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Research Dissertation

Experiences and perceptions of mathematics teachers with e-lessons: A case study of a secondary school in South Africa

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In Information Systems
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Declaration

I declare that this research report is my own unaided work. It is submitted for the degree of Masters of Information systems the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination to any other University.

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Musonda Martha Chalwe

15th January 2018

Dedication

I dedicate my Masters dissertation to my late younger brother Mwansa Chalwe. He was a pillar of excellence and though the youngest in the family, he was an inspiration to the entire family as well as all around him. Thank you for the great example that you gave us, your ambition and motivation to succeed is an encouragement to me, I am happy to have pursued this journey.

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Abstract

In January 2015, the Gauteng Department of Education (GDE) introduced technology to South African secondary schools in an initiative known as *"The Big Switch On*". The initiative is aimed at improving teaching and learning in South Africa as well as to achieve a level of global competitiveness in South African education. However, existing research in the fields of education and technology has shown that the introduction of technology does not automatically result in improvements in education. Furthermore, following the introduction of technology to South African secondary schools, Mathematics teachers at the blueprint school that was selected by the GDE for this technology in education initiative appeared to be more reluctant than other teachers to adopt technology. Using Engestrom's (1983) Activity Theory as the conceptual framework, this study explored the perceptions and experiences of mathematics teachers with regards to e-lessons through semi-structured interviews. This was in order to better understand whether the envisioned benefits of *"The Big Switch On*" have materialised, to understand the gap in existing research, and possible reasons behind mathematics teachers reported reluctance towards technology. The teachers had various perceptions and experiences of e-lessons, with organisational and peer support emerging as a major influence on teachers perceptions and attitudes. Additionally, it was found that the major teacher concern regarding e-lessons is the misuse of the technology by learners. Lastly, the benefits of technology are task specific and cannot be denoted as a holistic solution to problems in education.Technology is not a panacea for problems in education, or in mathematics. The multifaceted aspects that need to be considered when planning a technology in education initiative need to be considered, and these include, the teacher as an individual and the school as a complex organisation.

Keywords: E-lesson, Technology, Teaching, Mathematics, educational technology, Teacher, *"The Big Switch On"*, ICT, Activity theory, Contradiction, E-learning

Definition of terms

AT-Activity Theory is a descriptive, sociocultural theory that consists of six elements namely: subject, object, tool, rules, community and division of labour (Engestrom, 1987). These elements are interrelated as parts of the activity system. The *subject* carries out a task using the *tool*, in order to achieve an *object* that is the motive of the activity and is restricted by *rules*, affected by the *community* and has different tasks assigned to him/her/them (Engestrom, 1987).

Contradiction is an essential concept in AT that refers to tension between the components in an activity system, as well as clashes in an activity (Engestrom, 2001).

E-lesson is a subset of e-learning. It involves teaching/learning using PowerPoint slides, ebooks, word documents, educational software and videos (Thango, 2016; Sevilla, 2013).

ICT is an acronym for Information Communications Technology which describes technologies that are used for accessing, gathering, manipulating and presenting or communicating information. The technologies could include hardware (e.g. computers and other devices); software applications; and connectivity. For example access to the Internet, local networking infrastructure, and video conferencing all relate to ICT (Toomey, 2001).

Pedagogy can be described as the type of instructional approach used by a teacher and is generally defined as either constructivist/instructivist (Duffy & Jonassen 1992).

Reluctance in an information systems context is defined as non-use or a hesitation to adopt a technology (Tallvid, 2016).

"The Big Switch On" is an initiative of the Gauteng Department of Education. It aims to introduce technology into South African secondary schools in order to improve the current state of education. This initiative is expected to place South Africa in a position to compete globally and to improve the economic development of the country (Gauteng Infrastructure development, 2015).

Table of Contents

List of Figures

List of Tables

Chapter 1: Introduction

Historically, technology has been implemented in various industries, including education, in order to realise specific benefits, such as an increase in productivity or improved living standards (Newhouse, 2002). According to Cuban (1986), technology, mainly in the form of computers, was introduced to schools as far back as the 1960s. More recently, technology within the educational context has come to include the use of: educational software; mobile devices such as tablets, mobile phones, game consoles; Wi-Fi networks to access internet content (Huizenga, Admiraal, Akkerman, and Dam, 2009); and e-lessons, which encompass the use of PowerPoint slides supplemented by learning software and videos (Thango, 2016; Sevilla, 2013).

While technology in education has been introduced across various subject areas (British Educational Communications and Technology Agency, 2003) and has become a dominant trend in education (Chapman, Garret and Mählck, 2004), there appears to be a lack of consensus regarding the introduction of technology into an educational context. Those that advocate educational technology as a beneficial initiative claim that technology use leads to improved academic attainment (Moursand, 2006) and has the potential for substantial benefits such as: improved student engagement (Roden,2011); better efficiency and effectiveness in teaching and learning (Maginnis, White, & Mckenna, 2000); improved tracking of students' progress (Halverson & Smith, 2010); and eliminating distance barriers, thereby allowing access to teaching and learning material from any source (Halverson & Smith, 2010). According to Olaore (2014) and Clark (2002), the benefits accrued from technology in education far outweigh the challenges. With a contradictory view, Campuzano, Dynarski, Agodini, and Rall (2009) in their study on the effectiveness of reading and mathematics software, found that that particular software had no significant impact on reading and varying effects on mathematics. According to Campuzano et. al.,(2009), despite training teachers in the use of the software, some mathematics results were worse after the use of technology. Furthermore, Smith and Hardman (2014) claim that there is no difference between the academic results of schools that use information and communications technology (ICT) and those that don't. These contradictory findings seem to suggest that simply introducing ICT into a learning environment does not unequivocally yield improvements for teachers and learners.

In South Africa, technology has been introduced by the Gauteng Department of Education (GDE) in an initiative referred to as *"*The Big Switch On*"* (Gauteng Department of Education, 2014). In her speech at the programme launch of the second phase of this initiative, Motshekga

(2015), the minister of basic education, stated that the purpose of the initiative was to enhance teaching and learning and to bring South African education to a level of global competitiveness. The goal would be to improve the poor ranking of South African education in global forums such as the World Economic Forum (WEF) and the Trends in International Mathematics and Science Study (TIMSS). Since January 2015, *"*The Big Switch On*"* has been rolled out in seven pilot secondary schools, providing teachers and learners with: Wi-Fi and internet networks; interactive whiteboards; e-books and e-learning solutions; tablets to replace textbooks and chalkboards; and training in e-lessons. (Thango, 2016; Motshekga, 2015). Among the seven pilot schools, one has been identified as a blueprint school on which the rest of the schools in Gauteng will base their e-lesson models (Thango, 2016; Oxford, 2014).

A preliminary interview with the principal of the blueprint school in February 2016, raised the concern that, following the introduction of the new technology, mathematics teachers appeared reluctant to use e-lessons (Thango, 2016). Thango (2016) reports, however, that the teachers from the other subject areas began adopting the technology and making use of e-lessons. The mathematics teachers' reluctance towards using the technology (defined as non-use or a hesitation to adopt a technology) (Tallvid, 2016), has been documented in previous studies and is not a new phenomenon (Huang & Waxman, 1996; Norton, McRobbie & Cooper, 2000).

Despite the apparent reluctance of the mathematics teachers, the positive influence of technology in education appears to be more dominant in mathematics compared to other subjects. It has been postulated that this is due to the fact that mathematics and computer technology have a close connection, as computer science is said to have previously been a branch of mathematics, only becoming a separate discipline at a later stage (Aydin, 2005). Additionally, Jarret (1998) states that the potential benefits of technology in mathematics are being realised because "today's technology offers a bridge from concrete to abstract thinking, enabling students to observe and create multiple representations of mathematical ideas: numerically, graphically, and symbolically" (Jarret, 1998, p.9).

Regardless of the potential benefits of using technology within mathematics education, teacher reluctance to using this technology still exists (Toyama, 2015; Becker & Riel, 2000). This reluctance may be due to a number of reasons relating to the teacher, such as: the shift in teacher pedagogy that may be required to teach with technology (Duffy and Jonassen,1992; Pierce & Ball, 2009); self-efficacy (Ertmer,2005); lack of organisational support and training (Toyama, 2015); and teachers' objectives (Light, 2008). This research study explores these factors, along

with other literature and data showing this reluctance. These factors influencing teacher reluctance towards technology, along with other factors that are revealed in the literature and the data collected, were explored in this research study. Furthermore, as it is not clear whether technology in education is beneficial (Moursand, 2006; Campuzano et. al.,2009), this study explored the perceptions and experiences of mathematics at the blueprint school.

1.1 Research problem

The introduction of technology for teaching and learning by the GDE, is believed to be beneficial for teaching and learning (Cuban, 1986; Higgins, Xiao & Katsipataki, 2012) and is being framed as one of the ways in which the state of education in South Africa will be enhanced and brought to a level of global competitiveness (Motshekga, 2015). However, it seems that the use of ICT is not a panacea for an improved state of education, and simply introducing e-lessons into schools as a means of improving education may not produce the envisioned benefits (Campuzano et al., 2009; Smith & Hardman, 2014). Despite the introduction of technology across various subject areas, not all teachers adopt technology into their teaching (Becker & Riel, 2000; Toyama, 2015). Furthermore, mathematics teachers, in particular, were identified as being reluctant to use technology for teaching, in the form of e-lessons at the blueprint school selected by the GDE (Thango, 2016). Reasons for this reluctance appeared to stem from contradictions between the technological innovation and a number of factors relating to the teacher (Light, 2008, Toyama, 2015, Ertmer, 2005).

The research problem for this study is, therefore, technology is believed to be beneficial in improving the state of education in South Africa. However, technology is not necessarily a panacea for problems in education, and furthermore, mathematics teachers are somewhat reluctant to using technology to teach.

This is a multifaceted problem and was explored through the teachers' experiences and perceptions of using technology for teaching mathematics.

1.2 Aim of the study

The intention of this research is to explore and understand mathematics teachers' perceptions of, and experiences with, e-lessons. This exploration should possibly provide insights into the reasons for mathematics teachers' reported reluctance towards technology, the reasons for the disparities in existing research relating to technology in education, as well as whether there have been any benefits or drawbacks relating to the introduction of technology in education.

1.3 Objectives of the study

- To understand teachers' experiences and perceptions of conducting a mathematics e-lesson.
- To compare conducting an e-lesson to traditional teaching methods in order to understand the reasons for teacher reluctance towards e-lessons.
- To explore the teachers' perceived benefits and drawbacks of conducting e-lessons.

1.4 Research Question

Given the background on the formal introduction of technology in South African secondary schools (including the reported reluctance of mathematics teachers to use e-lessons; the dominant effect of technology on mathematics; and the tension in previous research in relation to technology in education), the primary research question for this study is:

What are the perceptions and experiences of mathematics teachers in relation to e-lessons?

In order to answer the primary research question, the following sub-questions were addressed:

1.4.1. What attributes of conducting a mathematics e-lesson influence teachers ' attitudes towards, and perceptions of, an e-lesson?

1.4.2 How does conducting a traditional mathematics lesson compare to conducting an e-lesson?

1.4.3 What are the perceived benefits or drawbacks of an e-lesson, based on the interaction between the mathematics teachers, the technology used, the classroom rules, the school, other teachers and different duties in the classroom?

1.5 Delimitations of the study

As this study was aimed at understanding mathematics teachers' perceptions of, and experiences with e-lessons, a school that has implemented e-lessons was explored in the research study as opposed to a non-technology-enabled school. The school that was chosen for the research study has been using e-lessons since January 2015. Furthermore, mathematics teachers from the selected secondary school were reported as being reluctant to use e-lessons initially, therefore this research focussed on the mathematics teachers of the school and not learners or teachers from other subject areas.

1.6 Summary

Chapter 1 highlights that the DBE has introduced technology to secondary schools in Gauteng, with the aim to improve the state of education. It is found that technology may not be the

unequivocal solution to problems in education, based on previous research. Furthermore, the mathematics teachers from the blueprint school selected by the DBE, are reported to be more reluctant to adopt technology than others, therefore mathematics teachers are explored in order to address this research problem. The literature review in Chapter 2 covers previous research that addresses these main points.

Chapter 2: Literature Review and Conceptual Framework

In view of the introduction and the research questions, and in order to develop a conceptual framework for this study, relevant literature was reviewed. Firstly, a general overview of technology use in education is explored with a focus on e-lessons, followed by a review of technology use in South African education with a focus on *"*The Big Switch On*"* initiative. Furthermore, the reasons for the tension in existing technology in education literature are explored, then technology use specifically in mathematics is presented. Thereafter, a review on possible reasons for teacher reluctance towards technology will be presented. Finally, based on the literature presented and on reviews of conceptual frameworks used in both Information Systems literature and in Psychology, a conceptual framework is presented in order to develop the conceptual lens for this study.

2.1 Technology in Education

The transformative power of technology in the workplace, the home and in communication and commercial activities, has brought about the desire for comparable changes within schools, with policymakers and other community groups looking to technology as the tool to improve education (Means and Olson, 1995). Chapman, Garret, and Mählck, (2004) claim that the use of ICT as a medium of instruction in education is becoming a dominant trend. Earlier forms of technology in education included radio, interactive radio, and instructional television, and focussed on direct instruction, while more recent forms of educational technology have incorporated the internet in order to facilitate communication and access to more resources by users (Chapman, Garret, and Mählck, 2004).

Different terms have been coined to describe technology in education, these include: *e-learning* (Cross & Cross, 2002), *computer-based training* (CBT) (Cross & Cross, 2002), *e-lessons* (Sevilla, 2003), *mobile learning or m-learning* (Crompton, 2013), *online distance Learning* (ODL) (Kaplan & Haenlein, 2016), and *massive online open course* (MOOC) (Kaplan & Haenlein, 2016). No matter the label, all of these incorporate the use of technology for teaching and learning, either over the internet or the direct use of educational software through mobile devices such as tablets (Chapman, Garret, and Mählck, 2004), smartphones and laptops (Mehdipour & Zerehkafi, 2013). As e-lessons are the focus of this research study, they are examined in detail below.

2.1.1 E-lessons

While various definitions have emerged over the years, an e-lesson can be broadly categorised under the title of e-learning (Cross & Cross, 2002). Barodiya, Kushwah, and Kaurav (2016) state that while in the past e-learning was delivered using a blend of computer-based methods like CD-ROM, today e-learning is primarily delivered over the internet. E-learning allows learners and teachers to go through the process of learning about technology, learning with technology and learning through technology (Department of Basic Education, 2004). Clark (2002) claims that the different media used for e-learning is not what is crucial, but rather that the focus is on e-learning being a set of content and instructional methods delivered using a computer (whether CD-ROM, a tablet, the internet, or an intranet) designed to build knowledge and skills related to individual or organizational goals. In contrast, Kozma (1994) states that the medium of instruction is as important as the content. For example, the use of live instruction while incorporating technology, compared to solely online instruction or not using technology at all, may influence learning. The "Clark-Kozma debate" (Becker, 2010; Marx 2006; Nathan & Robinson, 2001), as it is commonly referred to, was addressed in certain aspects of this research study as the different sections of an e-lesson that combine different media (Sevilla,2013) were analysed and explored.

Sevilla (2011) states that an e-lesson involves the use of presentation software to teach, namely: videos; learning management systems; educational software; and online education systems. E-lessons are comprised of the following sections: presentation; objectives; necessary knowledge; learning tasks; practice; and conclusion (Alonso, López, Manrique, and Viñes, 2005). These can be presented in different media, such as: tablets; laptops; mobile phones; and CD-Roms (Sevilla, 2013). According to Alonso et. al., (2005) the sections of an e-lesson can be further divided into either content or context category.

The content category includes the necessary knowledge that the teachers want to impart; the steps required to perform the task being learnt in the e-lesson, and the tasks themselves. The context category consists of: the presentation, which provides guidance to learners about the knowledge they are going acquire; the objectives, which describe what the learners are expected to know after the e-lesson; practice, which allows learners to do class exercises and facilitates group discussions; and the conclusion, which is a summary of the entire e-lesson and allows the learners to go over all the material that has been covered in the e-lesson (Alonso et al., 2005). In addition, Clark (2002) states that an e-lesson can be divided into three sections:

instructional method; instructional media; and media elements. The instructional method of the e-lesson is described as the techniques used to allow the learner to process information and learn, such as practice exercises and simulations (Clark, 2002). The instructional media refers to the method of instruction such as computers, workbooks, and even the instructor. Lastly, the media elements are defined as the text, graphics, and audio used to present the content (Clark, 2002).

These categories, identified by Alonso et al. (2005) and Clarke (2002), are interchangeable in that the context category identified by Alonso et al., (2005) consists of what makes up both the instructional method and instructional media categories defined by Clark, (2002), while the content category relates to the instructional method elements defined by Clark (2002). The different components of an e-lesson were explored in this research study and related to teacher goals and attitudes for further insight on teacher experiences and perceptions on e-lessons.

Those who are advocates of the use of e-lessons state that e-lessons are not only a useful teaching tool (Nguyen, Nguyen, and Hunger, 2006) but are actually superior to the traditional way of teaching as they allow for: improved student engagement and attitudes (Koedinger, 1997, Roden, 2011); better efficiency and effectiveness in teaching and learning (Maginnis, White, & Mckenna, 2000); improved tracking of students' progress (Halverson & Smith, 2010); the elimination of the distance barriers; access to teaching and learning material from anywhere (Halverson & Smith, 2010). Clark (2002) disagrees with the claims of the technology advocates, arguing that the projected positive impact of using e-lessons to improve education has not lived up to expectations as there have been no significant differences in educational outcomes as a result of using e-lessons (Drijvers, Ball, Barzel, Heid, Cao and Maschietto, 2016; Hardman, 2015; Oppenheimer, 1997).

Technology has gradually been introduced into education in different forms over the years, with e-lessons being one form of this technology. There is a well-known and long-standing debate on whether the media being used has any influence on the process of learning; commonly denoted as the "Kozma-Clark" debate.

The review of the current literature revealed that e-lessons are not able to unequivocally improve teaching and learning. With the recent introduction of technology into education in South African secondary schools, the problem space that was identified in this research study is explored in the local context in the section to follow.

2.2 Technology in South African Education

Technology for educational purposes is believed to have the potential to overcome spatial and fiscal barriers as well as capacity related constraints that currently exist in low to medium income countries (Department of Education [DoE], 2004). The Department of Education (2004) cited potential benefits of technology use in education as: increased learning opportunities; improvement in the quality of teaching and learning; and the redress of the existing inequalities in education. The DoE has set out to ensure that the benefits that can be provided by technology in education are reaped by all, by implementing measures and benchmarks on factors such as the number of e-schools and their level of e-readiness; the number of teachers trained at various levels of ICT proficiency; the type of content available to learners; the ratio of learners to computers; the range of technologies used in classrooms; and the internet connectivity available (DoE, 2004). In order to facilitate the adoption of technology by teachers, the DoE has been providing teachers with professional development and training specific to using technology for teaching, as well as assigning to schools ICT "champions" whose roles are to facilitate the use of ICT (DoE, 2004).

The prominence of ICT infrastructure in South Africa has been found to be highest in the Western Cape, Gauteng, and Northern Cape provinces. "The Big Switch On" initiative, which was rolled out (DoE, 2004) in Gauteng, presents an opportunity to better understand the experiences of teachers in relation to technology use. According to the minister of Basic Education, Motshekga (2015) *"*The Big Switch On*"* which was piloted in 7 schools in January 2015, "stands on six pillars, namely: connectivity; devices; e-Learning content; training and development (teachers and learners); support, security and maintenance; refurbishment and renovation" (Motshekga, 2015 p.1). Going digital consists of providing tablets to students, and Wi-Fi to schools for internet access, thus enabling learners to have access to learning material, workbooks, and other subject matter through the use of ICT (The presidency, 2015).

This initiative, championed by the GDE, was aimed at enabling improvement in the South African educational system where the system is lacking and to advance the education to a level of global competitiveness (Motshekga, 2015; Baloyi, 2015; the presidency, 2015; Thango, 2016). According to Motshekga (2015) *"*The Big Switch On*"* aims to have all public South African schools digital by the end of 2018. "Exposure to ICT allows learners to develop skills that will give them an edge in an ever-increasingly technology-saturated work environment" (Motshekga, 2015, p.1). "The Big Switch On*"* aims to enable learners to become more independent and self-directed by constructing their own knowledge, using the internet for

example (Motshekga, 2015). In the pilot schools that were selected for "The Big Switch On" students each have a tablet on which they access classroom content with a Wi-Fi connection available around the school, allowing both the student and teacher access to online educational content (UC Wireless, 2015; Motshekga, 2015).This type of pedagogic approach, claims Motshekga (2015), is in sync with the work ethic highly valued in today's global workforce.

Notwithstanding the aims and positive vision of this initiative, challenges have arisen since the start of "The Big Switch On". These challenges include crime and the lack of training. The tablets that students are using have attracted the unwanted attention of criminals and some schools do not have adequately trained teachers, resulting in the technology not being utilised (Oxford, 2013). It seems, based on a preliminary interview with the principal at the blueprint school, (Thango, 2016) that there was a lack of utilisation of the technology, especially amongst mathematics teachers who appear to be the most reluctant in making use of e-lessons for teaching (Thango, 2016).

The relationship between technology and mathematics is explored for further insight on what characteristics of mathematics may differentiate it from other subjects in relation to technology.

2.3 Technology in Mathematics Education

A number of different forms of technology that can be accessed on a computer or hand-held devices have been introduced specifically for mathematics. These include, Mathematics Analysis Software; scientific calculators; function graphics; Computer Algebra Systems (CAS); lists and spreadsheets; geometry and statistical packages (Pierce and Ball, 2009). These tools are the types of software that may form part of an e-lesson (Sevilla, 2016). The visualisation provided by technology, claims Connors (1997), empowers students and enables them to create their own understanding of mathematical concepts; facilitates easier graph interpretation (Hennesy, 2000); and encourages collaboration between students (Hudson, 1997).

Despite the different claims that the use of technology within mathematics education has the ability to improve teaching and learning, Drijvers et al., (2016) argue that "although technology can make the learning of particular mathematical content more easily accessible, it can also make that learning problematic" (p.8). Oppenheimer, (1997) proposes that a possible reason for this may be that using technology in mathematics minimises the view of a real world while emphasising the virtual world where students do not interact with real objects.

In a South African study named the "Khanya project", Smith and Hardman (2014) intended to understand the underlying reasons for the poor mathematics performance at high schools in the Western Cape of South Africa. The project was premised on the assumption that this poor performance was caused by a low capacity of teachers. Therefore, computers and software were introduced to some schools to combat the problem of low teacher capacity. However, when Smith and Hardman (2014) compared mathematics results of the schools that had been using the computers and software, and the schools that hadn't, there was no significant difference between the two groups. The technology did not provide a solution to the problem of the low capacity of teachers despite the assumption that it would. A possible explanation for this finding is that the role of technology serves to amplify and not minimise one's actual capacity or deficits, and therefore simply implementing technology will not provide the solution to existing problems (Toyama, 2015). In agreement, Roden (2011) adds that it is the appropriate use of technology that may yield benefits and not simply the use of technology in any way or form.

It is evident that accruing benefits from technology use within education appear to not be infallible and therefore the underlying reasons for these contradictory views are explored in the section to follow.

2.4 Disparities in previous research

There are various reasons cited as to why tensions in previous literature exist, with these reasons being attributed to the suggestion that "schools are complex social organizations situated within, and vitally affected by, other complex social systems including families, communities, and professional and regulatory agencies" (Cohen and Ball, 1999, p.1). Possible reasons that may account for these disparities in existing literature on technology within education, may be attributed to the following: focussing on the technology alone and not on the manner in which the technology is used (Costabile, De Marsico, Lanzilotti, Plantamura, and Roselli, 2005) ; teachers' pedagogical contexts (Light, 2008); the goals and strategies which need to be articulated by teachers and communities (Kay & Knaack, 2008); the commitment of the organisation where technology is being introduced (Toyama,2015); and teacher concerns (Karasavvidis, 2009; Njenga & Fourie, 2010; Lam & Tong,2012).

