **Thabo**: Because it is in the morning and people want to move to their workplace while it is still in the morning. It is lunchtime and probably people and the bus driver are on lunch.

Different other questions were asked and learners responded accordingly. Then the learners were asked to do the activity on time elapsed using a bus/train time table from their textbook.

The pedagogical value of ICT in this lesson is that the airplayed pictures involved some social activities and emotional expressions amongst the passengers. It was a practical scenario of early morning congestion of any commuter bus station. Some passangers were happy to be on time while others were late and left behind to get on the next one. With the pictures , David was able to utilise verbal and visual representations to encourage and help learners make connections with real-life situations. Time management is a life skill and using the TV to airplay, learners were reminded of their time management skills in their daily activities.

4.4.16 Summary of David's three lessons

David took advantage of ICT tools to enhance learners' conceptualisation, particularly its visual and audio aspects. This visualisation played a crucial role in the learning processes. For example, the concept of 'carrying and borrowing' of a '1hour' was confusing to the learners and difficult to grasp, but it became simple when learners saw from the video how the carrying over of 60 minutes was computed. The use of ICT was amplified by the mediational role of David. For example, David gave examples and asked questions to make connection between the content of the lesson and their everyday life. He also guided learners on how to calculatethe time elapse. The availability of the technological infrastructure that the school has put in place created a good learning environment and this might have contributed to David's decision to use technology in teaching the concept of time.

4.4.17 Section Summary

From the analysis of the lessons above, it is important to highlight that although all teachers believed in the potential of technology to improve teaching and learning, and used it in their teaching practices, their enacted practices demonstrated a lower level of use of technology. The use of technology was limited to the use of videos only. Teachers had iPad devices for each learner, and these devices embedded learner centered educational apps on the topic. However, all teacher participants did not use these apps. They relied on videos only.

4.5 Chapter Summary

This chapter analysed the data into two sections. The first section was set to address the first research question, "What are the teachers' beliefs, attitudes and behavioural intentions to use ICT tools in mathematics teaching?" The second question addressed the second research question, "How are teachers' beliefs, attitudes and behavioural intentions to use ICT tools enacted in the actual teaching of the concept of time?"

The first section revealed some positive perceptions in the use of ICT and in the pedagogical potential of ICT to improve teaching and learning. All participants felt the urge and motivatation to integrate ICT but the lack of onsite technical support, the lack of encouragement from the school leadership, unreliable ICT infrastructure,and lack of training and professional development in the pedagogical use of ICT discourage everyday ICT integration.

In the second section, lesson observations sought to observe the actions of the research participants to assess their behavioural tendencies in the use of ICT tools when teaching the concept of time. The four elements (PE, EE, SI, and FC) of the UTAUT model were used as categories from which identified themes and sub-themes emerged insightfully. During lesson observations, the use of ICT tools was an insight to motivate the teachers in teaching the concept of Time. Teachers believed that ICT tools had the potential to help them achieve their lesson objectives. This perception facilitated the teachers'teaching in a positive way which ultematly helped the learners to understand difficult concepts which otherwise could have been hard to teach using traditional method. In addition, the virtual tutor lessened the teachers' efforts in the actual teaching. This encouraged the learners and enhanced both visual and audio learning to all the learners at the same time. Although the technological devices seemed to be in place for the teachers to use, it was however found that there was need for the school to implement professional development programs for the teachers' needed technological skills, for effective use of ICT tools.

CHAPTER 5: DISCUSSION OF FINDINGS

5.1 Introduction

As in Chapter Two, the belief that technology can help improve teaching and learning is very common. In its white paper on e-Learning, the South African government claims that the use of technology will shift teaching from the traditional to modern teaching approaches marked by the classroom use of technology to investigate, collect, analyze and interpret the information (Department of Education, 2004). Following the publication of the White Paper on e-Education in 2004, many South African schools introduced technology into teaching and learning (DoBE, 2016). However, previous research, for example, Dlamini and Na'Allah (2015) indicate that many schools overlooked teachers' perceptions and the classroom context, providing the technological hardware without proper consultation and the preparation of teachers. Teachers are the agents of what happens in the classroom, therefore, failure to consider their perceptions and prior experience with technology can affect the pedagogical integration of technology negatively (Frost, 2017). The Unified Theory of Acceptance and Use of Technology (UTAUT) suggests that mere access to hardware may not translate to the uptake and effective use of technology in the classroom if teachers do not believe in the potential of technology to improve practices (Venkatesh et al., 2003). Etmer (2005) also regards teachers' pedagogical beliefs as the final frontier in the effort to integrate technology in the classroom. The present study used the UTAUT framework to investigate mathematics teachers' beliefs and behavioural intentions to use technology in their teaching. In this chapter, I engage with the discussion of salient findings that emerged from Chapter Four. The discussion in this chapter is organized around the research questions and the four constructs of the UTAUT model namely, Performance Expectancy, Effort Expectancy, Facilitating Conditions and Social influence.