Toyama (2015) argues that, in order to determine whether a technology is beneficial or not, the human context must be considered. Similarly, according to Karasavvidis (2009), teacher concerns need to be addressed in order for any technology innovation in education to be viable. Njenga and Fourie (2010) also concur, adding that the individual teachers' characteristics should

be considered when implementing e-learning. This presents a consensus that teachers need to be considered when exploring technology in education. The reasons for tensions in existing research that have been identified are expanded below.

Firstly, a teacher's *social environment or external influences*, can shape his or her actions and may greatly complicate endeavours to bring about improvement to the school (Cohen and Ball, 1999). These include families, communities and professional and regulatory agencies. Secondly, *Pedagogic contexts* can be described as the type of instructional approach that the teacher uses and is usually defined as either constructivist or instructivist (Duffy & Jonassen, 1992). The instructivist approach, according to Duffy and Jonassen (1992), is focussed mainly on presentation, memorisation, and recall of content alone. This approach is often described as teacher-centered, as the teacher decides on content, assignments, and assessments and directs the learning by presenting lectures and directing classroom activities and then questioning the students (Sparks, Thomas, Jackson & Alexander 2012). At the other end of the spectrum lies the constructivist perspective which claims that knowledge and skill develop only in situations in which learners have meaningful experiences (Dewey, 1938). Constructivist teaching is mainly characterised by "class-wide or small group discussions, reciprocal questioning, and self-assessment" (Sparks, et al., 2012, p.4). Thirdly, *teachers' goals and strategies* can be explained as being the objectives of the teacher and community, specifically what each intends to achieve when using the technology and how they use it (Kay & Knaack, 2008). These goals and strategies need to be articulated in order to avoid new technology taking them into a direction that they are uncomfortable with (Postman, 2000). Furthermore, the support or *commitment of the organisation (school)* to using technology refers to whether a support structure has been put in place by the school to allow the users of the technology to use it confidently; this could be through training, technical facilitators, and continuous support (Toyama, 2015). Organisational commitment has been highlighted in previous studies where it was found that attitudes are more positive, and technology implementations are more successful, at institutions that provide support to their teachers and learners (Cope& Ward, 2002; Toyama, 2015; Dahlstrom, 2015). For example, Farivar, (2014) found that lack of support for technological issues led to the failure of education technology initiatives previously. Additionally, *teacher concerns* can be described as the obstacles that teachers believe are related to using technology in their practice (Karasavvidis, 2009; Lam & Tong, 2012). For example, a teacher concern towards e-lessons reported by Schwartz (2003) is that teachers can get very frustrated with learners misusing the technology by searching for non-educational

websites on their tablets while in class, or learner negligence reported by Ali (2012) where a school policy had to be devised for learners charging their tablets. Lastly, *teacher characteristics* encompass pedagogic context, their objectives and teacher concerns, which include the desire and ability to use the technology and to take advantage of it (Toyama, 2015).

Due to the apparent ambiguities in existing research regarding technology in education, this section of the literature review explored the various reasons that may account for these contradictions. The main reason that encompasses all the various reasons is that schools are complex and therefore a number of different factors need to be considered in order for the phenomenon of technology in education to be studied. As this section identified and expanded on the various aspects of technology in education that need to be studied, the next section expands on the various reasons that relate specifically to teacher reluctance towards technology use.

2.5 Teacher reluctance to technology use

The *adaptability* of a teaching technology refers to how well it can be integrated into the usual activities, rather than being used as an add-on (Cohen, 1988; Vila-Rosado, Esponda-Argüero, Rojas, Díaz-Martín, 2016). Technology can either be adapted to traditional teaching styles (if it is indeed adaptable), or it is discarded completely (Cohen 1988; Vila-Rosado, Esponda-Argüero, Rojas, Díaz-Martín, 2016). Despite the introduction of technology to schools, Mundy, Kupczynski, and Kee (2012) assert that the majority of teachers that are introduced to technology only use it for administrative functions and not pedagogical ones.

Further reasons behind teachers' reluctance towards using technology in teaching have been identified and these include teachers with less experience of, or no training in, the use of technology in the classroom being less likely to use the technology (Cope & Ward, 2002). In addition, Herrington, Herrington, Hoban, and Reid (2009) state that teachers are reluctant to use technology due to reasons such as: lack of time; key facilitators leaving the school; different skills of teachers; lack of infrastructure to encourage the use of the technology; and lack of ongoing professional development. Expanding on the reasons identified by Herrington, Herrington, Hoban and Reid (2009):

- *lack of time* is described as teachers not being allocated enough time to learn how to use the technology for their teaching;
- *key facilitators* are described as individuals providing focus and direction for the teachers regarding the use of technology;
- *different skills* of the teachers refers to teacher proficiency with technology;

- *lack of infrastructure* refers to a support structure available for the teachers to ensure that technology use is trouble free;
- *ongoing professional development* refers to formal courses/training made available to the teachers to improve their computer literacy and proficiency (Herrington, Herrington, Hoban & Reid, 2009).

Additionally, teachers may need to learn how to teach with technology, as the use of technology in the classroom tends to favour a constructivist pedagogy (Pierce & Ball, 2009). These factors can be summarised as follows: factors related to training and professional development (Cope & Ward, 2002); factors related to organisational support, such as key facilitators and support from the school (Cope & Ward, 2002); factors related to the technology directly, for example adaptability and infrastructure (Cohen, 1988); and factors related to individual teachers, such as time and skill (Herrington, Herrington, Hoban & Reid 2009). These factors seem to collectively influence teacher reluctance and consequently act as barriers to technology use.

With the various reasons behind teacher reluctance to use technology, Ertmer (2005) suggests that in order to change teachers negative perceptions about technology, aspects such as self-efficacy should be considered (Bandura, 1997). By enabling teachers to learn how to use the technology they will believe in their own abilities and will, therefore, be more likely to use it (Paraskeva, Bouta, & Papagianni, 2008; Teo, 2009). However, it should also be noted that enhanced self-efficacy does not guarantee the actual use of technology as there are other aspects of the teacher to be considered (Wang, Ertmer, & Newby, 2004) Another aspect to be considered is the successful experience of others. Zhao and Cziko, (2001) state that if the teachers observe their peers or a simulation of the education in technology model being used successfully, they are more likely to use it as well. Finally, the social and cultural aspects should be considered. If the other teachers, the school administrators and school community in general, have a positive attitude towards the introduction of technology, then the teacher may be influenced to use technology as well (Becker & Riel,1999).

In addition, Bixler and Spotts (2000) claim that the use of technology in education is essentially a new way to teach and learn, therefore the adoption of technology for teaching and learning requires teachers to change their pedagogic practice (Pierce & Ball, 2009). With this change in pedagogic practice teachers find that their role with technology is less teacher centred and more learner centred. They lean towards a facilitator role through increased interaction with the

learners, such as walking around the classroom (Newlin &Wang, 2002; Jonassen, Peck & Wilson, 1999;Sankar & Karri, 2016), while the learner takes a more active role and is more than just a recipient of information, making their own choices on how to retrieve, manipulate or generate information (Sankar & Karri, 2016). Ilomäki and Rantanen, (2007) add that the classroom that integrates technology encourages fewer rules and is more free, as is the relationship between learners and teachers. In contrast Lim, Teo, Wong, Khine, Chai, and Divaharan,(2003), report that in a technology integrated classroom there are additional rules and procedures to be established due to the inclusion of computers, printers, monitors, CD-ROMs, and other technology resources. The combination of the elements described above seem to contribute to teacher reluctance to use technology and are in agreement with studies that have concluded that technology use does not necessarily bring about a change in the science of teaching as teachers are individuals and therefore each experience with technology will differ (Fullan, 2001; Niederhauser, 2001; Stoddart and Niederhauser, 1993; Van Dusen & Worthen, 1995).

In the South African context, the Department of Education has introduced some initiatives to attempt to combat teacher reluctance to use technology. These include: the introduction of facilitators to assist teachers with the use of technology; teacher development training programs; incentives for teachers to integrate technology into their daily practices; the promotion of computer use amongst teachers in their personal lives.

Despite teacher reluctance to use technology, Al-Quatani and Higgins, (2003) claim that ICT can aid teachers and learners by creating an "ideal" learning environment (Newhouse, 2002; Marshall, 2002). Al-Ammary (2012) concurs that not only does the introduction of technology enhance teaching and learning, but it also improves academic achievement. However, as previously stated, there are apparent tensions in existing studies regarding the notion that technology is of benefit to teaching and learning and not all studies are in agreement with this (Smith & Hardman, 2013; Campuzano et. al., 2009; Clark,2002). This implies that there is a need for further exploration in this subject area and thus both teacher reluctance, and whether the envisioned benefits of technology are being realised by mathematics teachers, were explored in this research study.

2.6 Summary of literature

The literature review initially explores technology in education and the different forms that have been introduced over the years. It goes on to explore e-lessons specifically, highlighting that they can be categorised under e-learning and divided into two categories; content and context. Secondly, the introduction of technology in education in South Africa was explored with *"*The Big Switch On*"* being described and the use of e-learning, and e-lessons in secondary schools being highlighted as part of this initiative as a way of increasing South Africa's global competitiveness. The reasons why the tension in existing research may exist are identified, with reasons including the fact that schools are complex, goals and objectives of using the technology need to be set and that teacher concerns and characteristics need to be addressed rather than solely focussing on the technology that has been introduced. Technology in mathematics is then explored, highlighting the tension in existing research, regarding whether technology use for mathematics is beneficial for teaching and learning. Lastly, the impact of technology on teachers is explored with the main influential factors identified being: teacher objectives; teacher self-efficacy with technology; influences from other teachers; the general attitude of teachers and the school towards technology; the teacher's pedagogic practice; and the shift/change that occurs when moving from traditional teaching to teaching with technology. Therefore, the literature reviewed highlights the fact that there is a growing trend involving the introduction of technology to education, and regardless of this trend, the envisioned benefits for a technology-in-education-initiative may or may not be realised, as schools are complex organisations. It follows that teacher reluctance to technology is an additional issue, therefore certain factors relating to the teacher and the technology need to be explored in order to better understand the technology-in-education phenomenon.

2.7 Conceptual Framework

According to Miles and Huberman (1994), the conceptual framework describes "graphically or in narrative form the main things to be studied and the presumed relationships between them" (p.18). Based on the disparities found in existing research and the reasons for teacher reluctance to using technology identified in the literature review, the key elements that were acknowledged when exploring technology in education were around the human context, specifically teachers and the multiple factors that are associated with them, including their peers and the organisation, as well as the teachers' experiences and attitudes towards the technology implemented (Solas, 1992; Peters, 2010; Di Blas & Paolini, 2013; Toyama, 2015; Light, 2008).

Therefore, this research study made use of the following definitions and relationships for these key elements:

- **Teacher** - A teacher is responsible for the classroom and within this duty it is essential to consider the various factors affecting their use of the technology. These factors include: the teacher's attitude (Becker & Riel, 1999); teaching goals (Kay & Knaack, 2008); self-efficacy (Ertmer, 2005); pedagogic context (Duffy & Jonassen, 1992); shift in pedagogic practice, which affects the role of the teacher (Fishman, 2006; Pierce and Ball; 2009); teacher concerns (Karasavvidis, 2009); training (Cope & Ward, 2002); experience (Cope & Ward, 2002); time (Herrington, Herrington, Hoban & Reid 2009); skills (Herrington, Herrington, Hoban & Reid, 2009); and influences from other teachers and the school (Ertmer, 2005; Zhao & Cziko, 2001).
- **Technology** - Technology has been a growing trend and has been introduced to enhance teaching and learning in the form of hardware, software or a combination of both (Chapman, Garret & Mählck, 2004). It is used by teachers in their pedagogic practice if it can easily be adapted to their pedagogy, otherwise, it is discarded completely (Cohen, 1988). There are contradictory views as to whether or not technology is beneficial for education (Clark, 2002; Kozma, 1994).
- **E-lesson** - An e-lesson is a class conducted while making use of technology, with software such as PowerPoint slides, video instruction, and hardware such as tablet technology (Sevilla, 2013). It can consist of different components, namely, a content section and a context section (Clark, 2002; Alonso et al, 2005).
- **Community -** The teacher's surroundings may influence his or her actions or attitude towards conducting an e-lesson. These surroundings include the school, other teachers at the school, external regulatory agencies, and the learners' parents (family) (Cohen & Ball, 1999; Toyama, 2015).

The four elements described above, and the relationships between them from a teacher's perspective, were explored in order to address the research question:

What are the perceptions and experiences of mathematics teachers in relation to e-lessons?

In order to address the research question, it was necessary to select a framework upon which the study could be based. The criteria used to select a conceptual framework to underpin the

proposed study were: relevance to the field of Information Systems (IS); and the suitability of the framework for providing an answer to the research question (Maxwell, 2005). Five frameworks were considered and are explored below:

2.7.1 Technology Acceptance Model (TAM)

TAM, originally developed by Davis (1989), states that behavioural intention, attitude, Perceived Ease of Use (PEOU) and perceived usefulness (PU) determines whether or not an individual will use a specific technology. Additionally, TAM suggests to answer the question of why users adopt a certain technology (Davis, 1989). Therefore, PEOU and PU are potential factors that affect the reluctance of mathematics teachers towards using e-lessons and could further be explored for the purpose of the proposed study.

2.7.1.1 TAM in qualitative educational technology studies

Several studies have examined TAM as a model to explain how people adopt and use e-learning. Selim (2003) used TAM to evaluate web-based learning, while Cheung and Chen (2005), explored internet-based learning with a focus on the motivation of students when using it.

A critique of TAM, according to Agarwal and Prasad (2011), is that it does not account for individual differences, while Wolski and Jackson (2011) claim that it does not explore the intricacies that would be specific to an educational context, such as, how the influence of technology changes relationships between students and teachers. Therefore TAM seems unsuitable, as the proposed study aims to describe the process of using e-lessons for teaching from a teacher's perspective while taking factors such as the relationship with students into consideration. Thus PEOU and PU would be insufficient, as the goal of this research study was not to solely address adoption of e-lessons.

2.7.2 Unified Theory of Acceptance and Use of Technology (UTAUT)

UTAUT is a combination of eight adoption theories, which include: Technology Acceptance model (TAM) (Davis 1989); combined TAM and TPB (C-TAM-TPB) Taylor and Todd (1995); Motivational Model (MM) Davis, Bargozzi and Warshaw (1992); Theory of Planned Behaviour (TPB) Ajzen (1991); Theory of Reasoned Action (TRA) (Fishbein and Ajzen 1975); Model of PC Utilization (MPCU)Thompson, Higgins, and Howell (1991); Innovation Diffusion Theory (IDT) Rogers (1995); and Social Cognitive Theory (SCT) Bandura (1986). UTAUT suggests that four core elements are direct determinants of technology acceptance and use: Performance Expectancy; Effort Expectancy; Social Influence; and Facilitating Conditions. The theory also suggests that the effect of these four elements is moderated by four factors: age; gender;

experience; and voluntariness of use (Venkatesh, 2000). UTAUT was considered because it not only highlights adoption and use like TAM, but combines elements from eight other technology adoption models (Venkatesh, 2000).

2.7.2.1 UTAUT in qualitative educational technology studies

Birsch and Irvine (2009) studied teachers' acceptance of technology in the classroom using UTAUT, with the study resulting in effort expectancy being the only influence on teachers' intentions to use the technology. Akbar (2013) claims that because teachers viewed technology as difficult to use, their intention to use was deterred. Gogus and Nistor (2012), also using UTUAT, studied educational technology acceptance and concluded that computer literacy is closely tied to acceptance and use of technology.

The critique of this theory is that external aspects, such as policy and environment, are not taken into account in this model (Waehama, McGrath, Korthaus & Fong, 2014). For this research study the environment and policy cannot be excluded as these may richly add to the answering of the research question, as it has been identified in the literature that the organisation (including its policies) and the teacher's peers (environment) (Becker & Riel,1999; Zhao & Cziko, 2001) may have an impact on teacher use or non-use of technology.

2.7.3 Khans E-learning framework

Khan's e-learning framework (Khan, 1997) is a self-assessment tool for institutions to evaluate the educational technology that they are using or would like to use. It consists of eight dimensions: technological; pedagogical; interface design evaluation of all the stakeholders that will be using the online education system; management; ethical issues such as plagiarism; student diversity; and institutional. The framework suggests that you keep the learner at the centre and ask these questions from each dimension as you design the e-learning software. This framework was considered as it directly addresses the e-learning context and the assessment tools may be used to evaluate the e-lessons being used at the school that was selected for this case study and from a teacher's experience.

2.7.3.1 Khans E-learning Framework in Qualitative educational technology studies

Abu-Shanab and Harb (2011) utilised Khan's framework to explore the use of e-learning in universities. They used two dimensions of the framework to assess the university's Blackboard learning systems; the pedagogical aspects and the interface design. Bashiruddin, Basit, and Naeem (2010) used the framework to study the barriers of e-learning implementations, using all eight dimensions to assess the barriers. A critique of this framework is that it does not take

cultural factors into account (Al-Huwail, Al-Sharhan &Al-Hunaiyyan, 2007). In addition, this framework is learner-centred (Khan, 1997) which does not suit the focus of this research study, which is to focus on the teacher.

2.7.4 Task-Technology Fit (TTF)

According to Goodhue and Thompson (1995), Task Technology Fit is the "degree to which a technology assists an individual in performing his or her portfolio of tasks" (p.216).
The TTF has been modified since its inception, with additional elements being added (Goodhue & Thompson, 1995; Cane & McCarthy, 2009) However, the generic version of TTF consists of five elements: task characteristics; technology characteristics; task-technology fit;and utilisation and performance impacts. TTF was considered due to the aspect that teachers' experiences with e-lessons could be assessed from a fit perspective.

2.7.4.1 Task-Technology Fit in Qualitative educational technology studies

McCarthy and McCarthy (2014) studied the perceptions of students on social media as a course tool and assessed the task-technology fit, finding that social media was fit for business courses at a university level. D'ambra, Wilson, and Akter (2013) also used TTF to explore the adoption of e-books by academics. Lastly, Sun and Wang (2014) assessed the task-technology fit of e-learning for different tasks, finding that the effectiveness of online learning by students depends on the alignment of the technology with the student needs.

TTF does not consider organisational aspects that may influence the user, despite their perceptions of the technology (Lin, Hung & Chen 2009). For example, organisational culture might be against change or the use of technology (Lin, Hung & Chen 2009) and this would affect an individual's utilisation of a technology tool. The organisational aspect is one of the factors that was being explored in this research study, therefore TTF would not be a suitable theory.

2.8 Conceptual Framework underpinning research Study

Based on the descriptions, critiques and on the suitability of the considered frameworks, it was necessary to identify a conceptual framework that would be suitable to answer the research question; by addressing the use/non-use of technology as well as whether any envisioned benefits have been reaped through teachers' experiences and perceptions. Activity Theory (AT) (Engestrom, 1987) was selected as the conceptual lens which was used to explore mathematics teachers' experiences and perceptions in relation to the dimensions identified in the literature review, which are the teacher, the technology, the e-lesson and the community.

2.8.1 Activity Theory

Although Information Systems (IS) is primarily concerned with the adoption of new technologies, it also addresses organisational action and social change (Avgerou, 2000) and therefore theoretical models from social psychology, argue Dista and Davis (2000) have been widely used to explain and predict IS use. IS research "draws from a diverse set of disciplines, with psychology emerging as a consistently dominant source of theories" (Saldanha, Malladi &Melville, 2013, p.1). Activity Theory (AT) was originally developed by Russian psychologists Vygostsky (1978) and Leont'ev (1981) and then further developed by Engestrom (1987). It is a psychology theory that bridges the gap between what people think and feel, and what people actually do (Kaptelinin, Victor, Nardi & Bonnie, 2006).

Activity theory is increasingly being used in education literature because it helps us to understand the relationship between the individual and the activity system, and the implications this has for the nature of learning" (Wheelahan, 2004, p.6).

Kuutti (1996) and Hasan (2001) argue that AT (Engestrom, 1987) is suitable for studying IS as it can be used to understand and analyse information systems while incorporating contextual features. For this research study AT (Engestrom, 1987) "brings the use of technology into the realm of specific human activity" (Allen, Karanasios & Slavova, 2014, p.6) by providing a holistic understanding of teacher collaboration, with the assistance of sophisticated tools such as information systems in a complex and dynamic environment (Hasan, 1999). AT's (Engestrom, 1987) historical roots are closely related with transformations in education (Gedera & Williams, 2016). Tay and Lim (2016) used AT (Engestrom,1987) to explore actions of the school teaching community in one-to-one computing and highlighted the importance of accounting for all factors by using a holistic approach when studying the integration of ICT into education. In an attempt to identify the objective of computer-based mathematics, Hardman (2007) used AT as a conceptual lens (Engestrom, 1987). Based on previous studies that have been conducted in a technology and educational context, and even more specifically for technology in mathematics education, AT (Engestrom, 1987) is suitable for the research study which aims at understanding Mathematics teachers' perceptions of, and experiences with, technology.

2.8.2 The Activity system

AT (Engestrom, 1987) consists of five interrelated components: Subject; Object; Tool; Rules; Division of labour and community. According to Engestrom (1999), the activity system triangle represents the interaction of the six components and how they affect and/or relate to each other. Within the activity system triangle, the subject refers to the individual, or group of individuals,

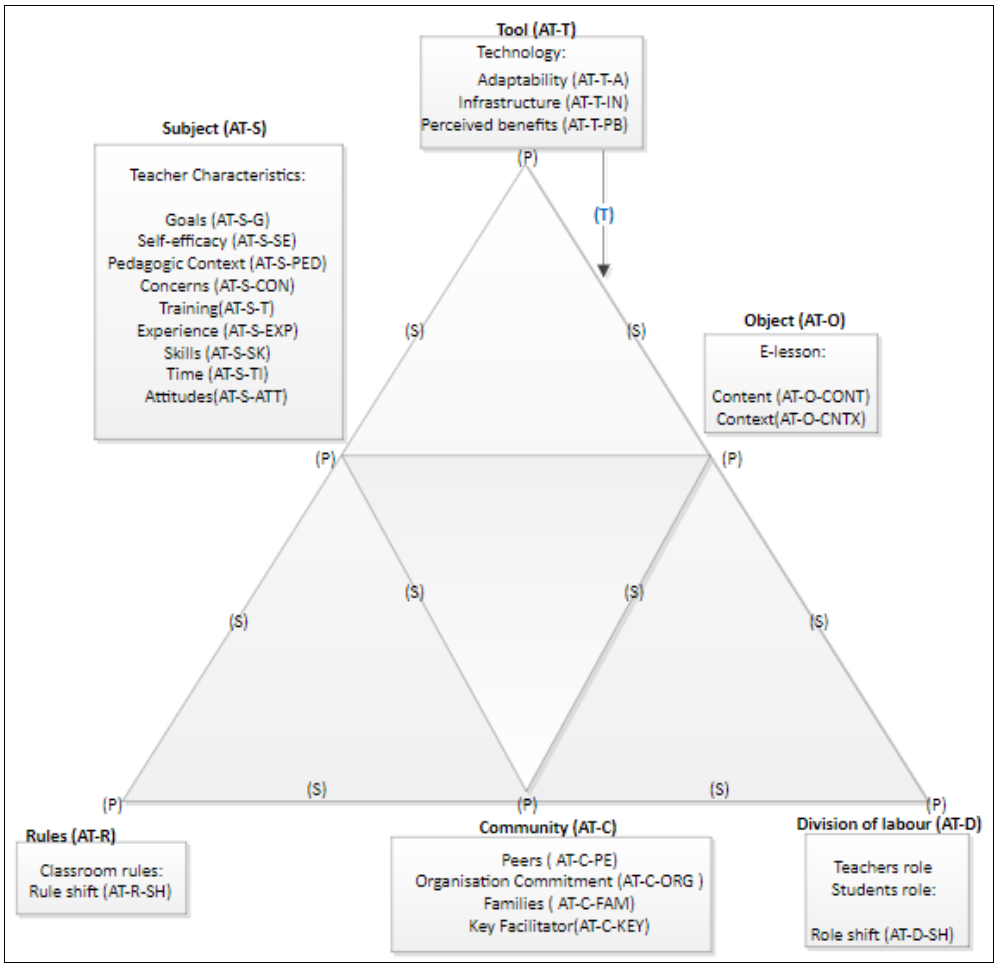
who are carrying out the activity. The subject uses the tool, which can be physical or psychological, to achieve an object, which is then transformed into an outcome. One subject can carry out various activities, each of which can have a different object. Rules refer to constraints on the subject's behaviour and can be formal or informal regulations. All other groups or individuals that work with the subject and share an object are referred to as the community. Lastly, the division of labour refers to the way work is divided in the activity system between the subject and the members of the community (Engestrom, 1987).

All the components of the activity system are interrelated and, furthermore, other activity system triangles can exist within one activity (Rochelle, 1998; Larkin, 2008). According to Ellis (2013), the structure of the triangle and sub-triangles represent the relationships between the elements depicting the interrelations within the activity system. The most rudimentary relationship in the triangle is that of the subject, object, and tool. The sub-triangles within the activity system triangle make up the interrelationships of the components of the activity system, for example between subject, rules, and community, or between the tool, subject, and object.

2.8.3 Contradictions

An essential concept in AT (Engestrom, 1987) that refers to the tension between the components in an activity system, as well as clashes in an activity, is called a "contradiction" (Engestrom, 2001). There are four sources of tension (contradiction) in an activity system: *Primary* which describes the characteristics of the elements in the activity system, for example a faulty tool; *Secondary* which occurs between the elements in the activity system, for example the subject not being able to use the tool; *Tertiary* which occurs between the same activities at different times in the activity system, for example introducing technology to a task that was previously carried out without technology; and *Quaternary* which occurs between different activity systems, for example, teaching by the teacher and learning by the student (Engeström, 1999; Hasan & Kazlaukus, 2014). Contradictions in AT (Engestrom, 1987) "enable the multidimensional analyses of complex activity systems such as those entailed in the provision of human services" (Foot, 2014, p.20) and are areas of improvement that could be considered (Hanifa & Quek, 2004). In this study, the concept of contradiction is critical as the contradictions identified were potential areas for improvement in policy and or technology regarding e-lesson use by mathematics teachers at a secondary school level. Quaternary contradictions were excluded as only one activity system was explored in the study.

For the purpose of the study and in order to answer the main research question (What are the perceptions and experiences of mathematics teachers in relation to e-lessons?), the elements from AT (Engestrom, 1987) were defined based on their descriptions above, as well as on previous studies (Hardman, 2005), as follows: the *subject* is the mathematics teacher; the *object* is to carry out a mathematics e-lesson ; the *tool* used to achieve the object is the technology that makes up an e-lesson; *Community* refers to the teacher's peers, the school, facilitators and students' parents; the *rules* are based on the teacher's classroom rules, how they carry out their lesson with/without technology; and the *division of labour* is the distribution of tasks in the classroom between the student and the teacher. Figure 1 below shows the activity system triangle which was used for the study, along with codes and illustrations of some of the contradictions which are discussed in the research methodology section of this paper.



Key: (P) –Primary contradictions; (S) –Secondary contradictions; (T) – Tertiary contradictions

Figure 1: Activity System triangle used in study (Engestrom, 1987)

2.8.4 Critique of AT

A salient critique of AT (Engestrom, 1987) is that the individual in the activity system is over-socialised (Wheelahan, 2004; Daniels, 2008). What this means is that little attention is paid to the individual or subject of the activity, but they are rather viewed as a part of society and therefore the essence of individual experience is not captured (Tolman, 1999). This relates to the standing debate in the field of social sciences on structure versus agency (Archer, 2003; Musolf, 2003); there have been different opinions on whether it is the society (structure) that determines an individual's behaviour or whether it is the individual (agency)(Pavone, 2014). Kaptelinin and Nardi (2006, p. 11) state that when dealing with ICT "activity theory has always had a strong notion of the individual, while at the same time understanding and emphasizing the importance of a socio-cultural matrix within which individuals develop." As this study was aimed at getting a sense of structure and agency, both were considered and addressed in the interviews with the teachers by firstly obtaining their individual opinions (agency) while exploring the focus areas identified previously: teacher's attitude (Becker & Riel, 1999); teaching goals (Kay & Knaack, 2008); self-efficacy (Ertmer, 2005); pedagogic context (Duffy & Jonassen, 1992); shift in pedagogic practice, which affects the role of the teacher (Fishman, 2006; Pierce and Ball; 2009); teacher concerns (Karasavvidis, 2009); training (Cope & Ward, 2002); experience (Cope & Ward, 2002); time (Herrington, Herrington, Hoban & Reid 2009); and skills (Herrington, Herrington, Hoban & Reid, 2009). In addition, structure was captured by considering influences from other teachers, the school, key facilitators and students' parents (Ertmer, 2005; Zhao & Cziko, 2001).

2.9 Conceptual framework Summary

The conceptual frameworks that were considered for this study are Unified Theory of Acceptance and Use of Technology (UTAUT), Khan's e-learning framework, Task Technology fit (TTF), Technology Acceptance Model (TAM), and Activity theory. Activity theory was the framework selected for the research due to the socio-cultural aspects that it takes into consideration. Chapter 3 will present the

Research methods using Activity theory as the underpinning lens through which data will be collected and analysed.

Chapter 3: Research Methodology

Using Activity Theory (Engestrom, 1987) as the conceptual lens, this research study explored mathematics teachers' (AT-S) perceptions and experiences regarding the use of technology (AT-T) to teach and to conduct an e-lesson (AT-O). This research study was carried out with an interpretivist paradigm while making use of both an inductive and deductive methods and utilising an exploratory research design. Qualitative data collection and analysis techniques were used to then conduct a case study and carry out a thematic analysis. The rationale behind these choices of research methods will be presented in this section.

3.1 Research Design

Underpinning the research strategy and design is the research philosophy. The interpretivist philosophy acquires knowledge through the "socially constructed nature of reality" (Klein & Meyers, 1999, p.72). This research study followed the interpretivist approach as the researcher entered the field with some sort of prior insight of the research context but assumed that this was insufficient in developing a fixed research design due to the complex, multiple and unpredictable nature of what is perceived as reality (Hudson & Ozanne,1988). As this research study was interpretivist in nature, aimed to understand the context of e-lessons in secondary schools, and the process whereby the use or non-use influences and is influenced by the context (Walsham, 1993), no independent and/or dependent variables were defined (Kaplan & Maxwell 1994). Complementing the interpretivist's paradigm, the inductive research approach works from the "bottom-up, using the participants' views to build broader themes and generate a theory by interconnecting the themes" (Creswell & Clarke, 2007 p. 23). Inductively generating codes from the data enables the "gaining of new insights, discovering new ideas and increasing knowledge of the phenomenon being studied" (Burns and Groove, 2001, p. 374) which is what characterises exploratory research. The inductive approach was used for the study, with emerging/inductive codes and themes being developed based on the data collected (Braun & Clarke, 2013) through thematic analysis to interrelate the initial and emerging codes into themes. However, prior to the inductive codes, *a priori* codes were developed based on the existing literature as a point of guidance for the study and these were be analysed deductively (Segura-Herrera, 2008; Miles & Huberman, 1994).

In addition, the study was exploratory in nature as the data collected on the use of e-lessons from perspective of teachers was conducted in their natural setting (De Vos, Strydom, Fouché & Delport, 2005), in order to gain a better understanding of the problem space as well as to clarify

what is taking place at the selected school, as this cannot be predicted based on theory (Hair, Babin, Money & Samuel, 2003).

The researcher collected qualitative data in the form of interviews, therefore it was analysed in the form of words rather than numbers (Kaplan & Maxwell, 2005). The rationale for choosing qualitative data analysis was due to the critique that the context and points of view of the participants are largely lost when data is numerically aggregated, therefore this research study made use of words from the teacher interviews that were then analysed. Lastly, a case study design was selected for the research study due to a number of reasons: firstly, it enables researchers to "investigate how the teachers experience the phenomenon within its real-life context", (Yin, 2004, p.1), which in this case is the school using e-lessons. Secondly, case studies are typically used in qualitative studies (Merriam, 1988) as it allows for the exploration of complex issues in a holistic in-depth investigation (Zainal, 2007). Lastly, case study design is a prominent research method used for studies concerning education (Gulsecen & Kubat, 2006). There are different types of case study, either single case or multiple case. A single case study is best used when the researcher only wants to study one single thing, for example a person from a specific group or a single group, for example a group of people (Yin, 2003). A multiple case is suitable for when the researcher needs to either predict contrasting results for expected reasons or either predict similar results in the studies (Yin, 2003), this was not the purpose of this research study. In this research the group was mathematics teachers at the blue print school selected by the DBE, therefore a multiple case study was not feasible for this research.

This choice of research paradigm, design, method, and data analysis and collection method allowed the researcher to aptly explore the complex issues specific to mathematics teachers using e-lessons and address the primary research question: *What are the perceptions and experiences of mathematics teachers in relation to e-lessons?*

3.2 Population and Sample

This research study employed purposeful sampling in order to identify an "information- rich" sample that allowed issues of central importance to the research question to be learnt (Patton, 1990; Patton, 2002). Purposeful sampling, state Palinkas, Horwitz, Green, Wisdom, Duan, Hoagwood, (2013), is a technique widely used in qualitative research for the identification and selection of information-rich cases. As the purpose of this research study was to explore the perceptions and experiences of mathematics teachers with regard to e-lessons, only schools that have introduced technology as a result of "The Big switch on" were considered for the

population. Of these schools, Sunward Park High School (SPHS), a public school in Boksburg, was selected as this the GDE's blueprint school for their e-learning strategy. The reasons behind their blueprint status are: the school has implemented its own digital business model which includes creating custom e-lessons; additionally, the school went fully digital with no use of textbooks, using educational software even before the formal introduction of technology into education at SouthAfrican schools in 2015 (MIB Technology, 2016; Thango, 2016). Therefore it was felt that this school would be most suited to answer the research question as the school is more immersed in technology than other schools that are part of "The Big Switch On" (Thango,2016).

3.2.1 The school

SPHS was established in 1975 and is located in Boksburg, which is a suburb of Johannesburg, South Africa. About 90% of the learners at SPHS are from disadvantaged backgrounds and attended township-based primary schools. There are about 1200 students and 56 teachers at SPHS, with a teacher to student ratio of 1:35 (Oxford, 2013; Sunward Park High School, 2016). While the matric pass rate at SPHS has been well above the national average, the mathematics matric pass rate has hovered around 25% in the past two years (Thango, 2016). SPHS was the first school in the Gauteng province to migrate to digital classrooms for all its students in 2012 (Oxford, 2013). Tablets were provided to SPHS to allow information sharing between teachers and students and they were loaded with video tutorials, multimedia content, digital libraries, teacher training material and e-textbooks (Mtshali,2013; Thango, 2016).

3.2.2 The teachers

In order to gather rich information that directly addresses the research question, a total of 6 mathematics teachers were selected; 2 from each of the grades 8 to 10 out of the population of 10 mathematics teachers.These grades were selected for the sample due to the fact that grade 11 and 12 secondary school teachers were not as available as they were preparing students for their final year matric examinations. Additionally, a grade 8-10 is where the foundation of secondary school subjects is laid (Thango, 2016). This research study catered for the event that not all teachers would agree to participate in the study. According to Creswell (1998) and Morse (1994) at least six participants are required for a qualitative sample of between 5 and 25 participants. This research study's selection of 6 participants falls within this criteria, in that the entire population of 10 teachers was invited to participate and 6 accepted this invitation. This was still a sufficient sample size, on the basis of the sample size suggestions by Creswell (1998) and Morse (1994).

Additionally, the concept of saturation was applied to the interviews. Saturation, state Ritchie, Lewis, and Elam, (2003), has a point of diminishing returns in that, as the study progresses, extra data collected does not necessarily turn into more useful information. For example, if after four interviews there was no new emerging information, then saturation would have occurred and thus the interviewer would stop and the sample size would have been revised (Mason, 2010). Furthermore, based on O'Reilly and Parker's (2012) claim that once saturation is reached no new data, themes or codes will emerge. By interview number six it was found that all the interview data had been covered in the codes and themes that emerged. Therefore, it seems saturation was achieved by the sixth interview for this research and the sample size of six teachers was therefore sufficient for this research.

It should be noted that the focus of sampling in a qualitative study is not representativeness, (which is how well a sample represents a population) as in a quantitative study (Neuman, 2009), but is rather focussed on how the selected sample, regardless of how small, sheds light on the phenomenon being studied (Ishak & Abu Bakar, 2014). Thus, the sample size for the study was six junior secondary school teachers who were selected purposively in order to provide information-rich data specific for answering the research questions (Patton, 1990).

3.3 Data Collection Method and Research Instrument

Using the Activity Theory as a theoretical lens, interviews were used to explore the mathematics teachers' (AT-S) experiences when conducting e-lessons (AT-O). According to Creswell and Clark (2006), an interview was used where one would like to "see the world through the eyes" of the respondent (p.87). Interviews can either be structured, semi-structured or unstructured (Flick, 2009). For this research study, a semi-structured interview was used, as it "delves deeply into a topic in order to understand thoroughly the answers provided" (Harrel & and Bradley, 2009.p.27), and thus facilitated the probing of teachers and acquiring further information relevant to the research question (Flick, 2009). The interview schedule consisted of 13 questions and each interview was approximately 40 minutes long. The interview questions were coded deductively, using *a priori* codes (Creswell & Plano Clark, 2006). The *a priori* codes were based on the conceptual framework as well as causation and correspondence factors that relate to the research question from the literature review (Hatch, 2002). Table 1 shows the *a priori* codes developed. Teachers' interview responses, however, were coded inductively, only after the data was collected (Miles & Huberman, 1994).

In order to ensure the accuracy of the interviews, member checks were carried out as a quality control strategy (Byrne, 2001; Lincoln & Guba, 1985). After the completion of the interview, the findings and interpretations were summarised and given to each respondent so that any inaccuracies could be addressed (Creswell & Clarke, 2007; Lincoln and Guba, 1985). The teachers were given the liberty to agree or disagree with the summary and whether it was a true reflection of their views, feelings, and experiences (Creswell & Clarke, 2007). A notable aspect of qualitative studies is that they progressively improve whereby the subsequent interview in a series is "better" than the previous interview. This is because more insights have been gained and therefore improvements can be made in the subsequent interviews (Holloway, 1997, p.121). This is the method that was used in this research study to assist in addressing participants' potentially varied and rich responses (Fassinger, 2005) where the insight gained from one interview was used to enrich the next.

3.4 Data analysis

Thematic analysis was used to identify and report patterns and themes within interview data by transcribing the interviews, identifying codes and then identifying themes (Braun and Clarke, 2006). Thematic analysis consists of the following six phases: analysing the data; developing codes for the data; searching for themes; reviewing themes; defining and naming themes; and producing the report (Braun and Clarke, 2006). This analysis can be carried out manually by the researcher or with the use of specialised software. The researcher manually carried out the analysis as this enables one to stay immersed in the data (Agar, 1991) rather than using a software program that alienates the researcher from the data (Seidel & Kelle, 1995).

Ryan and Benard (2003) state that there are different methods of identifying themes, either through an analysis of words, a careful reading of larger blocks of texts, intentional analysis of linguistic texts, or the physical manipulation of texts. This study made use of word repetition and intentional analysis of linguistic texts which will be justified and explored in phases 3 and 4. The next section explores each phase of the thematic analysis.

3.4.1 Phase 1: Analysing the data

Firstly, the interviews were transcribed by the researcher verbatim. According to Poland (1995), verbatim transcription provides an exact replication of what is recorded in the interview, thus enabling the meaning to be preserved and the perception and context to be captured. Manual transcription will encourage familiarity with the data and the researcher will be able to immerse themselves in the data (Braun and Clarke, 2006). It was crucial for the researcher to be immersed

as this allowed familiarity of the data collected in preparation for further analysis (Creswell & Plano Clark, 2006).

3.4.2 Phase 2: Developing codes

Coding is the division of recorded actions into relevant themes in order to extract and interpret meaning from them in a standardised form (Babbie, 2001). As previously mentioned, the initial codes for this research study were developed prior to data collection (Appendix C and Table 2) in order to facilitate the identification of items to be expected or to identify relevance for final analysis (Creswell & Plano Clark, 2006). These *a priori* codes, however, were open to modification and could have been disregarded altogether if they were not appropriate to the data collected (King, 2007). As themes consist of a combination of codes, an *a priori* code can be discarded if none of the data collected for it falls into any themes (King, 2007; Babbie, 2001). Table 1 below illustrates how the elements of the conceptual model (AT) were coded for the context of this research study in order to address the research question. Furthermore, the sub-codes that emerged from the literature are also shown in the table.

The codes shown in Table 1 below can be classified as descriptive. Descriptive are high-level codes that focus on labelling what is in the data and have no further meaning than their label (Miles & Huberman, 1994). The counterparts of descriptive codes are pattern codes, which are codes that are used to extract meaning from the data. The pattern codes will emerge from data collection (Miles & Huberman, 1994). Therefore, the research study was made up of two broad categories of codes; *A priori* (deductive) codes and emerging (inductive) codes, each of which consisted of descriptive codes which are labels that evolve into pattern codes, which are more meaningful (Miles and Huberman, 1994). The inductive codes were developed after data collection and analysis of the interview transcripts and were based on "expected patterns, striking, surprising, unusual, or conceptually captivating responses" (Creswell, 2007, p.153). This was a manual coding process that consisted of coding by writing notes on the transcribed interviews and using highlighters to indicate patterns and segments (Braun & Clarke, 2006). This was achieved in Microsoft word 2010 by typing comments and highlighting the relevant codes.

Element	Conceptual definition	Proposal definition	Sub-codes	Contradiction Type
Subject (AT-S)	Person or group of people that use a tool to achieve a particular objective (Engestrom,1987)	Mathematics Teachers: main phenomena of the study who carries out the activity of teaching. Any data that relates specifically to the teacher was classified under this element, based on the subcodes.	Self-efficacy (AT-S-SE) Concerns (AT-S-CON) Training (AT-S-T) Experience (AT-S-EXP) Skill (AT-S-SK) Time (AT-S-TI) Attitude (AT-S-ATT)	Secondary (S)
Object (AT-O)	The motive for the activity as per the subject (Engestrom,1987)	The presumed teacher's motive in the activity was to conduct an e-lesson for mathematics.	Content (AT-O-CONT) Context AT-O-CNTX)	n/a- May emerge from data collected
Tool (AT-T)	Anything from a physical object to a mental map or model used in the transformation process. (Engestrom,1987)	Any software and hardware used for the E-lessons, which include powerpoint slides, tablets, Wi-Fi connection videos, and interactive software for teaching.	Adaptability (AT-T-A) Infrastructure (AT-T-IN) Perceived Benefits (AT-T-PB) Perceived Drawbacks (AT-T-PD)	Tertiary (T)
Rules (AT-R)	Guidelines or restrictions for an activity in the activity system (Engestrom,1987)	These are the mathematics classroom rules and may vary per teacher. May change in an e-lesson compared to in a traditional classroom.	Shift in rules (AT-R-SH)	Secondary (S)
Community (AT-C)	The social context of the activity (Engestrom,1987)	Other mathematics teachers who may influence the teacher's decision to use technology.	Peers (AT-C-PE) The Organisation (AT-C-ORG) Families (AT-C-FAM)	n/a-May emerge from data collected
Division of Labour (AT-D)	The specific work allocated to members of the activity system (Engestrom,1987)	The role of the teacher when teaching. A contradiction has been identified in the literature, as the nature of the roles seems to change in an e-lesson setting.	(AT-D-SH)	Secondary (S)

Table 1: A priori coding Template: Codes from the conceptual framework

Once the data was collected, the deductive codes shown in Table 1 were matched with the inductive codes in order to have a more succinct number of codes that represent the study, as well as to discard the codes that were not represented in the data (King, 2007).

Contradictions (deductive codes)

Based on the *a priori* sub-codes defined from the literature (Table 1), contradictions have been identified.

The first potential contradiction is within the subject of the activity system (AT-S) where it was identified in the literature that the pedagogy of the teacher (AT-S-PED) may change in a more technology-led classroom (Pierce & Ball, 2009). According to the definition by Engestrom (2001) a primary contradiction is a change within a single element of the activity system, this is, therefore, a **primary contradiction**, coded as (P).

The second potential contradiction was identified in the Rules (AT-R). As reviewed in the literature, a shift in pedagogy (AT-S-PED) may lead to a shift in classroom rules (AT-R-SH) as a result of using e-lessons (Wang, 2002). This contradiction can be classified as a **secondary contradiction** as it is between two elements. i.e The teacher (AT-S) and the classroom rules (AT-R) are within the activity system (Engestrom, 2001), and is therefore coded as (S).

The third potential contradiction exists between the teacher (AT-S) and the division of labour between the teacher and the learner (AT-D), as the classroom duties may change (AT-D-SH) to become more constructivist in nature in a technology-led class room (Jonassen, Peck & Wilson 1999; Newlin &Wang, 2002). This was also classified as a **secondary contradiction.**

Contradictions explored

The contradictions listed above, could possibly lead to clashes and tension in the activity system as previous studies have found that teachers tend to be resistant to change and to be risk averse, specifically with regards to educational technology (Howard & Mozejko, 2015; Njenga & Fourie, 2010). This can be attributed to a number of concerns that the teachers have (Howard & Mozejko,2015), such as the technology being disruptive in terms of support needed if issues arise during a lesson or learners misusing the technology for uses other than learning. Additionally, being risk averse or open to change has been linked to individual personalities or culture in previous studies (Howard & Mozejko, 2015), therefore the contradictions may cause tension within some teachers and perhaps not in others.

These deductive contradictions were not imposed on the teachers in the interviews but were used in data analysis when appropriate, based on the data collected. The deductive contradictions were meant to be used as a guideline for the direction of the study (King, 2007).

Contradictions emerging from the interviews were added into the template of codes after data collection. The contradictions were coded with either (P) (S) or (T), which represent primary, secondary or tertiary contradictions, respectively.

3.4.3 Phase 3: Searching for themes

Once the transcribed interviews were collated along with their codes (both deductive and inductive), analysis was repeated in order to uncover themes in the data. To facilitate this, the researcher looked at the collated transcripts and sorted the codes into emerging themes (Braun & Clarke, 2006).

The initial search for themes made use of word repetition techniques, as this method is suitable for the analysis of semi-structured interviews and for the initial review of the data for themes (Ryan and Benard, 2003). The word repetition method involved the analysis of word frequencies in a participant's responses, as the repetitions of certain words, according to Strauss (1992) represent recurring themes in a participant's perspective. The linguistic approach was then used to refine the themes and involved searching for connecting words that define causal relationships within the data (Ryan & Benard, 2003). This approach was used as a secondary method of finding themes once the initial ones had been identified (Ryan & Benard, 2003). Connecting words could be: "before"; "after"; "as a result"; "next"; among others, and were used to define codes for the relationships in the teacher's perceptions (Ryan & Benard, 2003).

The themes from this phase were presented using a mind map in order to visually represent the data and clear the mind of previous assumptions about the subject (Buzan, 1993). Furthermore, the mind map allows one to develop a comprehensive understanding of all the key concepts involved in a subject area (Meier, 2007).

3.4.4 Phase 4: Reviewing themes

The themes developed in the previous phase were then refined by checking if they were too diverse, or if they had too much data or too little data within them (Braun & Clarke, 2006). Themes should include coherent data within themselves and should have a clear distinction between each other (Braun & Clarke, 2006). The latter are referred to, respectively, as internal homogeneity and external heterogeneity (Patton, 1990). This phase, therefore, consists of two

sub phases: level 1, checking for internal homogeneity; and level 2, checking for external heterogeneity.

- Level 1-internal homogeneity. This involved reading all the data extracts that fell within a potential theme and determining if the potential theme formed a coherent pattern (Braun & Clarke, 2006).

- Level 2 - external heterogeneity. The researcher re-read the interview transcriptions in order to ensure that the mind map painted an accurate picture of the data as a whole, this was to ensure accuracy and validity (Braun & Clarke, 2006). The themes were checked to ensure they did not intersect at any point and precisely represented the data without leaving out any prominent concepts (Patton, 1990).