5.2 Teachers' beliefs, attitudes and behavioural intentions to use ICT tools in mathematics teaching

5.2.1. Performance Expectancy (PE)

The overall findings from data collected using the Likert scale instrument showed that teacher participants believe in the potential of technology to achieve the instructional goals more quickly and to improve the presentation of the teaching materials. Furthermore, they believe technology highly engage learners in the lesson than traditional methods do. These findings from the Likert scale instrument were supported by the findings from the open-ended interview. In the latter, teachers appreciated the use of mathematics applications to engage learners directly with the content, and to accommodate the full range of learners' learning styles; giving them access to a plethora of resources on the topic and allowing them to explore it from different perspectives. Smit and Cronje (2002) argued that a strong belief in the affordances of the tool can lead to the user's adoption of that particular tool. The PE construct of the UTAUT model (Venkatesh et al, 2003) also considers the teacher's belief in the potential of technology as a necessary condition for the teacher to

accept its usage. In the present study, the school participants do not have the ICT policy to enforce the pedagogical use of technology by teachers. However, all participating teachers were observed using technology to achieve various instructional goals. This means that the teachers' PE may be the instrumental force which motivates them to adopt ICT in their teaching.

Reid (2002) cautions that ICT integration is not an easy task but an ongoing process of bridging the gaps between the content and technological knowledge. In the present study, teachers who did not have enough skills in ICT usage were technically limited in their teaching using technology. These findings on the lack of technical skills can be attaribute to the lack of training in the use of ICT in education as also revealed by a study by Becta (2004) that established that although teachers knew that they had to use ICT tools in their classrooms, they lacked confidence due to lack of skills and knowledge. The next section discusses this using the Effort Expectancy theme.

5.2.2. Effort Expectancy (EE)

The EE theme deals with the easiness of ICT usage. The findings from the Likert scale generally indicated that the teacher believed that using ICT was easy. Also in the interviews, most teachers claimed that using ICTs was effortless. The EE construct of the UTAUT model entails that the teacher is likely to adopt technology if he/she has perceived comfort to use it (Venkatesh et al., 2003). In addition to PE, this may also be the reason why teacher participants are using ICTs in their classrooms, although, as the findings in Chapter Four showed, their usage was limited to YouTube videos. Mere use of videos did not result in significant learning gains because the latter did not allow learners to interactively engage with the information. Videos were linear. At the pedagogical level, videos also amplified the traditional role of the teacher, allowing him/her to transmit knowledge in a strictly controlled and structured manner. This lower usage of ICTs possibly impacted learners' learning negatively due to some pedagogical opportunities that were missed. For example, learners could have used iPads to play educational mathematical games on the topic either individually or in group collaboration. Using computer games when learning mathematics brings motivation to both learners and teachers (Whitton, 2007), and collaborations allows learners to interact with each other and learn from one another. It also enriches learners' knowledge and lessens the teacher's work (NCTM, 2017).

It was noted that the teachers like Alice who had challenges working with the ICT tools, had inadequate training in ICT usage. The inadequacy in training leads to the teacher's lack of confidence, thus, reluctant to use ICT for complex teaching and learning tasks (Beggs, 2000). Unwin (2005) observed this in many developing countries, South Africa included. What the current study established also coorrobaotaes with finding from the studies by Dexter (2008); Fullan (2007) (as cited by Wilen 2020) that teachers could not use ICT tool as expected because of lack of training and support.This is also consistent

with findings by Leitwood (2004) whoes study revealed that teachers feared failure in the use of ICT tools due to lack of training. If teachers were provided with the initial training to develop appropriate skills and knowledge, effective ICT integration would follow rather than the mere use of ICT tools (Bectra, 2004). Therefore the lack of training in the pedagogical use of ICT may hinder effective ICT integration in mathematics teaching in the studied schools. Teacher participants may continue to simply use You-tube videos, for tasks that require innovation and creativity.