3.4.5 Phase 5: Defining and naming themes

Phase 5 involved further reviewing and analysing the data within each theme that was established in the previous phase, in order to create a definition that captured its fundamental meaning. At this stage, the researcher should be able to describe the content of each theme and its implications in no more than a couple of sentences (Braun & Clarke, 2006).

3.5 Deductive Analysis

Deductive analysis is often used in cases where the researcher wishes to retest existing data in a new context (Catanzaro 1988); this analysis is based on previous knowledge (Kyngas & Vanhanen 1999). Demonstrated below, the *a priori* (deductive) codes have been organised into themes relating to the research questions and based on the literature. Themes and codes based on the existing literature and conceptual framework are shown in Table 2 below in relation to the research quest

Research Question	Potential Theme	Codes included in Theme
What attributes of the activity of conducting a mathematics e-lesson influence teacher's attitudes and perceptions of an e-lesson?	*Factors affecting teacher reluctance*	**1. Teacher Characteristics (AT-S):** *Attitude (AT-S-ATT)* - The teacher's attitude towards technology can determine whether they use technology or not and is determined by other factors (Becker & Riel, 1999). *Goals (AT-S-G)* –technology should allow for what the teacher intends to achieve for their class (Kay & Knaack, 2008). *Self-efficacy (AT-S-SE)* – Lack of confidence conducting an e-lesson (Ertmer, 2005). *Pedagogic Context (AT-S-PED)* - the type of instructional approach that the teacher uses. This is usually defined as either constructivist/instructivist(Duffy & Jonassen, 1992). *Concerns (AT-S-CON)* - the obstacles that teachers believe are related to using technology in their practice (Karasvvidis, 2009). *Training (AT-S-T)* - professional development in the form of formal courses made available to the teachers to improve their computer literacy and proficiency (Cope & Ward, 2002; Herrington, Herrington, Hoban & Reid, 2009). *Experience (AT-S-EXP)* – amount of time using technology (years/months) (Cope & Ward, 2002) *Lack of Time (AT-S-TI)* - teachers are not allocated enough time by the school to learn how to use the technology for their teaching *Skills (AT-S-SK)* – proficiency with the technology (Herrington, Herrington, Hoban & Reid, 2009) *Technology* (AT-T) *Adaptability (AT-T-A)* – whether the technology could be integrated into the usual activities rather than being used as an add-on (Cohen, 1988). *Infrastructure (AT-T-INF)* - a support structure available for the teachers to ensure that technology use is "smooth" and trouble free Hoban and Reid (2009). **2. Rules (AT-R)** *Shift in Rules (AT-R-SH)* - as a result of the teacher's potential change

Research Question	Potential Theme	Codes included in Theme
		in pedagogic context (AT-S-PED), the classroom rules may also change. **3. Division of labour (AT-D)** *Shift in division of labour (AT-R-SH)* - as a result of the teacher's potential change in pedagogic context (AT-S-PED), the division of duties between student and teacher may also change. **4. Community (AT-C)** *Peers (AT-C-PE)* - seeing other teachers successfully using technology in addition to having a positive attitude towards it (Zhao & Cziko, 2001; Becker & Riel, 1999). *Organisational Commitment (AT-C-COM)* - has the school provided a support structure to allow the teachers the means to comfortably use this technology, this could be through training, facilitators, and continuous support (Toyama, 2015). *Facilitators (AT-C-KEY*) - individuals providing focus and direction for the teachers regarding the use of technology (Herrington, Herrington, Hoban & Reid, 2009).
Research question 2: *How does conducting a traditional mathematics lesson compare to conducting an e-lesson?*	***Theme:*** *Differences between traditional mathematics lesson and an e-lesson.*	**1. Teacher characteristics (AT-S)** *Teacher Pedagogy (AT-S-PED)* - The teacher's pedagogy may have to change for an e-lesson (Duffy & Jonassen, 1992). *Training (AT-S-T)* - teachers may need to learn to teach with technology in order to conduct an e-lesson (Pierce & Ball, 2009) *Time (AT-S-TI)* - Teachers may not have the time to learn how to teach with technology (Herrington, Herrington, Hoban and Reid, 2009). **2. Rules (AT-R)** *The shift in classroom rules (AT-R-SH)* - Changes in pedagogy may affect classroom rules (Duffy & Jonassen, 1992). **3. Division of Labour (AT-D)** *The shift in Division of labour (AT-D-SH)* - The change in pedagogy may affect classroom duties between student and teacher (Duffy & Jonassen, 1992).

Research Question	Potential Theme	Codes included in Theme
What are the perceived benefits or drawbacks of an e-lesson, based on the interaction between the mathematics teachers, the technology used, the classroom rules, the school, other teachers and different duties in the classroom?	*Perceived benefits/drawbacks of e-lessons.*	**3.5.4.1 Teacher (AT-S)** *Goals (AT-S-G)* – Teachers may feel technology either amplifies or hinders their actions to achieve their set goals (Toyama, 2015). **3.5.4.2 Technology (AT-T)** *Adaptability of technology (AT-T-A)* – Aspects of the technology that are adaptable to the teacher's instructional methods may be perceived as favourable by some teachers. **3.5.4.3 E-lesson (AT-O)** *Content and context of the e-lesson* (AT-O-CONT/AT-O-CNTX) - The structure and different parts that constitute an e-lesson may be perceived as favourable for a mathematics class by some teachers. **3.5.4.3 Rules (AT-R)** *The potential shift in rules (AT-R-SH)* as a result of a change in the teacher's pedagogic context when conducting an e-lesson as previously mentioned, may be viewed as favourable by some teachers. **3.5.4.4 Division of labour (AT-D)** *The potential shift in the division of labour (AT-D-SH)* between students and teachers in the classroom as a result of a change in the teacher's pedagogic context when conducting an e-lesson as previously mentioned, may be viewed as favourable by some teachers. **3.5.4.5 Community (AT-C)** *Organisational commitment (AT-C-ORG*) - support from the school may be viewed as beneficial for teaching by some teachers.

Table 2: Deductive analysis

3.6 Validity and reliability of research

In assessing the quality of a research study, validity and reliability should be considered. These concepts are predominantly used within a positivist paradigm in quantitative studies (Winter, 2000). As this research study was interpretivist and qualitative in nature, it is suggested that the concepts such as validity and reliability be redefined to cater for qualitative data collection (Lincoln & Guba, 1985). According to Lincoln and Guba (1985) and Tynjälä (1998) terms such as credibility, transferability, dependability and confirmability and trustworthiness should rather be used.

- **Credibility**

Credibility refers to whether the research captures exactly what is taking place in the context of the study and whether this has been achieved (Lincoln & Guba, 1985). According to Lincoln and Guba (1985), in order to address credibility, the interview should not be guided solely by the interviewer. The semi-structured interview used in this study has desirable qualities for addressing credibility, in that it allowed the participant to respond further than just what was asked (Harrel and Bradley, 2009). Furthermore, member checks after the end of the interview to verify the participant's responses ensured that the actual essence of what is taking place was captured, and this also increased the credibility of this research study (Byrne, 2001; Denzin, 1978).

- **Transferability**

In order to address whether or not a study can be applied to a context other than the one that is being studied, information richness must be safe guarded (Lincoln & Guba 1985). Transferability was achieved through the use of purposive sampling, as this selected participants that would provide the richest information pertaining to the research question (Patton, 2002; Yin, 2002). This means that a school similar to the blue print school, could use a purposeful sample similar to the one used for this research, and the study can be applied to that context as well (Yin, 2002). Furthermore, the thematic analysis described in rich detail, step by step, in order to allow transferability of this research to a similar context.

- **Dependability**

Dependability addresses whether research findings are reasonable, based on the data collected. The member checks will enable verification of the accuracy of transcriptions as well the interpretation of the data (Denzin, 1978). The verbatim transcription of interviews allows the

actual essence of what has been said to be recorded (Poland, 1995). In addition, making the transcribed interviews and subsequent data analysis available to participants to check for accuracy (Lincoln & Guba, 1985) is crucial in ensuring dependability. This option was offered to participants in the information participation and consent forms (See Appendix C). Furthermore, a second researcher (supervisor) reviewed the themes, codes and transcripts and provided comments on whether the themes adequately covered the data, as well as any codes that did not fit into a particular theme. The coding and theme process was then revisited.

- **Confirmability**

Confirmability is the degree to which the neutrality of the research interpretations can be demonstrated (Lincoln and Guba, 1985). Confirmability of this research study was addressed firstly, by member checks, allowing the participants to confirm the contents of their interview by reading them a summary at the end of the interview. Furthermore, the preconceived notions of the researcher, known as researcher bias, need to be addressed to improve the confirmability of the research (Patton, 1990). Researcher bias was addressed in the following ways; the participants and the school that were selected for the interviews, was purposefully selected, and based on criteria that related to the research question and not the researcher bias (Patton, 2002). Additionally, the researcher was intentionally aware throughout the research process that as the research instrument naturally she may have biases, this is key for coping with bias (Centre for Applied Research in Education, 1994). In this way, any biases and/or inaccuracies could be identified (Byrne, 2001).

The overall trustworthiness of a qualitative study, according to Creswell (1998), can be established by utilising the strategies mentioned above, with member checks being the most commonly used in qualitative research.

3.7 Ethical Considerations

Cohen & Manion (2000) state that carrying out research requires the researcher to obtain the consent and cooperation of the participants and the institutions involved. As this research study involved the mathematics teachers at SPHS, permission was obtained from SPHS (see Appendix D). In addition, education-based research at a public school in Gauteng, South Africa requires permission from the Gauteng Department of Education (GDE). This permission was granted (see Appendix D), as well as ethical permission from the university (see Appendix D).

3.7.1 Participant ethical considerations

Teachers were invited to participate after they had read the Information Participation Letter (Appendix C). Teachers that agreed to participate were asked to sign a consent form which clearly stated the intention of the research, that their participation would be voluntary, and that gave their permission to have interviews recorded. In order to avoid identification of teachers, and protect them from any possible negative consequences, based on their interview responses, pseudonyms were used in the research study. Furthermore, the interview recordings were only available to the researcher and have not been shared with anyone.

3.8 Research Methods Summary

Chapter 3 highlights that this research made use of an interpretivist paradigm, with both inductive and deductive methods of analysis. The data collection method was an interview and the theoretical lens used was activity theory. The research is single case study, which will make use of a thematic analysis, which is explored in chapter 4.

Chapter 4: Thematic Analysis

The main research question for this study is:

What are the perceptions and experiences of mathematics teachers in relation to e-lessons?

The research sub-questions that frame the study are:

1. *What attributes of the activity of conducting a mathematics e-lesson influence teachers' attitudes and perceptions of an e-lesson?*

2. How does conducting a traditional mathematics lesson compare to conducting an e-lesson?

3. What are the perceived benefits of an e-lesson, based on the interaction between the mathematics teacher, the technology, the classroom rules, the school, other teachers and different duties in the classroom?

The conceptual framework Activity Theory (AT) (Engestrom, 1987) is the lens through which the research question and research sub-questions were explored. The six elements of AT (subject, object, tool, rules, community and division of labour) were assigned deductive codes before semi-structured interviews were carried out with six mathematics teachers. In this study the elements were viewed as follows:

Subject, refers to the teacher;

Object, refers to conducting an e-lesson;

Tool, refers to the technology being used by the teachers;

Rules refers to the classroom rules;

Community refers to the teacher's environment at the school;

Division of labour refers to the roles and duties between the teacher and learner in the classroom.

A summary of the teachers (the subject of the activity system) is described below.

4.1 Summary of Participants

The sample consisted of six mathematics teachers that currently teach at the blueprint school. The teachers that were interviewed were selected using purposeful sampling, which brought about an information-rich sample that provided data that was central to the research question (Patton, 2002). This sample had a mix of teachers from grades 8 to 10, as these grades fit in both the General Education and Training (GET) and Further Education and Training bands that have been defined by the Department of Education.

Table 2 shows a summary of the teacher demographics. Pseudonyms have been used in order to ensure confidentiality of the participants. These were created based on the first letter of the participant's surname taking into account their cultural and demographic background.

Pseudonym	**Gender**	**Teaching experience (years)**	**Using technology to teach**
Smanga	F	2	Yes
Janet	F	5	Yes
Raj	M	14	Yes
Chauke	M	19	Yes
Vivian	F	33	Yes
Sarah	F	46	Seldom

Table 3*: Teacher demographics*

4.2 Analysis of the Interview Data

Following the interviews, the process of thematic analysis began using Braun and Clarke's (2006) six phase process which involves: analysing the data; developing codes; searching for themes; reviewing themes; defining and naming themes; and producing the report. It should be noted that although the process is represented as simultaneous phases, it is really iterative with each phase being repeated and revisited until the researcher is satisfied with the analysis (Braun & Clarke, 2006).

Howitt (2011) states that a number of studies that undertake thematic analysis do not detail the process, therefore, it is not easy to replicate. This study attempts to detail each phase of the analysis to avoid this limitation. The phases are detailed in section 4.3.

4.3 Thematic Analysis (Braun & Clarke 2006)

The thematic analysis process carried out on the data for this research is outlined in Figure 2 below, a detailed description per phase then follows.

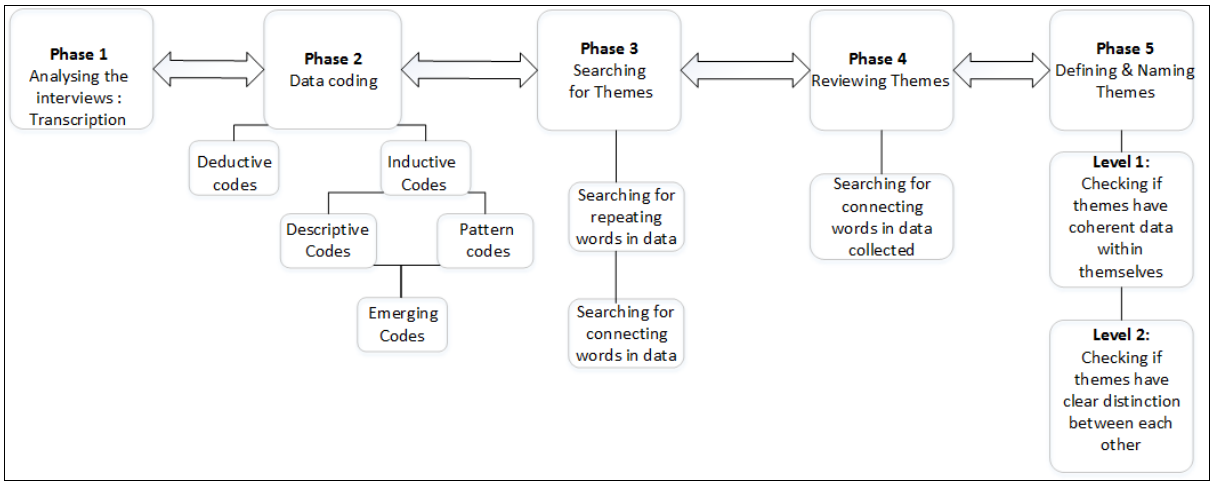


***Figure 2**: Thematic analysis for this research study*

4.3.1 Phase 1: Analysing the data

The transcription process allows for meaning to be preserved and perception and context to be captured (Poland, 1995). It is crucial for the researcher to immerse themselves in the data as this allows for the familiarity of the data collected, and preparation for the data for initial coding (Creswell & Plano Clark, 2006) which is explained phase 2. Therefore, the interviews were transcribed using Microsoft word and playing the audio recordings. This involved the reading and re-reading of transcripts and replaying of the recordings, thereby allowing the researcher to immerse herself in the data (Braun & Clarke, 2006).

4.3.2 Phase 2: Data Coding

After the researcher familiarised herself with the data, the process of data coding was initiated formally. This study undertook both deductive and inductive analysis.

Deductive Codes

Deductive codes were assigned prior to data collection in order to facilitate the identification of items to be expected in the interview data or to identify relevance for final analysis (Creswell &

Plano Clark, 2006) (See Appendix B). The deductive codes were descriptive and had no further meaning than their label (Miles & Huberman, 1994).

Inductive Codes

The inductive coding was done manually and involved writing notes on the interview transcripts (Appendix F) and using highlighters and pens to indicate patterns and segments (Braun & Clarke, 2006). This was achieved using Microsoft Word 2010. The researcher re-read the transcripts multiple times in order to identify and create inductive codes, with the interview transcripts being analysed for "expected patterns, striking, surprising, unusual, or conceptually captivating responses" (Creswell, 1998, p.153).

Descriptive Codes

The initial inductive codes that were identified from the data collected were descriptive codes, just as were the deductive codes. Descriptive codes are high-level codes that focus on labelling exactly what is in the data and have no further meaning than their label (Miles & Huberman, 1994). For example, when some of the teachers spoke about revisiting work, the descriptive code assigned to that section of the data was 'Revisiting work', with no further meaning than what was said.

Pattern Codes

The counterparts of descriptive codes are pattern codes. Pattern codes go further than descriptive codes and extract meaning from the data (Miles & Huberman, 1994). For example, the descriptive code 'revisiting work' which did not have any further meaning than what was found in the data, was grouped together with other similar descriptive codes such as 'homework', and 'review of previous material' in order to fit into one pattern code, 'prior knowledge'. The pattern code 'prior knowledge' encompasses all 3 of the descriptive codes and also gives them meaning. Figure 3 shows an extract from code list showing how the pattern code "Prior knowledge" was segmented:

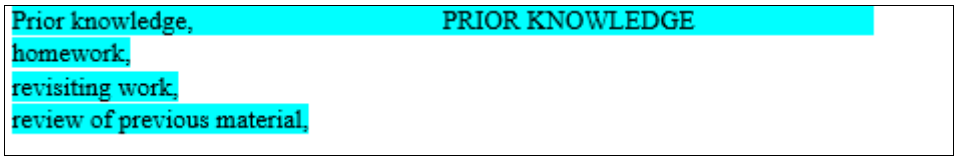


***Figure 3**: Extract from initial coding template*

Table 4 shows the 13 pattern codes that were a result of merging 85 descriptive codes (Appendix E) which were created as a result of the analysis of the interview data. It can be seen

in the table below that some descriptive codes are repeated for example “tablet misuse”, “training”, “control”, these are displayed in the table to illustrate the number of times they were repeated in the data, this is further explained in phase 3 (Figure 5). It is apparent that some codes have similar descriptions and they overlap. This was acceptable for this phase in the analysis process, as further review was carried out when creating themes in the phases that followed (Braun & Clarke, 2006).

Pattern code	Descriptive codes	Pattern code explained
Prior knowledge	Prior knowledge, homework, revisiting work, review of previous material	Includes any data that relates to going over work done, including revision and homework.
Classroom Rules	Particular classroom setup, classroom rules, no social media, classroom rules for all, take out tablets vs take out books, equality with learners, monitoring, new rules.	Entails the different rules that teacher have in their classrooms and whether or not these change when teaching with technology.
Improved teaching and learning	Easier teaching and learning effective teaching, smooth lesson, simpler teaching.	Includes any reported ways that technology simplifies or makes teaching more effective.
Benefits of technology	Personal development, benefits of technology, discipline, access to lessons anywhere, absent learners, benefits of technology, videos assisting teachers with their usual tasks, learner concentration.	Includes the perceived benefits of the technology tools that the teachers are using.
Teacher concerns	Abuse of tablets, teacher concerns, forgetting of tablets, more work, tablet misuse, tablet misuse.	Covers any of the concerns that teachers have towards technology.
Attitude towards technology	Positive attitude, Scared, nervous about technology.	Consists of the teacher's attitudes towards technology, whether positive or negative.
Controlling the classroom	Control the class, controlling the classroom.	Refers to teachers’ description of how they conduct their technology-led class.
Roles In the classroom	Not redundant, role of the teacher, effective teaching and learning, take out the best for the learner, students more responsible, role of the student, benefit of technology, responsibility.	Refers to the division of labour in the classroom – teacher duties and learner duties, as well as whether these change when teaching with technology.
Typical classroom	Learner-centric lesson, walking around during lesson, integration, sections learners didn’t understand, seldom use PowerPoint,	Covers the individual teachers and how they conduct their class.

Pattern code	Descriptive codes	Pattern code explained
	no change in teaching approach.	
Classroom goals	Improved average, assessment-based classroom goals, better marks, test results, classroom interaction, feedback, participation, Interaction.	Encompasses the teachers' goals for their classroom.
Support	On-site technicians, WhatsApp for support or in-person requests, immediate response, social technical support from peers, onsite support from technicians, encouragement, peer influence, help from other teachers.	Encompasses the support from the school as an organisation as well as support between teachers as peers.
Training and practice	Training, training and practice, in-person training, video training, training times, on-going training, practice, enhancing teachers' skills, practice, training, overcoming challenges.	Includes the different types of training the teachers have received as well as their perceptions of this training.
Teaching technologies	Learning Management Software (LMS) for classroom management, teaching technologies, graphs, Geogebra, visualising	Includes the different technology tools that are being used by the teachers and any benefits reaped from this technology.

Table 4: Descriptive codes and Pattern codes

4.3.3 Comparison of Pattern codes and Deductive codes

Continuing with Phase 2 of the thematic analysis, the 13 pattern codes were then compared to the deductive codes that were developed prior to data collection. This process was carried out in order to reduce the data and codes as well as to identify which codes were dominant in the study and which ones could be discarded as there were no major findings relating to them. A detailed description the deductive codes can be found in Appendix B.

The comparison process is shown in Figure 4 below. The pattern codes derived from Table 3, are shown in bold capitals, while the deductive codes are shown below them. In certain instances, more than one pattern code was matched to just one deductive code. This was an indication of a relationship between the pattern codes, and that they captured the essence of the similar findings.

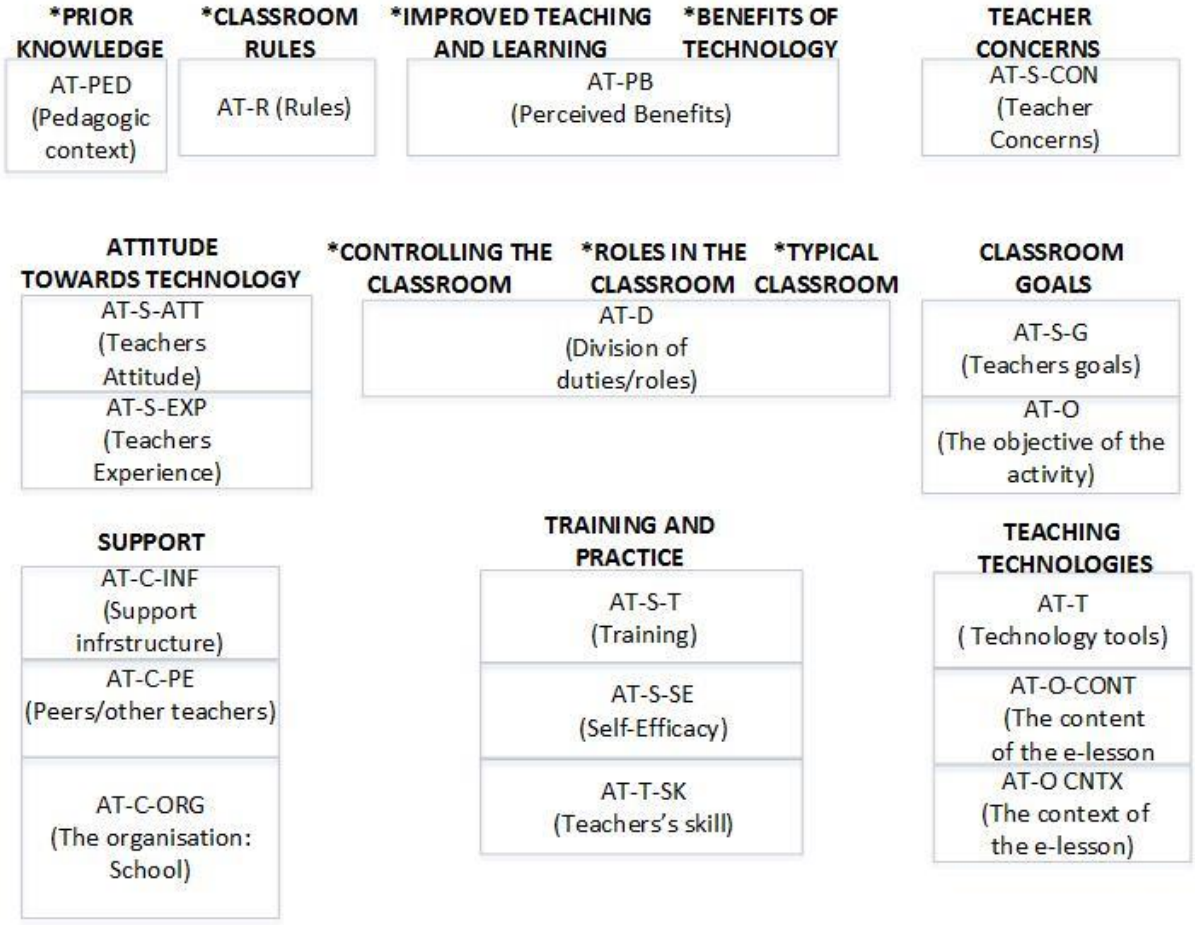


Figure 4: Comparison of Pattern and deductive codes

4.3.4 Justification of Matched Pattern Codes and Deductive Codes for final emerging codes

The deductive codes were assigned to elements of the conceptual framework in order to tailor the activity system triangle for this study. The sections below elaborate how each deductive code was matched to a pattern code that emerged from the data.

4.4.1.1 **Prior Knowledge - matched to pedagogic context (AT-S-PED)**

The inductive pattern code "Prior knowledge" entails revising work or homework and this was matched with deductive code Pedagogic context (AT-S-PED). The rationale behind this is, the data shows that the majority of the teachers typically go over homework, or revisit prior knowledge at the beginning of the class, and therefore can be seen as their pedagogic context.

4.4.1.1 Classroom Rules - matched to Activity system Rules (AT-R)

Classroom Rules is also matched with (AT-R) as they both refer to rules in the classroom.

4.4.1.2 Improved Teaching and learning, and Benefits of Technology - Matched to Perceived Benefits of the tool (AT-T-PB)

The inductive pattern code "Improved teaching and learning" was matched with Perceived benefits of technology (AT-PB) because improved teaching and learning were described by the teachers as one of the benefits they gained from using technology in the classroom. Benefits of technology were also matched to (AT-T-PB) as both codes refer to the benefits of using technology in the classroom.

4.4.1.3 Teacher Concerns- matched to Teacher concerns (AT-S-CON)

The inductive pattern code "Teacher concerns" was matched with the deductive code Teacher concerns (AT-S-CON) as both this pattern code well as the deductive code, referred to the concerns of the teacher.

4.4.1.4 Attitude towards technology matched to Teachers attitudes (AT-S- ATT)

The inductive pattern code "Attitude towards technology" was matched with deductive code Teachers Attitude (AT-S-ATT) and with Teachers experience (AT-S-EXP). The data seems to imply that teachers attitudes and the amount of experience they have using technology go hand in hand, therefore, these were grouped together based on the transcripts. An elaboration of this finding can be found in Chapter 5.

4.4.1.5 Controlling the classroom/Roles in the Classroom and typical classroom- matched to Division of duties (AT-D)

The inductive pattern codes "Controlling the classroom," "Roles in the Classroom" and "Typical Classroom" were all matched with the deductive code Division of Duties/Roles (AT-D). This match was made based on the interview data in which the teachers seemed to imply that their role in the classroom is to control students and that a typical classroom is conducted by controlling.

4.4.1.6 Classroom Goals – matched to Teacher goals (AT-S-G) and Object of the activity system (AT-O)

The inductive pattern code "Classroom goals" was matched to Teacher goals (AT-S-G) and Teacher objectives (AT-O) because both these codes entail the aim of the teacher as the subject of the activity system.

4.4.1.7 Support – matched to Teachers peers (AT-C-PE), Support infrastructure (AT-C-INF), and the school as the organisation AT-C-ORG)

The inductive pattern code "Support" was matched to four deductive codes as they all related to support being provided to the teacher. Teachers Peers (AT-C-PE), Support Infrastructure (AT-C-INF), the school as an organisation (AT-C-ORG), all these aspects were described by the teachers in relation to the support that is received from them.

4.4.1.8 Training and Practice-matched to Training (AT-S-T), Self-efficacy (AT-S-SE), the teacher's skill using technology (AT-S)

The inductive pattern code "Training and practice" was matched with three deductive codes; Training (AT-S-T), the teacher's Self-efficacy AT-S-SE) and the teacher's skill using technology (AT-S-SK). This match was due to the relationship that was found in the data between training, teacher self-efficacy and teacher skill.

4.4.1.9 Teaching Technology- matched to Technology tool (AT-T), Content of an e-lesson (AT-O-CONT), Context of an e-lesson (AT-O-CNTX)

The inductive pattern code "Teaching technology" refers to any technology that is being used to teach. This was matched with Technology Tool (AT-T), which refers to the technology being used in the activity of teaching. Additionally, the pattern code "teaching technology" was matched with deductive codes Content of an e-lesson (AT-O -CONT) and Context of an e-lesson (AT-O-CNTX). This was based on the teacher descriptions of the structure of an e-lesson.

4.3.5 Discarding of Deductive codes

As previously described, the rationale behind *a priori* codes is that they are developed prior to data collection in order to facilitate data analysis (Creswell & Plano Clark, 2006) but yet are open to modification and can be disregarded altogether if they are not appropriate to the data collected (King, 2007). The deductive code Learner's Families (AT-C-FAM) was discarded as it did not fall within any of the data collected or potential themes (King, 2007; Babbie, 2001). This code encompasses learners' parents and their possible influence on teachers' experiences and perceptions with technology. The code did not emerge as a dominant code as all the teachers stated that there is no influence from the parents relating to technology use or non-use.

4.3.6 Emerging codes

As shown in Figure 2, the emerging codes are the result of matching descriptive codes to pattern codes. In Figure 4 the 13 pattern codes each comprise of deductive codes which encompass the six elements of the conceptual framework AT. For example, the pattern code "Attitude towards

technology" is comprised of the descriptive codes (AT-S-ATT) and AT-S-EXP, which represent teachers' attitudes and teachers' experience respectively. Both these codes relate to the teacher who is the Subject (AT-S) in the Activity triangle.

4.4 Phase 3: Searching for themes

"A theme captures something important about the data in relation to the research question and represents some level of patterned response or meaning within the data set" (Braun and Clarke, 2006, p.82). The process of searching for themes entails finding the codes that can be combined into an overarching theme that then acts as a common thread that runs through the data (Braun and Clarke, 2006). The search for themes was conducted using Ryan and Bernard's (2003) word repetition and Linguistic approaches. This was then presented in a mind map (Figure 7), as detailed below.

4.4.1 Initial search for themes-Word Repetition (Ryan & Benard, 2003)

The initial search for themes made use of word repetition techniques, as this method is suitable for the analysis of semi-structured interviews as well as for the initial review of the data for themes, according to Ryan and Benard, (2003). The word repetition method involves the analysis of word frequencies in a participant's responses, as the repetition of certain words, according to Strauss (1992) represents recurring themes in a participant's perspective. For example, a repeated word in the interview data, is "control". When asked what they believe their role is in the classroom, Chauke, said the word "control" repeatedly. This was noted by the researcher as a theme in Chauke's perspective. Below is an extract from Chauke's interview which illustrates the repeated use of the word "control".

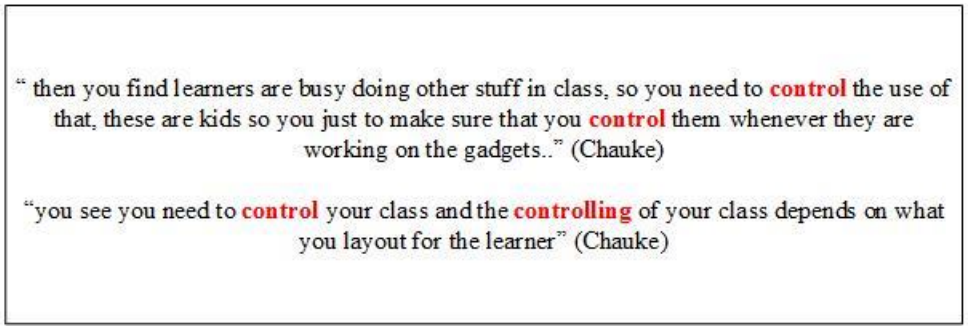


Figure 5: Secondary search for themes-Linguistic Approach (Ryan & Benard, 2003)

After looking at the repeating words in the participant's transcripts, the following initial themes were discovered: Controlling; training; tablet misuse; support; classroom rules.

4.4.2 Secondary search for themes-Linguistic approach (Ryan & Benard, 2003)

Following the initial search for themes, a secondary search was done using a linguistic approach. This approach searches for connecting words that define causal relationships within the data (Ryan & Benard, 2003). This approach is useful as a secondary method of finding themes once the initial ones have been identified (Ryan & Benard, 2003). Connecting words could be: "before"; "after"; "as a result"; and "next" among others, and were used to define codes for the relationships in the teacher's perceptions (Ryan & Benard, 2003). An example of how linguistic analysis was carried out in this research, can be seen in an extract from Sarah's transcript. When asked about her attitude toward technology she states that she was initially scared, then after encouragement from her peers, she felt less scared, see figure 6 below.

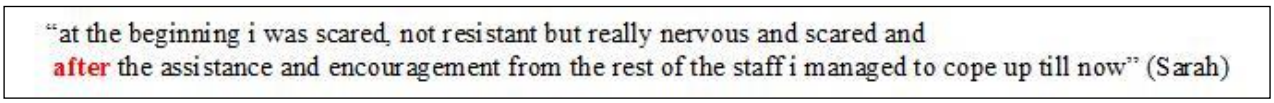

"at the beginning i was scared, not resistant but really nervous and scared and
after the assistance and encouragement from the rest of the staff i managed to cope up till now" (Sarah)

Figure 6: Extract showing connecting words

4.4.3 Mind Map

Visual representation is helpful in the process of sorting the different codes into themes (Braun & Clarke, 2006). As this phase involved sorting the different codes into potential themes, a mind map was used to carry out this task (Figure 7). Mind maps are a tool used to clear the mind of previous assumptions of the subject (Buzan, 1993) and develop a comprehensive understanding of all the key concepts involved in a subject area (Meier, 2007). Mind maps have a hierarchical structure and they are designed with general ideas in the centre and then each branch below that other includes more detail (Buzan, 1993). The combination of repeating words and causal relationships from the interview transcripts, as well as the emerging codes from phase 2, resulted in a mind map and the themes identified at this phase:

- Theme 1: Relationship between support and attitudes towards technology
- Theme 2: The classroom
- Theme 3: Benefits and Drawbacks of technology

Mind map-Searching for themes

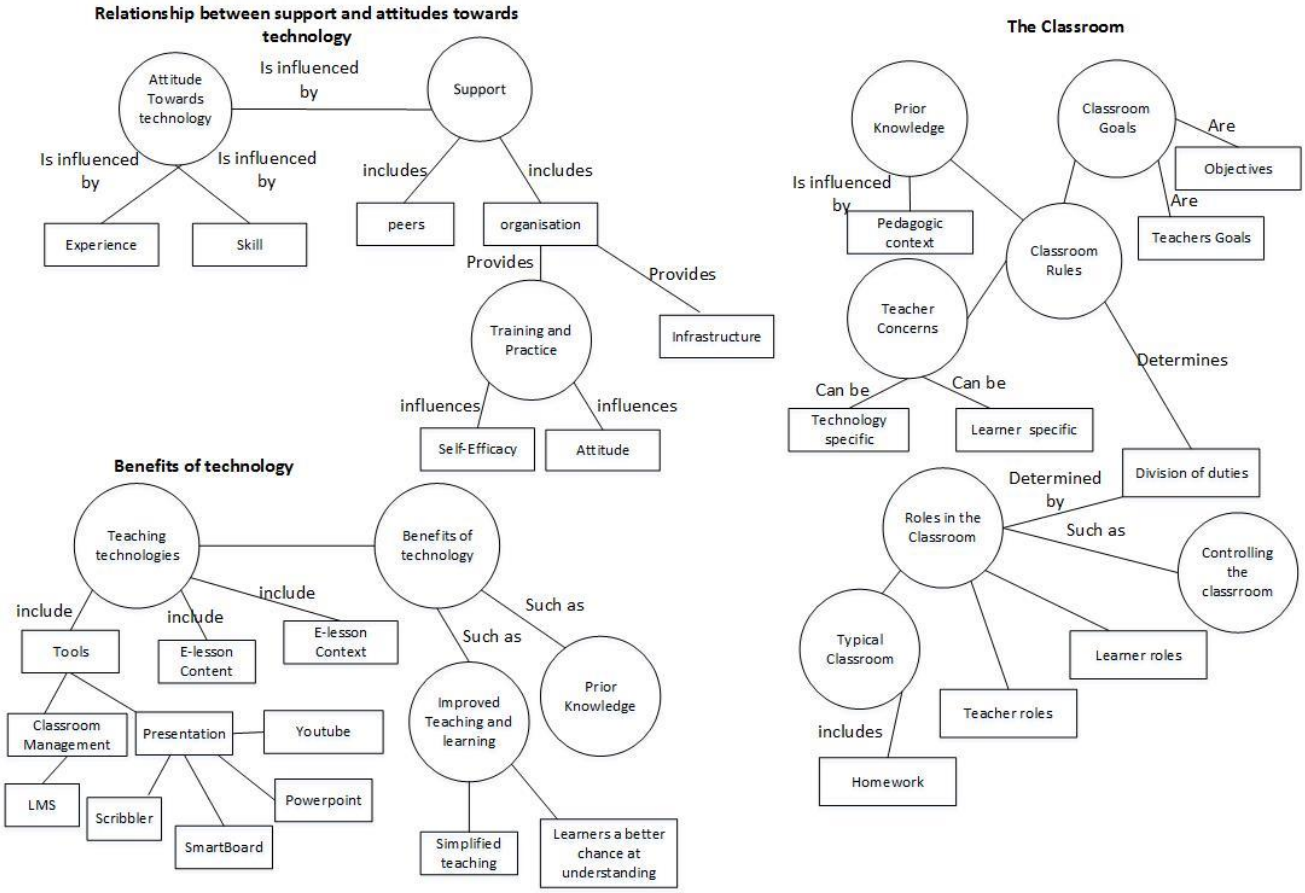


Figure 7:Mind map of codes segmented into possible overarching themes

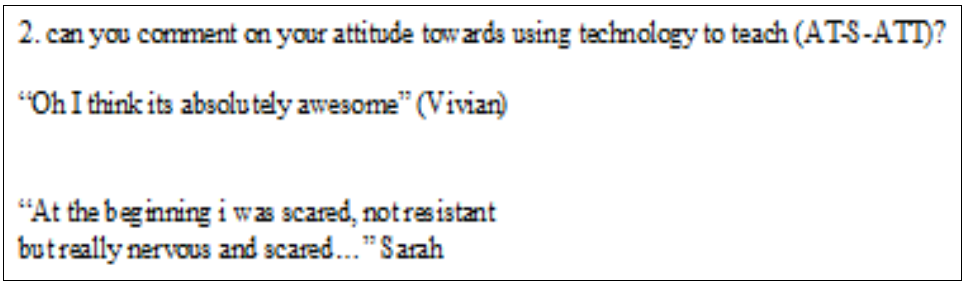
4.5 Phase 4: Reviewing themes

According to Braun and Clarke (2006), themes should include coherent data within themselves and should have a clear distinction between each other. This phase consists of two levels; level 1 is checking if the coded extracts fit within a theme; while level 2 is a check on whether the themes covered the entire data set (Braun & Clarke, 2006).These two levels can be described as internal homogeneity and external heterogeneity respectively (Patton, 1990); Internal homogeneity refers to whether the data collated within each theme is coherent in a meaningful way, while external heterogeneity refers to clear and distinct differences between the different themes (Patton, 1990).

4.5.1 Level 1 – checking internal homogeneity

Level 1 involves reading all the coded data extracts that form a theme. This is followed by checking if these codes form a coherent pattern within each theme Braun &Clarke, 2006). The

process of checking for internal homogeneity can be illustrated using the mind map from phase 3 (Figure 7). The theme "Relationship between support and attitudes towards technology" consists of the code "experience", which is a sub-code of "attitudes towards technology". This link between experience and attitudes towards technology was made based on data extracts from the interviews, which seem to show a relationship between teachers' attitudes towards technology and their years of experience with technology. For example, Sarah and Vivian both have over 30 years of teaching experience, however, Vivian has more experience using technology than Sarah and has a more positive attitude towards technology. Sarah's attitude is more negative. This suggests that experience with technology influences attitudes towards technology. An extract from these two teacher's interviews is shown in Figure 8.


2. can you comment on your attitude towards using technology to teach (AT-S-ATT)?

"Oh I think its absolutely awesome" (Vivian)

"At the beginning i was scared, not resistant
but really nervous and scared…" Sarah

Figure 8: Extract from interviews showing relationship between teacher attitudes and previous experience with technology

This process was carried out with all three themes in order to confirm internal homogeneity and then the researcher proceeded to the external heterogeneity check.

4.5.2 Level 2- checking external heterogeneity

In level 2, the researcher re-read the interview transcripts in order to ensure that the mind map (Figure 7) painted an accurate picture of the data as a whole. This was to confirm accuracy and validity (Braun & Clarke, 2006). The themes were checked to ensure they did not intersect at any point and precisely represented the data without omitting any prominent concepts (Patton, 1990). This was achieved by re-reading all the interview transcripts and re-reading all the themes.

4.6 Phase 5: Defining and naming Themes

Braun and Clarke (2006) suggest that if the analysis is carried out according to their recommendations, the researcher should be able to describe the content of each theme and its implications in no more than a couple of sentences (Braun & Clarke, 2006). Phase 5 involves further reviewing and analysing the data within each theme that was established in the previous

phase, in order to create a definition that captured its fundamental meaning. The themes from phase 4 were not changed in terms of content, but were renamed to have a more succinct and descriptive name for more fundamental meaning, using the researcher's discretion.

The final themes that were defined after the reviewing of themes from phase 4 are as follows:

- Theme 1 previously: Relationship between support and attitudes towards technology

  Redefined to: Influence of organisational and peer support on teacher attitudes and perceptions of e-lessons

- Theme 2 Previously: The classroom

  Redefined to: Typical Mathematics classroom with technology versus without technology

- Theme 3 Previously: Benefits and drawbacks of technology
  Redefined to: Perceived Benefits and drawbacks of teaching with technology

4.6.1 Definition of themes

Theme 1: Influence of organisational and peer support on teachers' attitudes and perceptions of e-lessons is comprised of the different initiatives that the school, as an organisation, has put in place to support the teachers' use of technology, as well as the support that has been shared amongst the teachers themselves, as peers. Organisational and peer support emerged as major themes after data analysis, therefore this theme aims to capture the essence of the impacts of organisational and peer support through the teachers' lived experiences.

Theme 2: Typical Mathematics classroom with technology versus without technology, consists of: how the teachers conduct their lesson in terms of their rules; what can and cannot be done in the classroom; their goals, i.e. what they intend to achieve as a result of their teaching; their concerns in the classroom; the divisions of labour/roles between the teacher and the learner in the classroom; their pedagogic context, which refers to the teacher's instructional approach in the classroom. All these aspects were considered for scenarios when technology is used in the classroom as well as scenarios where technology is not in use. The sub themes of Theme 2 are: Classroom rules; Classroom Goals; Teacher concerns; and Division of duties in the classroom.

Theme 3: Perceived benefits and drawbacks of teaching with technology encompasses the different technology that the teachers report they are using and the perceived benefits and/or drawbacks of this technology. The sub themes of Theme 3 are: technology teaching tools, which consists of the different technologies that are being used segregated by the purpose of the tool;

the benefits of technology, which consists of the different benefits of these tools as well as other benefits that are not tool specific; Drawbacks of technology, which consists of the various drawbacks identified by the teachers.

4.7 Thematic Analysis Summary

Chapter 4 summarises Braun and Clarke's (2006) phases of thematic analysis, in the context of this study. This chapter describes the 5 phase process and identifies themes and codes from the interview data. Three themes emerge as a result of the thematic analysis, and these are analysed and discussed in chapter 5.

Chapter 5: Interview Analysis and Discussion

This chapter entails the analysis of the interview data, guided by the three themes that were identified in chapter 4. Theme 1: Influence of organisational and peer support on teacher attitudes and perceptions of e-lessons, Theme 2: Typical Mathematics classroom with technology versus without technology, and Theme 3: Perceived Benefits and drawbacks of teaching with technology.

Each theme will be linked to the research question that it answers. Thereafter, the interview findings within a theme will be reported by providing a descriptive account (Ritchie, Spencer & O'Connor, 2004). Finally, a discussion will be presented to conclude each theme, in order to explore and interpret the findings, by linking them the literature (Burnard, Gill, Stewart, Treasure & Chadwick, 2008).

5.1 Theme 1: Influence of organisational and peer support on teacher attitudes and perceptions of e-lessons

This theme aims to answer research sub-question 1: What attributes of the activity of conducting a mathematics e-lesson influence teacher's attitudes and perceptions of an e-lesson?

Theme 1captures the extent and nature of the support that the teachers believe they have received from the school and from their peers in relation to the introduction of technology into the classroom. Furthermore, to identify whether the support has influenced their perceptions, attitudes, and self-efficacy towards e-lessons. This theme has been categorised into organisational support and peer support.

5.1.1 Organisational support

The first section of Theme 1 focuses on the organisational support provided by the school. The suggested reason behind the school's support and commitment is that the school is striving to be a technology-based school. The teachers report that this may be the reason behind their commitment to this initiative, *"I think because we're actually a technology-led school and we are striving to be paperless so we investing in technology use*" (Janet). Furthermore, the fact that the principal of the school is a mathematics teacher leads some teachers to believe there is more support for them as mathematics teachers, *" in terms of support the fact that our principal is a maths teacher is very positive (Charlie).*

The different forms of support that the teachers report they have received from the school include: training and providing technology infrastructure ; "*They've always done their best to make sure that we do our best that's one thing that they didn't compromise well" (Raj).*

5.1.1.1 Training

The school provides training in different contexts, for example before a specific technology is implemented, as well as if there are any updates made to the technology currently in use at the school, "*a few Saturdays ago we were training on the LMS so they're trying to train us on it before it's implemented so that we know exactly what to do, we had a lady here also last week that trained us on smart board to just show us all the new aspects...so every time something is new they try to get someone in to provide us training, or information on what's going on"* (Janet). Additionally, the teachers suggest that the frequency of training is constant. Smanga reports "w*e are usually on training", "it (training) is on-going definitely*" (Sarah), *"we normally have training* (Janet).

Notwithstanding the training that has been provided, Vivian and Janet report that practice is an essential activity; "*my training has been given to me up to the basics…so it's up to me then to practise it*" (Vanessa), "*we received training for the LMS... the rest is from practising, doing it, making mistakes and doing it over"(Janet).*

5.1.1.2 Effects of training

Self-Efficacy

Training seems to have made teachers more confident, as well as improved their self-efficacy with using the technology, thus facilitating a more extensive use of e-lessons in the schools. Teachers indicate that the training provided by the school has allowed them use the technology more comfortably and confidently "*there's still a lot to learn…according to the level of training that we have received right now I think I'm operating optimally on that level*" (Vivian), *"I think we have been trained on how to use it...so with regards to confidence...I am quite confident. I use it all the time, in fact, if there's a day that I can't use it is a nightmare*" (Raj).