Furthermore, Bowers and Stephens (2011) assert that if ICT innovation is not clearly understood by teachers, they can be misled to believe that teaching with that particular innovation is effortless. Teacher participants may also not understand what it takes to teach with ICT due to the lack of training in the pedagogical use of ICT, the reason why they claimed that using ICT was effortless. This is also consistent with the findings by Mailiza (2018) in a study in Indonesia where it was observed that Indonesian secondary mathematics teachers' lack of knowledge of both ICT and ICT use might link to the deficiency of training programmes. Wilem (2020) also found out that a large number of Indonesian secondary mathematics teachers are described by Harendita (2013) as digital migrants, widely believed to be less quick to adopt new technologies than digital native and they need more professional development and training concerning ICT and its use in classroom.

5.2.3. Social Influence (SI)

The overall findings from the Likert scale responses on how teachers were influenced by those around them showed that the principal, the school governing body, and their colleagues expect them to teach with ICT tools. Despite this, however, it is left to the teacher's discretion to either use it or not. This was also confirmed through the interview responses. The participants opined that, although the school provided them with ICT devices, it does not follow up to check if teachers use technology in their teaching. This is also consitaent with findings from previous studies ,for instance Pelgrum (2001) and Newhouse (2002) who also established that teachers felt that there was no clear plan from school administration about any changes that takee place , including the introduction and use of ICT tools in the classroom .Similar findings also came from a study by Mailizar (2018) in Indonesia who also revealed that 35% of Indonesian secondary mathematics teachers had never participated in any ICT-related training course This may suggest that the school management gives teachers the agency of leading the ICT integration in their classroom. Research, for example, Prew (2013) indicate that the school management must not only provide the hardware but must also support its usage and make its benefits clear to the teaching staff. This can be done by developing an ICT policy that spells out the vision and the mission of the school towards the use of technology in the school and the guidelines on how teachers are to use technology in their teaching. The teacher participants do not have this kind of school-based social and policy support. This will be further

elaborated on in the next section.

5.2.4 Facilitating Conditions (FC)

The theme of FC focused on teachers' perceptions about the quality of the technical and school support to promote ICT integration in the school. The teachers' responses on a Likert scale generally indicated that they were not happy with the technological facilities that were available.

The teachers' responses revealed that, although some facilities like computer-laboratory, teachers' iPads, and televisions were available, the school does not provide professional development programs (PDP) to develop teachers' pedagogical skills and technological competences in ICT lessons. The majority of teachers opined that the technological pedagogical knowledge they currently have was self-taught. This also corroborates with study findings by Dexter (2008) which indicated that ICT use in schools can be successful when school management sets clear learning goals. These goals can be accomplished with the help of technology as well as putting in place an ICT support system that creates a learning environment in the school to develop teachers' technological skills and ICT-supported pedagogical skills.

The findings also revealed that the school's FC lacked some compatibility. Moore and Benbasat (1991) define compatibility as the extent to which the new technology is perceived as conforming with the potential users' current values, needs, and previous experiences. Notwithstanding the teachers' views about the lack of compatible technological infrastructure, it was noted that they are not optimizing the use of the available technology. In their lessons, the use of technology was limited to YouTube videos yet there are many learner- centered educational mathematics apps they could use to support active learning. Therefore, it may sound pedagogically correct to not provide teachers with additional technology until they are able to optimize the use of the technology which is available.

5.2.5. Behavioral Intentions (BI)

The BI theme explored the extent to which teachers intended to use ICT in their teaching because of its benefits. The overall findings from the Likert scale showed that half the teachers remained neutral about this, a quarter of the teachers had positive behavioral tendencies towards the use of ICT tools in teaching, while the other quarter was motivated to use technology frequently in teaching due to the learning benefits it provide learners. Those who were neutral confirmed in the interviews that they would be willing to use technology frequently if they had access to reliable internet connectivity.

Based on the discussion of the findings from the previous sections s it can be alluded that, if these teachers were taught the various ways of using technology to support learning , their behavioral intentions to use technology would improve. All the participants were convinced that the use of ICT tools in their teaching was important and that they would recommend it to others. This is a social capital the school can capitalize on to promote ICT integration in mathematics teaching.

5.3 Teachers' enactment of ICT beliefs during Lesson observations

In this section the discussion is guided by the second research question where the teachers' beliefs, attitudes and behavioural intentions to use ICT tools enacted in the actual teaching?