Attitude

Chauke, who is one of the newer teachers to the school, reports that he started working at the blueprint school at a time when e-lessons were not really being used effectively in the mathematics department. Since then more training was put in place and this worked in his favour, *"the e-lessons in maths department were not being effectively used…the school has put in some training in place which is an advantage to me now".*

Sarah, who has 46 years teaching experience and describes herself as *"BBT…born before technology",* feels that the while the training has assisted her in not being as *"scared"* as she was initially, she "*gets lost very easily in the training sessions"* and thus procrastinates using the new

technologies "*every time something new comes in, I'm not scared anymore but then I think, wait not now.*

5.1.1.3 Infrastructure

Another form of support from the school is the infrastructure available to the teachers. The teachers report that there are on-site technicians available at the school to assist if there is any technical support needed, as well as technicians specifically designated for the mathematics department *"yea we do have technicians that are aligned to each department and also a lady, you just run to her or WhatsApp, "there is a problem in class", immediately she responds or sends the technician to come in…we have a lot of technicians, they are based here."* (Chauke); *"we've got, we've got lots of technicians… two maths technicians, for maths that provide support in the classroom* (Raj).Vanessa appreciates that presence of the technicians at the school, stating that technical glitches are a potential distraction to the learners *"the technicians know when I call, to come immediately because it's for my learners. You know if you get your learners up to a certain level of concentration if there's a mistake somewhere then you lose them."*

5.1.2 Peer Support

It is reported that some of the older teachers have not been keen to make use of e-lessons, "*there are some old teachers in the department who would say"ah, ah we don't think so…we need it in some sections but not all.*" (Chauke); "*I think initially when we were first introduced to the idea we had quite a few of, I'll say old teachers that were stuck in their ways and they didn't see this as a positive change*" (Raj). However, Raj reports that the older teachers' perceptions were altered when they actually saw other teachers working with e-lessons "*with time when they saw everybody starting to work with it…that began to change people's perception of the idea"*. Sarah, who refers to herself as "BBT"- Born before technology", concurs *"I was initially scared, not resistant, but really nervous and scared…all the assistance and encouragement from other staff encouraged me…we have a lot of young staff, and then they encouraged me a lot…you know, just like supportive, that's it, I can go to anyone and say, listen here help me with this, how do I do that that, they won't say no".*

Vivian however, complains that there are certain teachers that withhold assistance in order to appear more knowledgeable than their peers, "*certain teachers will share, other teachers won't share because they want to be the star they want to get the pat on the back- "oh you are so good"and they not prepared to share that knowledge".*

5.2 Discussion Theme 1 – Influence of organisational and peer support on teacher attitudes and perceptions of e-lesson

5.2.1 Organisational support

The support or commitment of the organisation (school) towards the use of technology refers to structures that have been put in place to allow the users to comfortably use technology. This could be through training, facilitators, and continuous support (Toyama, 2015). Toyama (2015) emphasises that technology is not the unequivocal solution to social problems, including improving and transforming education, therefore factors such as organisational support need to be explored and taken into consideration.

The findings of this study seem to indicate that training and infrastructure have been addressed by the school and the teachers appear to be content with the support being provided.

5.2.1.1 Training

Studies have indicated a relationship between training and improved self-efficacy. Bandura (1997) describes Self-efficacy as one's belief in their ability to carry out an activity. In existing research it is suggested that when teachers believe in their ability to teach with technology, they are more likely to actually use it (Paraskeva, Bouta, & Papagianni, 2008; Teo, 2009). Similarly, in this research, the teachers believe that the training provided by the school is sufficient and has actually increased their self-efficacy with regards to conducting an e-lesson. In spite of this, it should be noted that enhanced self-efficacy does not guarantee the actual use of technology (Wang, Ertmer, & Newby, 2004). For example, Sarah, who is one of the teachers who was anxious and nervous towards conducting and e-lesson, was less anxious after attending training. However, she went on to mention that she takes long to catch on with concepts that are taught in the training sessions and therefore procrastinates putting the training into practice and using technology to teach. This finding reiterates the importance of professional development for teachers who are older and have not used technology for the majority of their careers (Cope & Ward, 2002)

5.2.1.2 Infrastructure

The technical support infrastructure provided by the school is an issue of importance, as technological issues have led to the failure of many education technology initiatives previously (Farivar, 2014). In this research, the technical support provided by the school is carried out by technicians that are on site, and the teachers appreciate that they can just “run” to the technicians as malfunctions serve as distractions in the classroom. This can be seen as an advantageous form of support from the school and an aspect that should be kept consistent due to its importance and benefits.

5.2.2 Peer support

Zhao and Cziko (2001) claim that, if teachers observe their peers, or a simulation of the education in technology model being used successfully, they are more likely to use it as well. The findings of this research concur, as the older teachers who were invested in their pedagogic practices, warmed up to technology use after seeing their peers using it. This reflects the influential power of peers on each other, as they share goals and experiences. Furthermore, this is claimed to be a better method of convincing teachers that have a bad perception of technology to use it, in comparison to technology specialists selling the idea to teachers (Zhao and Cziko (2001).

5.3 Summary Theme 1

In order to answer the research sub-question, "What attributes of the activity of conducting a mathematics e-lesson influence teacher's attitudes and perceptions of an e-lesson?" The findings suggest that organisational support from the school promotes teachers' self-efficacy and positive attitudes and perceptions towards conducting e-lessons. Training and peer support are reported to have brought about more positive attitudes towards, and perceptions of, technology. The training provided by the school reportedly has improved the teachers' self-efficacy, while encouragement from peers was found to be effective in altering negative perceptions of technology due to the shared goals and experiences of teachers as peers. Other forms of support from the school include technical staff and addressing teachers' concerns, which brought about more positive attitudes in the teachers as well. Organisational and peer support are, therefore, critical factors that influence teachers attitudes and perceptions of technology.

5.4 Theme 2: Typical Mathematics classroom with technology versus without technology

This theme directly relates to research question 2: How does conducting a traditional mathematics lesson compare to conducting an e-lesson?

In order to answer this research sub-question, this theme aims to capture the essence of the differences that exist in the activity of conducting a mathematics e-lesson in comparison to conducting a traditional lesson. There are five subsections covered in this theme: classroom goals; classroom rules; teacher concerns; roles in the classroom (including controlling the classroom and the description of a typical classroom) and pedagogic context. Thereafter a discussion of the theme will follow.

5.4.1 Classroom Goals

Some of the teachers suggest that their goal, whether teaching with or without technology, is based on either learner assessment, learner interaction or learner feedback. Chauke and Raj believe that students' marks after assessment are an indication that their teaching goal has been met "*If I assess my*

learners at the end of the day and I get the expected results such as better average or an improved average" (Chauke); "*their marks to me is an indication that I'm doing something right*" (Raj). In addition to the learners' assessment results being an indication of goal achievement, some teachers also consider learners' results as a form of self-assessment for themselves "*when learners do a test …and then you check the test results….I know how well I presented this…it is really what I measure myself with*"(Sarah). Sarah suggests that feedback and interaction from her learners is the goal when teaching "*when I'm getting feedback from the learners and it's positive and they are excited and I can see that maths was fun".*

5.4.2 Classroom Rules

When analysing the data collected regarding classroom rules, teachers believed firstly that structure was essential; secondly that rules do not change regardless of whether one is using e-lessons or not; and thirdly, that rules in the classroom are transformed when teaching with technology. These views are elaborated below.

5.4.2.1 Structured rules are essential

It was reported that classroom rules, for most of the teachers, involve a very structured process. This process entails asking the learners to line up outside and before being instructed to go into the class and take out their books or their tablets. Chauke believes these structured rules are essential for him to have control of the classroom *"see you need to control your class and the controlling of your class depends on what you layout for the learner, so like generally when learners come into class it's a norm that they stand up, make sure that every desk is aligned .. I have to say "take out your tablets" because with this technology some of them have got cell phones and all that stuff"* (Chauke).

Vivian complains about other teachers not being exemplary despite their stern criticism of learners. She believes that classroom rules should apply to both teachers and learners. She expresses her frustration and reports, *"It doesn't say these are the rules for the students, they are classroom rules…For pete's-sake. You as a teacher are part of your class aren't you? Or are you the selected diva in that class and rules do not apply to you"* (Vivian).

Janet believes that while she is not strict to ensure that learners are with her in the lesson, she doesn't allow them to accesss social media in her classroom. *"I don't think I'm that strict as long as they don't go on social media ".*

5.4.2.2 Rules remain the same

With regards to a shift in rules when teaching with technology versus teaching without technology, Chauke believes that it is not classroom rules that change but rather it is the media, i.e. the move from

books to mobile devices as substitutes. *"There's no rule that has been changed yea…actually because they are using technology stuff…it is like saying take your textbook and put it on the table"* (Chauke).

Additionally, Sarah, another teacher, believes there is completely no change in their classroom rules. Sarah adds that she has not noticed a change in rules and her focus is on discipline and learning and is more traditional in nature, *"no they have not changed at all. I'm still really on the old school.., with my discipline, you will learn in my class, nothing more, whether you like it or not*" (Sarah)

5.4.2.3 Rules have transformed

Within this group of teachers there were differing opinions; some suggested that the proposed transformation of classroom rules as a result of technology has led to more classroom rules, while others believe there are now fewer rules.

Janet reports that now the use of technology is allowed in the classroom whereas, previously, the learners would be asked to keep their smart phones away from class, *"normally we will say no cell phones no tablets but now since we using e-lessons it has to be 'take out tablets' most of the time… if they don't have a tablet for one or another reason, then they will use their smart phones"*. Raj believes that because there is now technology allowed in the classroom, this calls for more rules and stricter control in the classroom in order to monitor learners closely and ensure that they do not stray from the classroom material, *"you have to be very strict now that we've introduced tablets... you have to make sure that, that learners are utilising the tablets for the correct purposes. You know, we have to monitor that while we teaching they not playing games... they're not listening to music so, headphones and all these things they're not allowed in my class...so here, we had to adapt, you know to make it successful, but they can carry on doing their own things if you're not monitoring*".

Notwithstanding the introduction of new rules, which according to Raj creates more work on the teacher's part, Raj also feels that in the long term the effort by teachers is worth it *"you know, I don't think there are any negatives to it you know, because you know rules are there to be enforced, so, if we introduce something new obviously we have to enforce, so there's nothing negative, there's much more work involved but it pays up in the long term"*

Vivian, on the other hand, who also reports that classroom rules change when teaching with technology, believes that there are fewer rules when teaching with technology because the teacher is now more involved with the learners, which gives the learners a feeling of equality, and encourages them to perceive the teacher and the classroom differently. According to Vivian, this shift to a less hierarchical classroom structure promotes effective teaching and learning, *"I think there are fewer rules... Because you are so part of the learners that you don't get time to sit at the table and eat*

now...or be on the internet or be on your damn phone or all the things the learners are not allowed to. It forces the educator to become part of that, and once the learner realises that, "Oh but ma'am is now a part of us" "she's now part of us...she's with us...rules apply to her as well, Once they have that you've got that class in the palm of your hands and effective learning and teaching can take place, I think e-learning is awesome instrument as far as effective learning and teaching."

5.4.3 Teacher Concerns

Some of the teachers report concerns towards using technology in the classroom. These include tablet misuse and negligence from the learners. "*I think the challenge is like in any other subject when learners start abusing the tablets"* (Sarah), *"at the moment, the fact they use it for something else, they use it for socialising, they use it for other purposes than their classwork" (Janet).* Sarah, however, does not feel that this impacts on her classroom as she limits the use of technology *"this does not happen in my class...I try to minimise the usage of the tablet in my class...I tell them, 'only take out your tablets when I tell you to do so'... you don't use a tablet when I teach."*

Learner negligence was highlighted mainly due to learners periodically not bringing their tablets to school or claiming they are unable to charge their tablets due to lack of electricity*," on some days you'll find that not all learners bring their tablets during the day"* and *"some learners will say that they have no electricity to charge their tablets"*(Raj).

While there are concerns, two of the teachers report that they would rather not focus on concerns related to the use of technology as they are passionate about teaching with technology. Smanga, the teacher who has only ever taught with technology reports, *"I love technology"*. Vivian, an older teacher with some technology development experience claims *"I do not look at the concerns right now, my focus is pure implementation and getting the knowledge across effectively".*

5.4.4 Roles in the classroom (Division of labour)

The division of labour refers to both the teachers' role in the classroom as well as the learners' role. Teachers seem to have varied opinions in this regard, with some suggesting that since the introduction of tablets their duty in the classroom is to now control the learning environment; others feel that division of labour in the classroom remains the same; while yet others believe the tablet has brought about more equality into the classroom.

Chauke and Sarah feel that control is essential, especially since the introduction of tablets, as the learners could be misusing the tablets, *"you need to control…the learners are using the tablets, you are using the laptop…and you don't know what it is that the learner is engaging in... you just to make sure that you control them whenever they are working on the gadgets"* (Chauke). The need to be a

"boss" in the classroom is emphasised by Sarah, due to the types of learners in school nowadays, *"well I'm the boss in my class… and because of the type of learner, that we have now, you can't, you can't let them be free in your class, unfortunately, I would say, it's not a free attitude in the class anymore"* (Sarah).

Raj and Janet seem to disagree with Chauke and Sarah, claiming that there is no shift in roles as the teacher's role is to teach effectively and the learner's role is to participate and interact in class, regardless of whether there is technology being used or not, *"look I think there are boundaries, there have to be boundaries, my core responsibility is to, is to ensure that effective teaching takes place so I will have to instruct at the same time we have to share the duty, as well we have to have discussions, we have to interact so it's a bit of both"* (Raj). Janet agrees, stating, *"I think my main duty is to teach. To make sure they understand the work and that they actually do the classwork and homework…their duty is still to learn, I don't think, even though the message may change the duties will stay the same."* While the division of duties has not shifted, Raj does feel that the introduction of technology has facilitated a more responsible attitude amongst learners *"well I can say that, that, learners have become more responsible… I'm talking from my class, they know because, we've spoken about the rules, so they tend to adhere to the rules because they' know that it's a winning formula .it's a recipe for success basically so they're responsible in that way too, to ensure that they have the necessary tools, to make sure that effective learning and teaching takes place."*

In terms of a shift in division of labour, Vanessa feels that equality in the classroom is important and that she is more of a facilitator in the classroom; "*so if they shout at me, I shout at them, if they klap me, or push me out of the way, I'll do the same thing… it is more learners are constructing their own knowledge… what I said to one of my classes today, I'm just an instrument I'm a facilitator, I'm not a teacher I'm a facilitator.*"

5.4.5 Pedagogic Context (Teachers Pedagogy)

Pedagogy can be described as the type of instructional approach used by a teacher and is generally defined as either constructivist/instructivist (Duffy & Jonassen 1992). The combination of all the above; the classroom goals, rules, teacher concerns and roles form part of the teachers pedagogic context.

5.5 Discussion Theme 2-Typical mathematics classroom with technology versus without technology

5.5.1 Classroom Goals

According to Postman (2000), teachers' goals need to be articulated in order to avoid new technology taking them in a direction that they are uncomfortable with. The findings suggest that the teachers' goals, whether utilising technology in the classroom or not, are based on two major premises; feedback from learner assessments and learner interaction in the classroom. The technology should, therefore, be adaptable enough to allow the teachers to achieve these goals (Cohen, 1988) and this could perhaps promote positive perceptions of the technology.

5.5.2 Teacher Concerns

Some of the teachers report concerns which were mainly associated with the learners misusing the tablets for social media or for non-class related activities, and learner negligence, for example not charging their tablets or not bringing their tablets to class. Tablet misuse has been reported as a concern in other studies, such as Schwarz, (2003) where teachers became so frustrated by tablet misuse in their classroom that they unplugged the wireless transmitter. This was because their students were engaging in non-academic activities via the internet and not paying attention to the teacher.

Learner negligence was a similar finding in a study by Ali (2012), where a policy had to be devised to encourage learners to charge their tablets as not bringing their tablets to class was equated to not bringing their textbooks to class. Additionally, this finding on teacher concerns fits well with a number of other studies (Lam &Tong, 2012; Schwarz, 2003) therefore it seems tablet misuse and learner negligence are areas that need to be addressed as teacher concerns.

Lastly, in Cope & Ward's (2002) study on experienced teachers and their perceptions of technology, it was found that teachers with no prior experience in using technology to teach, need professional development in using teaching technologies in order to alter their negative perceptions. An interesting finding was that two teachers, Vivian and Smanga, were not at all focussed on their concerns towards the technology but were more interested in the implementation and use of it. Smanga has only ever taught with e-lessons and Vivian has prior experience developing and using teaching technologies. A possible reason that Smanga and Vivian didn't focus on their concerns or negative perceptions of technology is that both have prior professional development relating to teaching technologies. Thus the importance of professional development in teachers that have not had prior exposure to technology can be highlighted as a key point that may affect perceptions of technology.

5.5.3 Rules

From the findings, differing schools of thought emerged with regards to classroom rules when teaching with technology; some of the teachers report no shift in rules, others report that there are fewer rules, while yet others report that there are more rules.

The teachers who do not report a shift in rules believe that technology is simply the medium of instruction, or a means of delivering a lesson. For example, a tablet could be a substitute for text book, "*instead of saying take out your books we say take out your tablets*" (Chauke). In the seminal Kozma-Clarke debate, Clark (2002) claims that the medium is but a mere vehicle and what actually has more influence on education is the teacher's method of teaching. Kozma counters this and claims that medium is more than a vehicle for delivery and can be used to reap more benefits in an educational context (Kozma, 1994). This finding appears to lean towards Clark's (2002) perspective in the Kozma-Clarke debate described above.

Furthermore, Ilomäki and Rantanen, (2007) state that the classroom which integrates ICT encourages fewer rules and it is more free, as is the relationship between learners and teachers. Vivian's view on rules reflects a similar opinion, as she believes that there are fewer rules when technology is introduced and this is reportedly due to the teacher's integration with the learners in a technology-led classroom.

Lastly, Lim et al., (2003), report that in a technology-integrated classroom there are additional rules and procedures to be established due to the inclusion of computers, printers, monitors, CD-ROMs, and other technology resources. In agreement, Raj believes there are more rules, as the teachers need to be stricter due to the risks of tablet misuse and the fact that technology-specific rules need to be integrated into the classroom.

Based on these findings it seems that there is no definitive answer regarding whether or not technology calls for more classroom rules or not as the teachers' perceptions and pedagogies vary. This variation may be attributed to teachers being individuals with various experiences and different personalities (Farrel, 2007). Therefore, it appears that the teachers' experiences of technology in the classroom cannot be understood by one universal perspective, but rather can be explored as a combination of different experiences of individuals.

5.5.4 Roles in the classroom (division of labour)

It appears that the roles/division of labour in the classroom, when conducting an e-lesson versus when not, are similar to the classroom rules discussed above, which are relative to the teacher and their individual perception of technology. Some teachers believe that learners become more responsible,

while some teachers believe that they have a more facilitative role or that their role is to control the classroom even more when conducting an e-lesson. Lastly, some teachers believe that there is no shift in the roles at all. This difference in teacher perceptions can be attributed to the teacher's pedagogic context which refers to the individual teacher's approach to teaching (Duffy& Jonassen, 1992).

5.5.4.1 Learners are more responsible

Sankar and Karri (2016) in their study suggest that the learner takes a more active role in a technology-enabled classroom and is more than just a recipient of information. Rather, the learner makes choices on how to retrieve, manipulate or generate information. Echoing this, the findings also suggest that there is a shift in roles from the learner perspective, with the learner being more responsible in an e-lesson due to the benefits that they may reap if they abide by the teacher's methods and play their role as well.

5.5.4.2 Teacher facilitates or Controls the Classroom

Additionally, Sankar and Karri (2016) claim that it is important that the teacher takes on a facilitator role in a technology-led classroom. Rather than being the centre of the class, they should assist and interact with the learners more by walking around the classroom, as an example. In agreement with the literature, Vivian views herself as a facilitator in the classroom and attempts to promote equality between the learners and herself, and she walks around the classroom as she conducts an e-lesson. In disagreement with Sankar and Karri (2016), the rest of the teachers seem to be of the view that controlling the classroom and being the boss is necessary, this may be due to the concern that learners may misuse technology (Schwarz, 2003; Lam &Tong, 2012).

5.5.4.3 No shift in roles

While it can be argued that the classroom rules may change when conducting an e-lesson (Sankar and Karri, 2016; Wang, 2002; Clark, 2013), some teachers report that there is no shift in rules at all when technology is used to teach, as the teacher's role is still to pass on knowledge through teaching, and the learner still has the role of participating, interacting and learning in the classroom. This is an agreement with studies that state that technology use does not necessarily bring about a change in the science of teaching as there are a number of aspects to consider, for example the teacher, the teacher's objective, the classroom rules, the community, the technology and/or the classroom roles (Stoddart and Niederhauser, 1993; Van Dusen & Worthen, 1995, Engerstrom, 1987).

Similar to the classroom rules described prior to this section, the perceptions and experiences of teachers differ regarding teaching with technology as opposed to teaching without it. This could be due to the teachers' individual beliefs as they experience technology differently (Fullan, 2001;

Niederhauser & Stoddart, 2001). This finding reiterates that there is no set solution on how to use technology in the classroom and that teachers' beliefs and perceptions need to be accounted for when implementing technology in education, as it is not a panacea for improvements in education.

5.5.5 Pedagogic context

The teacher's pedagogic context consists of the teacher's goals, rules, concerns and roles. After analysis of the interviews the teachers pedagogic contexts can be classified as either instructivist, constructivist, or unclear. The instructivist approach, according to Duffy and Jonassen (1992), is focussed mainly on presentation, memorisation, and recall of content alone. This approach is often described as teacher-centred, as the teacher decides on content, assignments, and assessments and directs the learning by presenting lectures and directing classroom activities and then questioning the students (Sparks, Thomas, Jackson & Alexander 2012). At the other end of the spectrum lies the constructivist perspective which claims that knowledge and skill develop only in situations in which learners have meaningful experiences (Dewey, 1938). Constructivist teaching is mainly characterised by "class-wide or small group discussions, reciprocal questioning, and self-assessment" (Sparks, et al., 2012, p.4). Based on the teachers responses and descriptions of their typical mathematics classroom, some characteristics such as, goals focussed on classroom interaction (Duffy & Jonassen, 1992),or the perception that learners are more responsible for their learning in a technology enabled classroom are more constructivist (Sparks, et al., 2012). While the characteristics such as controlling the classroom, being "the boss" in the classroom, and having the main goal being the results from learners assessments are more of an instructivist nature (Duffy & Jonassen, 1992). The findings don't necessarily point to technology favouring a more constructivist approach as the teachers responses varied.

5.6 Summary Theme 2

In order to answer research sub-question 2: " How does conducting a traditional mathematics lesson compare to conducting an e-lesson?" Theme 2 covers: classroom goals; classroom rules; teacher concerns; division of labour; and pedagogic context, specifically comparing an e-lesson and a traditional lesson. Of these aspects, teachers' perceptions of classroom rules and roles differ, while perceptions of classroom goals and concerns were similar amongst the teachers. Each teacher had the classroom goal of either a high average when assessing learners or of learners interacting in the classroom. The teachers also seem to have a unified view on their classroom concerns, mainly focussing on tablet misuse by the learners and learner negligence.

The overall finding with regards to classroom rules and division of labour/roles when conducting an e-lesson and when not, was that there were differing views regarding whether the same methodology that applies to a traditional lesson would apply to an e-lesson. This finding suggests that individual differences play a major role in teachers' rules and roles in the classroom. Not all teachers will conduct their classroom in the same way regardless of technology, as teachers have concerns, goals, pedagogic contexts and different professional development backgrounds (Farrell, 2007; Freeman & Johnson, 1998).

5.7 Theme 3: Perceived Benefits and drawbacks of teaching with technology

Theme 3 relates to the third research sub-question: "What are the perceived benefits or drawbacks of an e-lesson, based on the interaction between the mathematics teachers, the technology used, the classroom rules, the school, other teachers and different duties in the classroom?"

In order to answer the above research sub-question, Theme 3 explores teachers' perceived benefits and drawbacks of technology when they conduct e-lessons. Firstly, the tools that make up an e-lesson have been described and classified according to their purpose; classroom management tools or presentation tools. The perceived benefits of the tools are then described where applicable, followed by the perceived drawbacks of technology,and finally, the structure of an e-lesson, which is a combination of these different technology tools, is described. Some perceived benefits mentioned by teachers are: enhancement of existing teacher skills - *"Technology has enhanced my skills…I have become an even better teacher*" (Chauke); Vivian, who previously developed educational software, states that she developed software in order to enhance the teacher's skill - "*I wrote software... to help enhance teachers... so they can say okay my lessons have been worked out*" (Vivian); simplified teaching - "*technology makes teaching simple. It facilitates learners understanding*" (Raj); "t*eaching with technology is much easier and learners can easily understand"* (Chauke); and more learning opportunities for the learner - *"technology gives learners a better chance at learning"* (Janet).

The perceived drawbacks described by the teachers include;

Learners misusing technology, and classes being disrupted by technology malfunctions.

The section below describes tool specific perceived benefits.

5.7.1 Teaching technology tools in use

The teachers report that the following software tools are being used in their classroom: LMS, Moodle, PowerPoint, YouTube, Siyavula, scribbler, Train your brain (TYB), GeoGebra, smartboard, maths, and science.com. These tools are grouped into two categories below, based on their purpose. The tools have been grouped into classroom management and presentation tools.

5.7.1.1 Classroom management tools

The two tools that were reported as classroom management tools were the Learning Management System (LMS) and Train your brain (TYB). They are described below:

- **Learning Management System**

An LMS is classroom management software utilised to manage classrooms and learning, by allowing the exchange of material through uploads and downloads as well as communication between learners and teachers (Ellis, 2009). The blueprint school currently makes use of an LMS which they refer to as "LMS" and not by any specific name , *"they had been using Moodle and now they are replacing it with LMS"* (Chauke), "*LMS is going to work very well, I like it"* but that it is intended to facilitate management and not teaching tasks *"not for the subject (maths) particularly… but for the management of the school".*

- **Train Your Brain**

Train your Brain (TYB) is a portal for learners and teachers that allows upload and download of lessons (Thango, 2016). The teachers upload their lessons on this portal and the learners can download it at any time.

- **Perceived Benefits-classroom management tools**

The classroom management tools, LMS and TYB allow the storage of learning material on a portal and have the advantage of allowing re-visiting of class work at a later stage, *"Say a child was absent now they can go through the recording. Also for the next grade, so it's one and the same thing now, which is much better because it makes them go over their work until they prepare, if something they have missed they can go back*" (Chauke); "*See the thing is its good uh, uh, from a learners point of view because if they didn't understand a certain concept, if they didn't understand my method then they can go back to the PowerPoint and go through it*" (Raj).

5.7.1.2 Presentation tools

For the presentation of content, teachers mentioned, YouTube, PowerPoint, and GeoGebra, smartboard, Siyavula, maths and science.com.

- **YouTube**

"*YouTube is a website used for educational videos"* (Chauke). It was acknowledged for having useful content that the teacher can play for learners, reportedly aiding the teacher's explanation, "*the videos assist with giving the learners an opportunity to view something being done first on video and then you as the teacher come in and explain"* (Chauke).

- **PowerPoint**

"PowerPoint is used to project content to the learners" (Vivian). The integration of YouTube and PowerPoint, reports Raj, can be used to create a seamless lesson, "we download *those YouTube videos, save it, as a file and then we upload it into our PowerPoint so, everything is integrated, we don't have jump from one place to another…it ensures a smooth lesson…there's no interruptions, no need to go back into YouTube or whatever"*. Furthermore, emphasis was placed on PowerPoint for facilitating the review of classroom content at a later stage; "*I like the fact that we can use PowerPoint and the learners can refer back to it*" (Janet), *"See the thing is it's good, from a learners point of view because if they didn't understand a certain concept or if they didn't understand my method then they can go refer to the PowerPoint again"* (Raj).

- **Scribbler**

Scribbler is reportedly used *"when you present your lessons but you're controlling the lesson"* (Chauke), "*and it also enables the teacher to record their lessons"*(Raj).The reported benefit of Scribbler is that teachers and learners are able to review the lesson material at any point at school or at home. Additionally learners that are absent, or those who would like to go over a concept that they did not understand, can take advantage of this tool : "*I find that there are learners who are absent for some reason and they missed out on a day, it's easier for them now to go and download the lessons coz remember in our lessons we've got the classroom activities list, the home work activities listed as well so they don't lose out on anything…and we have downloaded, good, good, videos so they can view them at the same time, and they can do that at home as well so it helps a lot"* (Raj).

- **Geogebra**

Geogebra is "*a tool that can be used for graphs instead of manually drawing them*' (Smanga), it can be used to draw the graph for a function (Sarah) and "*is used when you want to visualise graphs and functions*" (Chauke). Geogebra, was highlighted by many of the teachers, as they believe this tool makes it simpler to show graphs, as the visualisation provided to the learners is of great benefit, "*With Geogebra it's nicer when you show learners graphs so that they can easily see instead of me having to draw, it takes time so if I'm using Geogebra it makes everything simpler*" (Smanga), "*Geogebra is useful when you want the learners to visualise, for example, graphs and functions, this is easier than drawing the graph*" (Chauke).

In addition one of the teachers acknowledges how useful Geogebra is but goes on to state that she may not have skill in using it; *"Geogebra …if you take functions/graphs, you type in the function, or*

you write the function and then you drag it, up till you get to a point and, there's also the sketch and then you can do the movement of the sketch or transformation, it's amazing. If you ask me to do it now, I won't be able to do it I will still have to practise and practise" (Sarah).

- **Smart Board**

The Smartboard, *"is a replacement for the traditional chalk board, used to present material to the learners*" (Sarah). The smartboard was acknowledged for convenience, in terms of not having to erase it each time content was written on it, in comparison to the traditional chalk board. Additionally, the ability to save the content written on the smart board was highlighted as well as the games that are available to engage learners, *"well smartboard, is an advantage, the fact that I don't have to constantly erase, like with chalk… and the nice thing about the smartboard is that I can save everything that I want on the board so I can access them later, and if I want to put it up for my kids I can put it for them to download.. I do the same with the PowerPoint* (Smanga), *"the smartboard has all these fancy games and I think that we can use in class that can keep the learners focussed"* (Janet).

- **Other tools**

Another two tools that were mentioned, although not highlighted as much as the others are, Sivavula and Maths and Science.com; "*Siyavula has lots of questions for the learners to practise*" (Chauke), *"Maths and Science.com is a website that some of the teachers use to download teaching material from"* (Chauke).

Lastly, in contrast to all the other teachers who highlighted specific tools and their benefits, Vivian reports that all the tools work together to have an impact and she cannot highlight any specific one, she places the responsibility on the teacher to decide on what is best for the learner: "*you know what I explore all of them because every one of them are unique and can deliver a uniqueness to a bigger picture I cannot say Moodle is not good, I cannot say Siyavula is not good, I cannot say that scribbler is not good, I cannot say LMS is not good, you can grasp from all of them and take out the best for the learner".*

5.8 Perceived Drawbacks of e-lessons

The teachers highlight that there are some drawbacks of using e-lessons such as learners using tablets for purposes other than learning during classes; "*uhm, i think the challenges is like in any other subject when learners starts abusing the tablets..and doing funny things in the class*"(Sarah), "*concerns at the moment, the fact that they use technology for something else, they use if for socialising or other purposes than their classwork"*(Janet). Another drawback is that the class could

be disrupted if technology malfunctions and support is not immediate; "*when i call the technicians they know to come immediately because it's for my learners..You know if you get your learners up to a certain level of concentration, if theres a mistake somewhere then you lose them*" (Vivian).

5.9 Structure of an E-lesson

The integration of the technology tools that have been described above constitute an e-lesson. It seems that there is not one standard structure of e-lesson used by the teachers. Some believe in a rigid structure, others feel the e-lesson is dependent on the learner's needs while another perception is that it is integrated and therefore there are no defined steps to follow.

5.9.1 Rigid structure

Teachers with a more defined e-lesson structure suggest that an e-lesson usually begins with introductory questions, a PowerPoint presentation, classwork and then assigning homework going over homework corrections "*so the lesson has introductory questions, we've got between 3 to 5 questions, so we get learners to answer those questions, thereafter we look up the answers which are also part of the lesson, and then we've got a PowerPoint presentation which includes notes and the lesson…we've got a video slide and then we've got the classwork activity.. And then we've got the homework activity*" (Raj); "A*n e-lesson it starts with an overview and then there is also, questions so you can make learners to know what was in the previous lessons and then it introduces the new topic, then we do corrections"* (Smanga).

5.9.2 Dependant on learner needs

On the other hand, Chauke reports that there is no set structure for his e-lesson, but rather the structure is dependent on the learners' needs *"Basically, it all depends on what learners did not understand and whether you need to play the video again"... or if you need to explain something before you introduce a new concept which you want to show the learners".* While Vivian believes that an e-lesson facilitates more integrated teaching *"it's all integrated, there's not a phase where you lecture like many teachers do... I give the heading, I give the date, right this is what we're going to do and then I give the background to that heading: but I do that while I'm walking, because I've got a tablet, and I work on the tablet that reflects on the board*."

Lastly Sarah reports that she doesn't frequently make use of e-lessons and their various tools in order to teach as she still teachers regardless of the technology, *"I still teach....look in maths it's like working out sums and problems, so we work it out together, like you would've done with your black board same thing, same thing...my approach of teaching didn't change*". On the occasion that she does conduct an e-lesson she reports, *"The e-lesson consists of a PowerPoint presentation; which I*

use very seldom... The PowerPoint can also be downloaded on the learner's tablets for their, use so they can go home and watch the PowerPoint… I very seldom…really very seldom use it".

5.10 Discussion Theme 3-Perceived Benefits and drawbacks of teaching with technology

Pierce and Ball, (2009) assert that there are different forms of technology that can be accessed on a computer or hand-held devices, introduced specifically for mathematics. In this study, the different forms of technology used by the teachers were classified into two categories; classroom management tools and presentation tools. Sevilla (2013) states that an e-lesson involves the use of presentation software; videos; learning management systems; educational software; and online education systems to teach. The combination of the tools used in this study can also be described as an e-lesson. The perceived benefits of e-lessons were specific to the tools; LMS, TYB, PowerPoint, YouTube, Geogebra, scribbler, and smartboards. These benefits are explored below.

5.10.1 Benefits

The benefits of technology described in this research are similar to those described in prior studies: enhancement of existing teacher skills; aiding the teacher's explanation; simplified teaching and learning; convenience; more learning opportunities for the learner; seamless lesson; review of classroom content; revisiting of class work; visualisation; and to engage learners (Department of Education, 2004; Halverson & Smith, 2010; Maginnis, White, & Mckenna, 2000; Roden, 2011).

5.10.1.1 Enhancement of existing teacher skills and aiding the teacher's explanation

Toyama (2015) describes the amplification of one's ability, asserting that the role of technology serves to amplify and not minimise one's actual capacity or deficits, and therefore simply implementing technology will not provide the solution to existing problems. This means that if the teacher does not have already existing pedagogic skills, technology will not miraculously improve teaching. Some teachers in this study report that technology makes them even better teachers and that software enhances teaching. However, some researchers oppose this view reporting that in some cases technology in fact hindered teaching and learning (Smith & Hardman, 2014; Campuzano et. al., 2009; Clark,2002), while a large part of educational technology researchers view technology as completely beneficial for education (Al-Ammary, 2012;Al-Qahtani & Higgins, 2003; Newhouse, 2002; Marshall, 2002. This research seems to lean more towards the view that technology will simply enhance or amplify one's already existing abilities and not minimise the deficits (Toyama, 2015).

5.10.1.2 Simplified teaching and learning, convenience, and more learning opportunities for learner

The teachers highlighted that teaching is simpler and more convenient when they use technology. For example, they can save their lessons and upload them on the school portal, or with the smartboard they can save the work that is being presented in class. This is a vital aspect as the saved lessons can be referenced in the future.

5.10.1.3 Re-visiting of class work and Review of classroom content

Halverson & Smith (2010) state that technology eliminates distance barriers and allows access to teaching and learning material from anywhere. This benefit was reiterated by the teachers in this study, stating that even absent learners could access the classroom material from home, and was extended to even learners that simply wanted to revisit the class work.

5.10.1.4 Seamless lesson

The combination of different tools into one presentation allows the teacher to present an integrated and seamless and integrated lesson, despite different content being presented (Chan, Roschelle, Hsi, Kinshuk, Sharples, Brown, Patton, Cherniavsky, Norris, and Soloway, 2006). This was highlighted as one of the benefits of conducting an e-lesson by the teachers. For example, YouTube videos can be embedded in the PowerPoint presentation, allowing for different content to be presented and accessed in one place.

5.10.1.5 Visualisation

Connors (1997) claims that the visualisation provided by technology empowers students and enables them to create their own understanding of mathematical concepts, facilitating easier graph interpretation (Hennesy, 2000., Jarret, 1998).The teachers' comments regarding the presentation tool Geogebra, reaffirm the views from the literature. This tool was commended for allowing graphing to be presented in a simpler and more effective way than actually drawing a graph. From this finding, it could be suggested that graphing is one of the subject areas in mathematics that technology is beneficial for. However, it should also be noted that only the teachers who were able to use the tool, based on training or prior experience, reaped the graphing benefits.

5.10.1.6 Engaging learners/ improved student engagement

The teachers in this study state that their learners engage more in the classroom when technology is being used; some state that this could be because they know it is a "winning formula". In agreement, Koedinger (1997) asserts that the use of technology in classrooms engages learners, thus improving

their attitude towards learning. In addition, Roden (2011) highlights that it is not merely the use of technology but rather the appropriate use of technology that engages learners. This seems to suggest that technology is being used appropriately at the blueprint school, in the instances that student engagement actually improved. However, it is not clear from the study in which instances specifically that this occurred.

5.11 Leveraging of perceived benefits

The benefits highlighted above can be further explored using the Substitution, Augmentation, Modification and Redefinition (SAMR) framework by Puentedura,(2012) , or the Technologial, Pedagogical, and Content knowledge framework (TPACK) by (Mishra and Koehler, 2006), which have been used in previous studies to improve the use of technology in learning context

In SAMR Substitution refers to using new technology to perform an old task, Augmentation refers to further using the technology to modify how the old task was carried out, Modification refers to changing the way a task is completed by using technology, and, Redefinition refers to completely new tasks that were previously inconceivable. The Substitution and Augmentation elements collectively form the enhancement layer of SAMR while the Modification and Redefintion elements form the Transformation layer (Puentedura, 2012). Examples of these layers shown in this research are: Substitution; an example is how the Smartboard is perceived as having the same function as a traditional black board; *"is a replacement for the traditional chalk board, used to present material to the learners*"(Sarah); Augmentation; for example the smartboard in addition to presenting material, allows the presentation material to be saved, "*and the nice thing about the smartboard is that I can save everything that I want on the board so I can access them later.."* (Smanga); Modification;
in this research an example of this is the use of Geogebra to draw a graph instead of drawing it themselves, the teachers simply enter the function, "*Geogebra is useful when you want the learners to visualise, for example, graphs and functions, this is easier than drawing the graph"*(Chauke).
Redefinition: for example uploading the class presentation onto the learning management system, for absent learners to be able to access it, "*Say a child was absent now they can go through the recording"* (Chauke).
Furthermore using TPACK as a lens, the intersecting areas: Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), Pedagogical Content Knowledge (PCK), and Technological Pedagogical Content Knowledge (TPACK) are used to provide insight on how teachers can use technology to present content, using an appropriate pedagogic context through the application of technologies (Mishra and Koehler, 2006). TCK refers to the knowledge of the content that is to be

taught as well as the technology that can be used to present or teach this content, TPK refers to the teacher's knowledge of how to teach with technology and PCK refers to the teacher's knowledge of the subject that they are teaching. These could be applied to this research as follows: TCK: for example the teacher's seem aware that the tool Geogebra is suitable for presenting graphs, or that YouTube can be used to combine various types of content such as video and text to create. TPK: in this research it cannot be concluded for certain whether the teachers are aware of how to teach with technology, as it is suggested that the training provided to the teachers by the school is based on the tools and not how to teach using technology. PCK in this study the subject is mathematics, this dimension of the TPACK framework was not explored in this study as it was beyond the scope of the research question).

This discussion of the perceived benefits of technology, based on the SAMR and the TPACK model provides a picture of how technology can be leveraged to be beneficial for education, as well as the different types of knowledge that teachers need to have in order to incorporate technology in their classrooms. From this research it can be seen that the transformation layer in the SAMR has been reached using some of the technology tools, however, there are areas were technology is being used as a mere substitute to traditional teaching tools, and these areas should be explored further.

5.12 Summary Theme 3

In order to answer research sub-question 3: "What are the perceived benefits or drawbacks of an e-lesson, based on the interaction between the mathematics teachers, the technology used, the classroom rules, the school, other teachers and different duties in the classroom?", the findings from Theme 3 seem to suggest that the benefits of conducting an e-lesson are specific to the task that the teacher is carrying out and what the teacher is trying to achieve. For example, Geogebra is beneficial for visualisation when teaching graphs, while PowerPoint slides and YouTube can be combined for the seamless integration of a lesson. This echoes the argument presented in the introduction of this research paper that technology does not unequivocally bring improvements to education. It is more a tool to enhance the teachers' existing skills, and furthermore, needs to be utilised in a manner that will maximise benefits, by identifying which classroom tasks are more suitable for a specific teaching technology (Roden, 2011; Toyama, 2015). The perceived drawbacks relating to tablet misuse in the classroom and the disruption of the classroom due to malfunctions of the technology were highlighted as well.Lastly, the TPACK and SAMR frameworks provide insights on how to leverage the perceived benefits of technology in teaching.

5.13 Findings in relation to Conceptual Framework

AT (Engestrom, 1987) is the conceptual framework used for this research. The unit of analysis of AT is the activity system triangle which consists of six elements:

Subject: the teacher is the subject of the activity system and is the main actor in the system; **Tool**: the technology is introduced to the activity system as the tool which the subject (teacher) will use to carry out the activity; **Objec**t: The objective of the subject (teacher) is assumed to be the conducting of an e-lesson; **Rules**: are what mediates the activity of teaching, such as the classroom rules; **Community**: this is anything surrounds and possibly influences the teacher, for example, their peers; **Division of labour**: these are the roles and duties of the participants in the activity system, in this case, the teacher's duties and the learner duties in the classroom.

- **Subject**

The teacher was analysed in terms of their attitude (Becker & Riel, 1999); teaching goals (Kay & Knaack, 2008); self-efficacy (Ertmer, 2005), Pedagogic context (Duffy & Jonassen, 1992); shift in pedagogic practice, which affects the role of the teacher (Fishman, 2006; Pierce and Ball; 2009); teacher concerns (Karasavvidis, 2009); training (Cope & Ward, 2002); experience (Cope & Ward, 2002); time (Herrington, Herrington, Hoban & Reid 2009); skills (Herrington, Herrington, Hoban & Reid, 2009); and influences from other teachers and the school (Ertmer, 2005; Zhao & Cziko, 2001).

The findings seem to indicate that teachers are individuals with their own attitudes, beliefs and characters, which is what ultimately influences their perceptions and experiences with regards to e-lessons.

- **Object**

It was assumed that the object of the activity system was to conduct an e-lesson. However, the study showed that teachers have varying attitudes, beliefs and goals and, in this regard, they are not centred on technology but rather on assessments and classroom interaction.

- **Tool**

The tool in the activity system was the different forms of technology that were introduced to the school. This was summarised into two main categories; presentation and classroom management. It was found that if the subject (teacher) uses the tool (technology) appropriately, then the object (conducting an e-lesson) can be achieved. Additionally, it was found that the tools are beneficial for specific tasks and this should be explored in order to reap maximum benefit.

- **Rules**

The views of the teacher (subject) on the rules that mediate the activity system (the class room) are varied and will be discussed further below in the contradictions section.

- **Community**

The community (school and peers) had a major influence on the subject's attitudes and perceptions of technology as highlighted in the discussion above.

- **Division of labour**

The division of labour in the classroom varied and will be discussed in the contradictions section below.

5.14 Contradictions

As contradictions are points of tension in an activity and can be referred to as points for improvement (Engestrom, 1987), they will be addressed in the recommendations section of chapter 6. The contradictions in the activity system are as follows: the shift in rules when conducting an e-lesson; the new set of concerns that arise as a result of technology in the classroom; and the shift in the teacher's role (as well as the learners). The opinions of the teachers regarding these contradictions vary, this, additionally, is a contradiction in itself. AT (Engestrom, 1987), uses the concept of contradictions as points for change in an activity system. They can either be; primary (within a single element in the activity system); secondary (between different elements in the activity system); tertiary (as a result of a new element being introduced to the activity system); or quaternary (between activity systems). The table below summarises and classifies the contradictions found in this study after inductive analysis.

Contradiction	**Primary/Secondary/ Tertiary**	**Reason for classification**
The shift in rules –Some teachers believe there are more rules when teaching with technology, some believe there are less, and some believe there is no shift at all	Primary	This contradiction is perceived differently by all the teachers, therefore it seems as if it is specific to the teacher as an element in the activity system.
The new set of teacher concerns –When the learners use tablets in the classroom, most of the teachers worry about misuse of the tablets and negligence from the learners	Secondary	This contradiction occurs between the teacher and the technology, and is secondary as it is between 2 elements of the activity

		system.
The shift in the division of labour in the classroom-Some teachers believe they are the boss in the classroom, while others believe they have more of a facilitator role, and some believe there is no shift at all.	Primary	This contradiction varies per teacher, therefore, it has been classified as a primary contradiction within teachers as an element of the activity system

Table 4: Contradictions in the activity

5.14.1 Tensions caused by Contradictions in the Activity System

Previous studies have found that teachers tend to be resistant to change and to be risk averse, specifically with regards to educational technology (Howard & Mozejko, 2015; Njenga & Fourie, 2010). Therefore, the contradictions listed in table 4, could possibly lead to clashes and tension in the activity system. For example, Vivian describes herself as being more of a facilitator when she teaches, while Chauke describes himself in a more controlling role. It might be,for example that the faciliative role is more constructivist (Duffy & Jonassen, 1992), therefore Vivian may be comfortable with the shift in division of labour; while this shift may cause tension for Chauke's pedagogic practice.

5.15 Analysis and Discussion Summary

Chapter 5 is an analysis and discussion of the three themes that were identified in chapter 4. The various aspects of the teacher's interviews were highlighted and then linked to literature in the discussion section. The contradictions identified in the study are then highlighted along with how they could perhaps lead to tension. These insights from the discussion are the basis of the concluding chapter to follow.

Chapter 6: Conclusion, Implications, and recommendations

The motivation of this study was based on the fact that the use of technology in education has been viewed by some as an unequivocal solution to problems in education. South Africa formally introduced technology to secondary schools in Gauteng in January 2015, with the goal to improving the status of its education. However, the claim that technology automatically resolves problems in education has been disputed in literature (Drijvers, Ball, Barzel, Heid, Cao and Maschietto, 2016; Hardman, 2015; Oppenheimer, 1997).

Some scholars view technology as beneficial to education, while others do not believe that technology lives up to this expectation. This gap in educational technology studies provided an opportunity for the exploration of technology use in education. The reason that mathematics teachers were selected as a starting point is due to a preliminary interview that was conducted at the chosen school, where the principal stated that the mathematics teachers were the last to adopt technology after it was introduced to the school.

Purpose of the research

The purpose of this study was to explore the perceptions and experiences of secondary school mathematics teachers with regards to e-lessons. The research objectives are shown below:

- To understand teachers' experiences and perceptions of the activity of conducting a mathematics e-lesson while considering: technology; the teachers' peers; the school; classroom rules; and the division of duties within a classroom.
- To explore the differences between conducting an e-lesson in comparison to traditional teaching methods.
- To understand teachers' perceived benefits of conducting e-lessons

AT (Engestrom, 1987) is the conceptual framework through which this research was conducted. It allowed a holistic view of the activity of teaching mathematics to be obtained. The research was based on an interpretivist paradigm using both inductive and deductive coding and utilising an exploratory research design. Interviews were conducted and analysis techniques were used to then conduct a case study and carry out a thematic analysis three themes emerged from the thematic analysis:

- Theme 1: influence of organisational and peer support on teacher attitudes and perceptions of e-lessons;
- Theme 2: Typical Mathematics classroom with technology vs without technology;
- Theme 3: Perceived Benefits of teaching with technology.

6.1 Summary of Findings

The findings in Chapter 4 explore the perceptions and experiences of mathematics teachers with regards to e-lessons from an Activity Theory perspective. These findings are summarised below, per research objective based on the 3 themes for this study.

- **Objective 1:** To understand teachers' experiences and perceptions of the activity of conducting an e-lesson mathematics while considering technology, the teachers' peers, and the school.