5.3.1.Alice Betty and Charlene's enactments

As in Chapter Four, three teachers, Betty, Alice and Charlene used You-tube in their teaching. Alice's lessons used the You-tube videos to explain the concept of time. The video helped her to make the abstract concept of time visual, and to provide learners with different multimodal perspectives from which to explore the topic. Her teaching aligned with her performance expectancy, especially her belief that ICT allows to improve the presentation of the teaching materials and to achieve instructional goals more quickly. The video, together with her mediational role helped to accommodate a variety of learning preferences; and as a result, majority of the learners were able to apply the concept and answered all the questions. Alice actual teaching supports Davis (1993) and Ventakesh and Bala (2008) assertion that the beliefs in the potential of technology to improve practices are likely to lead to the adoption and use of technology.

Furthermore, in Chapter Four, Alice acknowledged that teaching with ICT is not easy. In other words, she expressed the need to be developed in the technological pedagogical knowledge. In the actual teaching, she had difficulties finding where she had saved the video due to the lack of technological knowledge. Ghavifekr and Wan Athirah (2015) attest that the teacher's lack of technological skills may lead to some pedagogical opportunities being missed in the lesson presentation. In the context of the present study, there were iPads for learners. Yet, Alice relied on the video only to teach the concept of time. There could have been more learning gains if she had used educational applications on the topic to engage learners directly with the content and if she had provided opportunities for peer and collaborative learning (NCTM, 2017).

Betty's actual teaching made use of YouTube videos to explain how to convert units of time and the seasons of the year. The technology used helped her to visualise the concepts, it also helped her to play her pedagogical role effectively. She posed the video here and there to elaborate on the explanations from the virtual tutor and to ask questions that helped learners apply the information to everyday context, thus promoting the learners' higher- order learning. For example, after the virtual tutor had explained the attributes of the seasons of the year, Betty asked learners to mention the clothes they put on in each season and to give reasons. This activity helped learners to apply the knowledge from the video to their own life, and therefore to assimilate it. The above aligned with Betty's beliefs in the potential of technology to help achieve instructional goals more quickly. Without technology, it could have been difficult for her to visualise the attributes of the seasons of the year and the major activities that are done in each season.

Important to note in Betty's lessons, as indicated in Chapter Four, being a digital native

gave her familiarity with technology, thus she did not experience any technological challenge in her actual teaching. In addition, despite being a new teacher, she used the technology reasonably in a sound pedagogical manner. She did not rely on the technology alone to explain concepts to learners but provided explanations, and examples, and asked real-life questions to foster higher- order learning. This finding was unexpected as one would expect new teachers to struggle with the effective use of technology in the classroom due to the lack of the classroom experience.

Like the other 2 Charlene also used You-Tube videos to help the learners understand the concept of time elapse which is generally perceived and seen as a hard concept to grasp. This was a good approach because the You-Tube video showed how in the actual life situation time elapse is calculated which enhanced the learners' understanding of the time elapse. In Charlene's class, learners used the school iPads in groups and individually to practice the knowledge taught. This was in line with her espoused belief that ICT tools allow to meet each learners learning needs quickly.

5.3.2. David's enactment

Unlike the other three teacher David did not soley rely on You-tube videos. The salient findings from the observation of David's three lessons showed that technology added more value to his teaching than traditional methods could have done.

In one incidence, David used a virtual tutor to explain the concept of "carrying and borrowing of an hour". Converting time is a hard concept for grade 5 learners, but with the help of the virtual tutor, learners were able to see and grasp how to carry over and how to borrow an hour. It could have been difficult for David to explain in such a way if technology had not been used. Olsson (2009) attests that ICT visualisation enhances understanding of hard concepts. David's ICT usage in this section agrees with his espoused belief that using ICT tools benefits learners' learning.

In another incident, David used a technologically simulated environment to teach time management, which is an important skill learners must develop. Time management is an important life skill. With the help of the virtual environment, the learners became aware of the social activities and emotional expressions amongst the commuters on a busy morning at a bus station. Some commuters were happy for being on time while others were not happy for being late and left behind to get on the next bus. From the verbal and visual expression in the video, not only the learners understood and made connections with the real life situation, but were also reminded of their time management and the choices they make in their daily activities.

5.4. Chapter Summary

In conclusion, this chapter presented the discussion of salient findings that emerged from Chapter Four. The first section of the Chapter organized the discussion of findings around

the first research question “What are the teachers’ beliefs, attitudes and behavioural intentions to use ICT tools in mathematics teaching?”, and the Performance Expectancy, Effort Expectancy, Facilitating Conditions and Social influence constructs of the UTAUT model. The section focused on the findings that emerged from the analysis of the data collected using the questionnaire (Likert scale) and interviews. The section showed that teacher participants believed in the potential of technology to achieve the instructional goals more quickly and to engage learners in the lessons. It also showed that not only does technology help to make abstract concepts alive, but it also accommodates the full range of learners’ learning styles, giving them access to a plethora of resources on the topic and allowing them to explore it from different perspectives. The second section of the Chapter discussed the findings which emerged from lesson observations with a focus on how the teachers’ espoused beliefs were enacted in the actual teaching.

This chapter unveiled some gaps between teachers’ espoused beliefs and their enacted practices in the actual teaching. For example, most teachers believed that teaching with technology was easy, however, during the lesson observations some were uncomfortable using technology to teach the concept of time, and the use of technology amplified traditional teaching. This means there is need to train the participants in the effective use of technology in mathematics lessons, if the use of technology is to add value to teaching and learning. The next section presents the conclusion.

CHAPTER 6: CONCLUSION

6.1. Introduction

In undertaking this study, I aimed at exploring the primary mathematics teachers'disposition towards the use of ICT tools in teaching the concept of time. I sought to address the importance of the mathematics teachers' beliefs, attitude and behaviour (BAB) in ICT mediated lessons. Thus in doing this research, I hoped to have a clear understanding of the teachers' BAB so that appropriate interventions can be recommended. In this concluding chapeter, I provide the summary of my findings from Chapter Four and Five and the discussion of the mathematics teachers' BAB in ICT mediated lessons. I also consider the implications from these findings, the limitations of the study and make recommendations in relation to the teacher professional development based on the findings.

The study was guided by two research questions. The first research question, focused on the teachers' beliefs, attitude and behaviour (BAB) intentions in using ICT tools in mathematics teaching. The second research question explored how the teachers' beliefs, attitudes and behavioral intentions in using ICT tools were enacted in the actual teaching of the concept of time. Data was collected using teachers' questionnaire, lesson observations and audio-tapped interviews. This was then analysed by using the constructs of the UTAUT model namely; PE, EE, SI FC and BI. The answers to these research questions may provide new insight to understand the role the teachers' beliefs, attitudes and behaviour (BAB) play in ICT mediated mathematics lessons. They may also help the policy makers, principals, teachers, and academics in teacher training institutions to make informed decisions when designing and developing teacher training and professional development programs in ICT

6.2. Summary of Findings

With respect to the first research question, findings that emerged from the analysis of the data collected using the questionnaire (Likert scale) and interviews showed that teacher participants believed in the potential of technology to achieve the instructional goals more quickly and to engage learners in the lessons. It furthermore showed that not only does teaching with technology help to make nonconcrete concepts alive, but it also lodges the full range of learners' learning styles, giving them access to a surplus of resources on the topic and allowing them to explore it from different perspectives.

In general, findings indicated that teachers believed that using ICT tools in teaching the concept of time, was easy and effortless although they do not understand the ICT affordances and various ways of using ICT to enhance learner conception. The findings of the study also showed that while the school management gives teachers the agency of leading the ICT integration in their classrooms, it however fails to provide them with proper training in the pedagogical use of ICT in mathematics teaching.

Other findings indicated that teachers were not happy with the technological facilities that were available. It was however noted that, despite their unhappiness they were still not able to optimize the use of the technology which is available because they lacked the desired technological pedagogical knowledge. The school's failure to initiate professional development programs (PDP) in support of ICT integration seems to be contributing to this.

With respect to the second research question, findings which emerged from the lesson observations, with a focus on how the teachers' espoused beliefs were enacted in the actual teaching, showed that using ICT tools did not only motivate the teachers to teach, but also encouraged the learners to learn. This encouraged the learners as both visual and audio learning was enhanced to all learners at the same time. It also helped in achieving the teachers' teaching objectives. The learning gains that emanated from such ICT usage was that learning was enhanced and this enabled the understanding of abstract concepts of the topic Time. Furthermore, the teachers' efforts in the actual teaching were lessened by the virtual tutor. For example, the explanation of the concept of "carrying and borrowing of 1 hour" was computed as 60 minutes. This concept could have been difficult for the teacher to explain in such an easy way without the use of technology. The use of ICT tools reinforced this conceptualisation and facilitated the involvement of all the learners.

It was also found that although the teachers' belief in using ICT tools benefited the learners'learning, there were however some gaps between the teachers' espoused beliefs and their enacted practices in the actual teaching. It was observed that although most teachers believed that teaching with technology was easy, however, during the lesson observations some of them were seen to be uncomfortable when using ICT tools in the teach the concept of time.

It was also found that the teachers lacked the needed skills to effect the pedagogy in the teaching of mathematics with ICT tools, and were erratic using technology. It can therefore be explained that the use of technology just amplified the traditional teaching. This means that there is need to train the participants in the effective use of technology in mathematics lessons, if the use of technology is to add value to teaching and learning.

6.3. Limitations of the Study

The following were the limitations to this study.

Firstly, Given that this study was done conducted in the foundation and intermediate phases, it could have been difficult for some teachers in these phases to find proper online tools to engage the learners with, other than just You-tube videos to present a mathematics lesson and in particular the topic of "time".

Secondly, teachers knew that they were being observed, therefore, they might have changed their behaviours in the actual teaching. For example, the researcher could not

have observed all the enacted espoused beliefs at the time when the teachers were not making an explainable movement or action. To address this, the study used multiple data collection tools for a triangulation purpose.

Thirdly, it was found that although there was a policy for ICT integration, and some teachers were skilful in technology, the teachers were limited in the skills to pedagogically value the use of ICTs in their lessons.

Lastly, with only four teachers involved in the foundation and intermediate phases, the results cannot be generalized to a larger population, unless a bigger study is carried. The results of this study therefore apply to the particular school used for the study only.

It is important to note that although the above reasons have been presented as limitations, they did not, however, have major implications as the focus was on the teachers' beliefs, attitude and behavior in their ICT mediated lessons.

6.4. Implications of the findings of study

The following implications were derived at from the findings of this study.

Firstly, although most teachers believed that teaching with technology was easy, findings showed that during the lesson observations some of the teacher were uncomfortable using technology to teach the concept of time. This implication as the availability of technological devices did not help those teachers to teach, but otherwise amplified traditional teaching.

Secondly, it was noted that despite the teachers' perceived ease of use, they still do not understand the ICT affordances and various ways of using ICT to enhance learner conception. Furthermore, they do not understand that just mere usage of ICTs was not enough to make significant changes to teaching and learning. Furthermore, findings indicated that teachers were also not happy with the technological facilities that were available. In spite of their unhappiness they are still not able to optimize the use of the technology which is available because they lack the desired technological pedagogical knowledge. The school's failure to initiate professional development programs (PDP) in support of ICT integration seems to be contributing to this.

6.5. Recommendations for practice

The use of ICT tools in schools has been of great importance across the globe due to rapid growth of modern technologies. This could be an engine of development, particularly in enhancing technological skills in schools, teachers and all learning institutions. The potential benefits of teachers being skillful in ICT usage have also brought about an increase in the number of schools wanting to use technology in teaching and learning (International Society for Technology in Education, 2011). Therefore, the school principals must support teachers in their endeavor to integrate ICT in mathematics teaching. There must be a provision of a proper training for effective use of technology.

Further more, mathematics teachers especially need to be trained on effective use of ICTs in mathematics and education as well; for instance, an introduction of a course on ICT in education with emphasis on subject integration for teacher educators would be one measure that can be taken. There is need to improve facilitating conditions (FC) and an ICT policy to guide teachers if the use of technology is to add value to teaching and learning. The policy makers and principals should accept an approach to track changes in thinking processes and related teaching practices about educational ICT integration.

6.6. Recommendations for further Research

There is a need for further research to be conducted with an increased number of participants and research sites, including public and private schools. This will provide a more better understanding of the teachers' beliefs, attitudes and behavioural (BAB) intentions to use ICT in mathematics lessons.

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Appendix 1: Survey Questionnaire

Exploring the mathematics teachers' beliefs, attitude and behavioural Intention to use ICT: A case study of four mathematics teachers

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Performance Expectancy					
Using ICT would enable me to achieve the instructional goals more quickly					
Using ICT would help improve the presentation of materials in my lessons					
Using ICT would significantly increase learners' engagement in my lesson					
Overall, I would find using ICT to be advantageous to my teaching					
Effort Expectancy					
Teaching with ICT is easy					
I find my interaction with ICT tools clear and understandable					
I think learning to teach with ICT is easy					
It is easy to prepare a lesson which integrates ICT					
Social Influence					
People who are more important to me would expect me to teach with ICT					
Most people who are important to me would find using ICT in the classroom beneficial					
Most of my colleagues believe using ICT is a wise decision					
I cannot divorce from technology, technology is part of our daily life.					

Facilitating Conditions					
The school has compatible technological infrastructure to support teaching with ICT					
The school has an ICT integration policy					
Onsite support is available					
Ongoing professional development program on ICT integration is available					
Behavioural Intention to use technology					
I will frequently use ICT in my teaching because of its benefits					
I will recommend ICT to other teachers					
I will continue using ICT in my teaching because of its benefits					
Given the chance, I want to use ICT in my teaching					

Appendix 2: Observation Check list

Exploring the mathematics teachers' beliefs, attitude and behavioural Intention to use ICT: A case study of four mathematics teachers

Element of the UTAUT model	Influencing factors	Attributes/ traits	Observation/ comments
Performance Expectancy (PE)	Beliefs	Acceptance	
		Trust	
		Certainty	
	Enthusiasm	Interest	
		Excitement/ passion	
		Desire/ eagerness	
	Motivation	Incentive- tool availability	
		Desire to embrace ICT	
		Drive- determination/ ambition/ initiative	
	Willingness	Readiness/ inclination	
		Preparedness	
Effort Expectancy (EE)	Determination	Will power	
		Purpose	
	Energy	Liveness	
		Vigor	
		Dynamism	
	Exertion	Force	
		Action	
		Application	
	Complexity	Difficult to use	
		Easy to use	
Social Influence (SI)	Image	Social approval- teacher's opinion	
	Attitude	Beliefs/ feelings	
		Behavioral tendencies towards ICT	
		Arrogance	
		Insolence	
		Defiance	
	Perception	Notice	
		Distinction	
		Remark	

Facilitating Conditions (FC)		Settings- place of work	
		Situation- is it appealing?	
		Atmosphere	
		location	

Appendix 3: Interview Schedule

Exploring the mathematics teachers' beliefs, attitude and behavioural Intention to use ICT: A case study of four mathematics teachers.

1. In your teaching with technology, do you find any credibility in the use of ICT tools, and do you acknowledge that ICT tools are valuable in teaching the concept of Time? How certain is that? (In other words can you convince me? Are your sources credible and can they be trusted?
2. How do the ICT tools influence your behaviour towards teaching?
3. Department of Educations teaching with ICT tools contribute to you being enthusiastic in your teaching? What do you think are the advantages of using ICT tools when teaching?
4. How often do you use ICT tools in your teaching? Department of Educations this use come naturally? Is it imposed?
5. How motivated are you to teach with ICT tools? How Department of Educations the use of ICT tool help the learners understand the topic?
6. In your use of ICT tools, could you describe what energises you /or drives you to use the tools? And how determined are you in your continued use of the tool? Why so? To what extent do ICT tools help you achieve your teaching objectives?
7. What challenges do you face when using ICT tools? Now that you have been using it, do you sometimes feel that using ICT tools make your teaching complicated? (Easy to use, access to the internet, mobile, TV, downloading, communication e.g. WhatsApp).
8. What ICT devices do you use for teaching the concept of time? Do you use it in all the topics? What is the difference in learning gains when teaching with ICT tools and when teaching without ICTs?
9. In your use of ICT tools, Department of Educations the technological advancement of ICT push you to use ICT tools as teaching aides?
10. How have you embraced the use of ICT tools in todays' changed times? For example, social media, internet, digital apps, YouTube?
11. How has this impacted on your social standing? In tune with changed times?
12. Department of Educations the environment in which you teach support the use of ICT tools? For example, air play, smart boards …? Why? Do these tools enhance teaching capabilities?
13. Do you ever feel comfortable when using ICT tools? Especially when teaching the concept of "Time?" If so, how?
14. How do you position yourself in terms of beliefs, attitudes and behaviour when using ICT tools?
15. How would you recommend other mathematics teachers to use ICT tools ?
16. Do you have any other information to share with respect to the use of ICT tools in the teaching of the concept of time?