  Firstly, it was found that the aspects of conducting an e-lesson that may influence teachers' perceptions and attitudes relate to organisational and peer support. Both these aspects of the activity of conducting a mathematics e-lesson appear to bring about positive attitudes, improved self-efficacy and positive perceptions of technology in the teachers.

- **Objective 2:** To identify the differences between conducting an e-lesson in comparison to traditional teaching methods

  It was found that the contradictions that exist in the activity of teaching mathematics with technology as opposed to without technology are: the shift in rules when conducting an e-lesson; the new set of concerns that arise as a result of technology in the classroom; the shift in the teachers' and learners' roles. These contradictions brought about the finding that teachers are individuals with differing beliefs and perceptions, regardless of technology.

- **Objective 3:** To understand teachers perceived benefits of conducting e-lessons.

  Finally, the findings suggested that the benefits of conducting an e-lesson, based on a teacher's perspective are: enhancement of existing teacher skills and aiding the teacher's explanation; integration/seamless lessons; simplified teaching and learning; convenience and more learning opportunities for learners; re-visiting of class work and review of classroom content; visualisation for graphs; and engaging learners/improved student engagement.

  Each of these benefits related either to presentation technology or classroom management technology and not all the technologies brought about the perceived benefits that are listed. This suggests that not all technology will automatically bring benefits to the classroom and the appropriate use needs to be implemented in order to reap benefits.

6.2 Significance of the study

This study contributes to the body of knowledge on the use technology in education in general and, specifically, for mathematics. Geiger, Forgasz, Tan, Calder, and Hill (2012) state that "how teachers develop technology enhanced approaches to pedagogy, and how the knowledge required to implement

such pedagogy successfully is acquired, are still open questions in need of further research" (p.126). This research focussed on the social and technological aspects of using technology within an educational context using Activity Theory as the conceptual lens (Engestrom, 1987).

Furthermore, the contradictions found in this research indicate that teachers may be risk averse and resistant to technological change based on their personalities and pedagogic contexts.

6.2.1 Academia

The existing body knowledge on the introduction of technology to education in low- to middle-income countries, more specifically in South Africa, has been enriched through the exploration of mathematics teachers' experiences and perceptions with e-lessons. An Activity Theory perspective (Engestrom, 1987), within an Information Systems study, allows the factors that affect technology in education to be considered and described, while exploring the impact of technology on the process of teaching (Isroff & Scanlon, 2002). This research has enriched the information system's body of knowledge by providing a psychological perspective and framework for e-lessons and education. This is similar to previous studies such as Hasan, (1999), Tay and Lim, (2016) and Hardman, (2007).

6.2.2 Practitioners

For Information system practitioners, mathematics teachers have provided information-rich responses relating to their perceptions and experiences of technology. Therefore, practitioners may apply the recommendations given in this study in order to identify which technologies are beneficial for mathematics and how they can be appropriately used. Furthermore, practitioners may take into account the individuality of the teachers as users of the software, as the findings of this study indicated that this was a key element to be explored with regards to technology in education.

6.2.3 Policy makers

The detailed perspectives from mathematics teachers may provide policy makers in South African education, such as the DBE and the GDE, with further insights that could inform their policy. The contradictions identified in the study can be used as a point for improvements. For example, teachers concerns about tablet misuse could result in a policy that caters for this concern before technology is rolled out at schools, or more training on using technology can be provided to teachers who need professional development.

6.3 Limitations and Further research

The limitations of this study were related to the data collection instrument and time.Semi-structured interviews were used as the data collection instrument. Since the information collected was self-reported by the teachers, there might have been limitations of self-reported data, such as response bias, on the part of the participants (Alshenqeeti, 2014). Further research could include observations of the teachers in their classrooms to supplement the interviews in order to improve the accuracy and validity of the reported data (Gray, 2009). It should be noted, however, that member checks were conducted in order to improve the validity of the data collected (Byrne, 2001; Denzin, 1978).

Another limitation is the nature of semi-structured interviews which, although they allow for rich insights to be collected (as the researcher can divert from the original interview questions and probe the interviewee for more information) (Harrel and Bradley, 2009), they make the interviews more time consuming to analyse, as was the case in this research.

Additionally, time-related limitation resulted in only the teachers being explored and not the learners. The study would not have been completed in the allocated time if learners were analysed as well. Further research could obtain the learner perspective in order to delve deeper into the findings from this study. For example, the teachers highlighted the Geogebra tool as beneficial for graphing and visualisations, while learners' perspectives of the same tool may provide additional insights.

Lastly, only mathematics was explored, therefore further research into other subjects, such as English and the sciences, could be conducted for perspectives on those teachers' perceptions and experiences of e-lessons.

6.4 Recommendations

The recommendations for this study stem from the main findings;

1. Peer and organisational support play a major role in influencing teachers' attitudes, perceptions, and self-efficacy towards technology.

2. Teachers are individuals and their perceptions and experiences with technology will differ.

3. Teachers are mainly concerned about tablet misuse and learner negligence of tablets.

4. The benefits of technology teaching tools for mathematics are: the visualisation provided for graphs; the simplicity of the task when using technology; and the amplification of already existing teacher skills.

Based on the major findings, the recommendations for practitioners (teachers), scholars, and policy makers are presented below.

6.4.1 Information Systems Practitioners

It is recommended that information systems practitioners, that design and implement software and hardware for e-lessons, are made aware of teacher goals, concerns and, perceived benefits and drawbacks of technology, and make this the basis of their implementations (Postman, 2000). This recommendation comes about based on the findings, as it seems that the teachers' perceived benefits of technology were task-based. Additionally, information systems practitioners should bear in mind the individuality of the teachers when designing and implementing software, in order to cater for differences in culture and beliefs. Interviews with the teachers are thus suggested as a proposed means of addressing the above recommendation.

6.4.2 Education Practitioners

From the findings, the blueprint school carries out on-going and consistent training and this is assisting in providing positive perceptions and attitudes towards technology (Paraskeva, Bouta, & Papagianni, 2008; Teo, 2009). The older teacher, however, complained about getting lost in the training sessions, although the training did improve her self-efficacy slightly. The school can provide additional training sessions for the older teachers in order to make them more comfortable and perhaps remedy this problem. In addition, there is a major difference between training to use a specific technology and training on how to teach using technology. This should be highlighted by the school and both of these types of training should be provided to the teachers.

Furthermore, web filter software can be implemented in order to provide a standard way to tackle teachers' concerns towards tablet misuse (Murdoch & Anderson, 2008). This software allows certain websites to be blocked from the learners' laptops, thereby blocking any non-educational material. There are sites such as YouTube that have the potential to be both educational and non-educational and this should be taken into consideration when implementing web filter software, as trade-offs will need to be made (Murdoch & Anderson, 2008).

Lastly, the software tools that the teachers highlighted for specific benefits can be explored further in the training sessions provided by the schools, in order to make all the teachers aware of the potential beneficial uses of them. For example, the Geogebra tool is beneficial for visualisation or Siyavula is beneficial for learner practice questions. Not all the teachers may be aware of these benefits, therefore these benefits can be raised to all the teachers as an additional tip as well as training to enhance the teachers' skills. Furthermore, the tools that provide innovative and efficient ways to carry out traditional teaching tasks, and form part of the transformation layer in terms of SAMR analysis should be discovered by the schools and highlighted to the teachers, who may or may not be aware of the

tools functionality. For example uploading recordings and presentations on the LMS is a completely new and efficient way of sharing information between teachers and learners and should be highlighted to the teachers who may not be aware of this functionality.

6.4.3 Academia

The motivation of this study was based on a gap in existing research regarding technology in education, with some researchers stating that technology is superior, and indeed beneficial, to improving teaching and learning with others stating that technology is not an unequivocal solution to improving education. The findings imply that the gap in research could be due to the various elements relating to the teacher that are not always explored holistically in research studies.

Furthermore, the findings imply that the benefits and drawbacks of technology should perhaps be explored further for specific subject areas and specific tools within mathematics, in order to identify which aspects of technology can indeed benefit education and which ones are more of a drawback for teaching. The tools that allow leveraging of technology for a more transformative result should be explored further, for example graphing tools such as Geogebra that allow the teacher to enter a function, which results in a graph being drawn, is transformation as opposed to the traditional method of drawing a graph on the board.

6.4.4 Policy Makers

The findings of this research seem to imply that implementing technology in education can indeed be beneficial for mathematics. However, the recommendation to policy makers, such as the GDE and DBE, is that a clearly articulated educational technology policy should be drawn up, and this should cater for teacher's individuality in terms of their pedagogic practice, which may include: the different roles that they take in their classroom, for example facilitative versus controlling, their different classroom rules, their teaching goals and their concerns.

Additionally, the tools that have been identified as beneficial for specific subject areas should be explored before being implemented in schools. Perhaps teacher engagement and involvement in consultative meetings could address this recommendation.

6.5 Conclusion

The gap in existing research regarding whether or not technology results in benefits for education is evident in numerous studies, with some scholars being for technology and others being against it. The notion that there is a "one size fits all" technology solution for all teachers and all subject areas is possibly the reason disparities exist in technology in education studies. These disparities can be attributed to the suggestion that, "schools are complex social organizations situated within, and vitally

affected by, other complex social systems including families, communities, and professional and regulatory agencies" (Cohen and Ball, 1999, p.1).

Furthermore, from the findings, it seems that the gap in previous studies is perhaps due to the difference in teachers as individuals with their own characteristics, perceptions, and experiences. Thus studies need to take this into consideration when exploring technology in education.

Secondly, the researcher has found that despite the teachers' individuality, training and peer support are a major aspect in encouraging teachers to conduct e-lessons, and these should have increased focussed, especially for teachers who have not had any prior experience with technology or those that are stuck in their ways and prefer traditional teaching methods.

Finally, the benefits of technology are more task specific than tool specific. This means that a tool can be useful for a specific subject area or task being carried out in the classroom, but this does not necessarily mean it is the solution for teaching the subject as a whole. The beneficial aspects should be capitalised on and explored in order for benefits to be reaped where they can be.

Whether technology is beneficial for education is not a simple "yes" or "no". The teachers as individuals,and the factors and characteristics that encompass them, as well as the complexity of a school as an organisation, need to be explored and considered at a greater multifaceted level in order to reap the potential benefits that the use of technology can offer.

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Appendix A- Research Instrument: Interview (40 Minutes)

Section 1

Demographics: Please answer the following questions, in order to enable the researcher to get a sense of the demographics of participants

Please indicate you Gender

- ○ Male
- ○ Female
- ○ Prefer not to say

Please indicate the number of years you have been teaching for

- ○ 1-5 years
- ○ 6-10 years
- ○ 11-20 years
- ○ 21-30 years
- ○ 31+ years

Do you currently make use of e-lessons?

- ○ Yes
- ○ No
- ○ Sometimes
- ○ Other

Please specify…….

Section 2

Based on Engestrom's (1987) Activity System Triangle, the teacher in relation to the activity of teaching mathematics will be explored in this section. Potential contradictions are coded by either (P) (S) (T) depending on whether they are primary, secondary, or tertiary.

Activity Theory Subject (The Teacher) (AT-S)-Focus on Reluctance and perceived benefits

1. Can you briefly describe your approach to teaching mathematics - detail a typical lesson (AT-PED)
2. Can you comment on your attitude towards using technology to teach? (AT-S-ATT)
3. Do you have any concerns regarding conducting an e-lesson, if yes can you briefly explain these? (AT-S-CON)

4. Can you comment on whether you believe that you are/would be comfortable using e-lessons/technology to teach? (AT-SE) and how do you believe this is has affected your use or non-use of technology?
5. Please describe what you would consider a successful class in which your goals for a lesson are met? (AT-S-G)
6. Do you believe technology assists you in reaching these goals?(AT-S-G)
7. Briefly explain the type and amount of training you have received aimed at using technology to conduct an e-lesson (AT-S-T)
8. If you are currently making use of e-lessons, can you describe your experience or skills (AT-S-SK) (AT-S-EXP) with e-lessons and the effect it has on your attitude (AT-S-ATT) towards using technology to teach?

Section 3

Based on (Engestrom, 1987) Activity system triangle, the tool in relation to the task of teaching mathematics will be explored in this section

Activity Theory- Tool (AT-T) (Technology) - Focus on both teacher reluctance and benefits

9. Can you describe the software/hardware tools that the school has provided to facilitate e-lesson, for example, Microsoft PowerPoint, Moodle, LMS, Tablets?
10. Can you comment on how these tools have affected your teaching? (AT-T-A)
11. If you are conducting e-lessons, can you comment on the support infrastructure (For example if there are malfunctions) provided by the school and whether this influences your use or non-use of technology? please describe (AT-T-IN)
12. Are there any key facilitators at the school designated to assist you with using the technology, if yes how do they assist you? (AT-T-KEY)

Section 4

Based on Engestrom (1987) Activity System Triangle, the Object in relation to the teacher when teaching mathematics is explored in this section.

Activity theory Object (Teaching using an e-lesson) (AT-O) –With a focus on perceived benefits

13. If you are making use of e-lessons, can you comment on the different sections of an e-lessons are there different sections for example what will be learnt, how it will be learnt? (AT-O-CONT)

14. If you are making use of e-lessons, Can you comment on whether your e-lesson has a section where students can practice what has been learnt and have group discussions, as well as a summary of what has been learnt (AT-O-CNTX)
15. Can you comment on whether you believe the e-lesson components you have just described add value or are beneficial in your teaching? (AT-O-PB)(Perceived benefits)

Section 5

Based on (Engestrom, 1987) Activity system triangle, the rules in the mathematics class room will be explored in this section.

Activity theory Rules (Mathematics classroom rules) (AT-R) – with a focus on perceived benefits and teacher reluctance

16. Teachers tend to have specific rules in their classroom, can you describe the specific rules in your classroom? (AT-R)
17. If you are using e-lessons, can you comment on whether you think the use of e-lessons has affected your classroom rules? (AT-R-SH) (S)-Potential secondary contradiction if rules change when using an e-lesson
18. If you believe e-lessons have affected your classroom rules do you perceive this change in rules as a benefit or challenge?

Section 6

Based on (Engestrom, 1987) Activity system triangle, the community surrounding the teacher will be explored in this section. **Activity Theory- Community (AT-C)**

19. Can you describe how the opinion of other teachers has affected your attitude towards technology? (AT-C-PE)
20. Can you describe the schools commitment to providing teachers support regarding technology and do you believe commitment from the school has affected your teaching with technology and how? (AT-C-ORG)
21. If applicable, can you describe how your students' parents affect your use or non-use of technology towards technology? (AT-C-FAM)

Section 7

Based on (Engestrom, 1987) Activity system triangle, the division of labour between teacher and student, in the mathematics class room will be explored in this section. Contradictions are codes as (P) (S) (T) **Activity theory Division of labour (Teacher and student duties in the classroom) (AT-D) - With a focus on perceived benefits by the teacher**

22. How would you describe your role in the classroom in relation to the student? (AT-D)
23. If you are currently making use of e-lessons, do you believe that your role is different depending on whether you are conducting an e-lesson compared to when you are not? (AT-D-SH) (S)-Potential secondary contradiction if division of labour changes when using an e-lesson – only if yes then ask the next question
24. If you believe that your role changes, can you comment on whether your change in role is beneficial/detrimental for your teaching?

Appendix B: Data dictionary

Code	Meaning
AT-S	The teacher(Subject of the activity system)
AT-S-G	The goal of the teacher when conducting a mathematics class (sub code of AT-S)
AT-S-SE	The teachers self-efficacy regarding technology use(sub code of AT-S)
AT-S-PED	The teachers pedagogic practice (sub code of AT-S)
AT-S-CON	The teachers concerns regarding technology use (Sub code of AT-S)
AT-S-T	The teachers training in technology use for teaching (sub code of AT-S)
AT-S-EXP	The teachers experience with technology have they used it before? (sub code of AT-S)
AT-S-SK	The teachers skill(proficiency) with technology (sub code of AT-S)
AT-S-TI	The amount of time or lack thereof, to incorporate technology or learn how to use it in the classroom (sub code of AT-S)
AT-S-ATT	The teachers attitude towards technology(Sub code of AT-S)
AT-O	The objective of the entire activity system(The teachers objective)
AT-O-CONT	The content of the e-lesson and how this relates to assisting the teacher to achieve their goal(sub code of AT-O)
AT-O-CNTX	The context of the e-lesson how this relates to assisting the teacher to achieve their goal (sub code of AT-O)
AT-T	The technology (the tool used to carry out the activity)

AT-T-A	The adaptability of the technology to the teachers pedagogy (sub code of AT-T)
AT-T-INF	The support (technical) available to the teachers for the technology (sub code of AT-T)
AT-R	The rules in the activity system, which is the mathematics classroom
AT-R-SH	The shift in rules when technology is used (Sub code of AT-R)
AT-C	The teachers environment and surroundings
AT-C-PE	The influence of other teachers on each other (Sub code of AT-C)
AT-C-FAM	Learners parents and their influence on teachers experiences and perceptions with technology (Sub code of AT-C)
AT-C-KEY	Designated staff to assist teachers with technology use as well as encourage them (Sub code of AT-C)
AT-C-ORG	The support provided by the school to the teachers with regards to technology use (AT-C-ORG)
AT-D	The division of duties between teacher and student in the mathematics classroom (Division of labour in the activity system)
AT-D-SH	The shift in the division of duties when an e-lesson is conducted (Sub code of AT-D-SH)

Appendix C- Participation and Consent Forms

Good day,

I am Miss Chalwe, a student from the School of Economic and Business Sciences at the University of the Witwatersrand (Wits). I am currently completing my Masters in Information systems (MCom). Following the introduction of technology into secondary schools by the Department of Education, I am interested in understanding mathematics teacher's experiences with e-lessons at a secondary school level. The use of technology and the introduction of e-lessons for all grades and subjects at Sunward Park High School has presented me with an opportunity to carry out academic research to investigate **the experiences and perceptions of Grade 8 to 10 Mathematics teachers with e-lessons.** I would like to take this opportunity to invite you to take part in this research.

The reason that you were selected was on the basis that you are a junior Mathematics teacher at Sunward Park High school, which is a school that uses e-lessons, and this is the focus of the research. This research holds no preconceived notions as to whether teachers should or should not use e-lessons in their classroom but rather aims to understand the experiences of teachers since the introduction of e-lessons**.** Aside from its academic value, the study results may inform educational institutions as to teachers' experiences regarding using e-lessons to teach and may also inform technology professionals about issues related to technology use from a teacher's perspective and may allow improvements to be made if applicable and possible.

Your participation is entirely voluntary and involves no risk, penalty, loss of benefits, sanctions, or job-loss whether or not you choose to participate. There will be no direct benefit to you from the research, but a report back on the research's findings will be made available to you and the school. If you agree to take part, you will be required to participate in an interview, which will last approximately one hour. Arrangements will be made at a time and place that is suitable for you on the school premises. During the interview, you may refuse to answer any questions that you feel uncomfortable with answering. Additionally, your honest answers are important and there are no right or wrong answers. With your permission, the interview will be recorded and notes will be taken. No one other than the researcher will have access to the recordings or notes taken. To ensure your confidentiality your name and personal details will be kept confidential and will not be written on the interview notes and transcripts, code names will be used instead, Sunward Park High school will be identified as the school being studied however. The notes from the interview will be kept until no longer needed for producing publications, during this period only myself and my supervisor will have access to them, thereafter they will be destroyed. The research will be will be available to Wits University, The Department of basic education, and online as all Wits dissertations are made available online.

Should you have any questions, or should you wish to obtain a copy of the results of the interview, please contact me on 076 2044 583 or email : Musonda.chalwe@digiata.com or my supervisor Suzanne Sackstein on 011 717 8158 or email: suzanne.Sackstein@wits.ac.za

Kind Regards,

Musonda Chalwe (Masters by Dissertation student class of 2016) School of Economic and Business Sciences , University of the Witwatersrand, Johannesburg

Teacher Consent Form-Interview

Project Title:

Experiences and perceptions of mathematics teachers with e-lessons: A case study of a secondary school in South Africa

Researcher: Musonda Chalwe

I, _____, volunteer to participate in the research project being conducted by Musonda Chalwe from the University of the Witwatersrand. I understand that this research project is designed to study the experiences of Mathematics teachers with e-lessons at Sunward Park High School in order to provide a more detailed understanding of the use

As a teacher at Sunward Park High School I understand that I am being invited to take part in an interview. I understand that in agreeing to participate:

- My participation is voluntary and I will not be paid for my participation.
- The interview will last approximately 1 hour; Notes will be written during the interview.
- I understand that if I feel uncomfortable in any way during the interview I have the right to decline to answer any question or to leave the interview session.
- I understand that the researcher will not identify me by name in any reports using the information obtained from the interview. My confidentiality will remain secure.
- Administrative and other teaching staff at Sunward Park High School will neither be present during the interview not have access to raw notes or transcripts of either the observation or the interview. This precaution will prevent any of the findings having personal negative repercussions for me.
- If I choose to be interviewed, I have the right to view and comment on the transcribed interview data before the findings are analysed.
- I have read and understand the information sheet provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.
- I have been given a copy of this consent form.

Circle the applicable option

I hereby agree / disagree to participate in the **interview** for this study.

I hereby agree / disagree to the **audio recording of my interview** for this study.

Name _____ Date _____

Signature _____

Teacher Consent Form- Audio Recording

Project Title:

Experiences and perceptions of mathematics teachers with e-lessons: A case study of a secondary school in South Africa

Researcher: Musonda Chalwe

I, _____, understand that this study involves the audio recording of my interview with the researcher. I understand that my name or any other identifying information will not be associated with the audio or audio recording or the transcript a code name will be used to identify me. Only the researcher and her supervisor will be able to listen to the recordings. The audio recording will be transcribed by the researcher and erased once the research is no longer needed for publication. Transcripts of my interview may be reproduced in whole or in part for use in presentations or written products that result from this study. Neither my name, ID Number, Address nor any other identifying information (such as my voice or picture) will be used in presentations or in written products resulting from the study.

As a teacher at Sunward Park High School I understand that I am being invited to take part in an interview that will be recorded. I understand that in agreeing to participate:

- My participation is voluntary and I will not be paid for my participation.
- The interview will last approximately 1 hour and will be recorded in an audio format
- I can decline to be recorded if I so choose.
- I understand that if I feel uncomfortable in any way during the interview I have the right to decline to answer any question or to leave the interview session.
- I understand that the researcher will not identify me by name in any reports using the information obtained from the interview. My confidentiality will remain secure. Subsequent uses of recordings and data will be subject to standard data use policies which protect anonymity of individuals and institutions.
- Administrative and other teaching staff at Sunward Park High School will neither be present during the interview not have access to raw notes or transcripts of the interview. This precaution will prevent any of the findings having personal negative repercussions for me.
- If I choose to be interviewed and recorded, I have the right to view and comment on the transcribed interview data before the findings are analysed.
- I have read and understand the information sheet provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree to the recording of my interview
- I have been given a copy of this consent form.

Circle the applicable option

I hereby agree / disagree to the **audio recording of my interview** for this study.

Name _____ Date _____

Signature _____

Appendix D-Permission letters

For administrative use:
Reference no. D2017 / 256 A
Enquiries: Diane Buntting 011 843 6503

GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GDE AMENDED RESEARCH APPROVAL LETTER

Date:	**24 August 2016**
Validity of Research Approval:	**24 August 2016 to 30 September 2016**
Previous GDE Research Approval letter reference number	**D2017 / 227 dated 05 August 2016**
Name of Researcher:	**Chalwe M.M.**
Address of Researcher:	**46 Athlone Street; Sandringham; Johannesburg; 2192**
Telephone / Fax Number/s:	**076 2044 583**
Email address:	**mchalwe@yahoo.com**
Research Topic:	**E-lessons to teach Mathematics: A case study at a Secondary School.**
Number and type of schools:	**ONE Secondary school**
District/s/HO	**Gauteng East**

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved. A separate copy of this letter must be presented to the Principal, SGB and the relevant District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted. However participation is VOLUNTARY.

The following conditions apply to GDE research. The researcher has agreed to and may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

CONDITIONS FOR CONDUCTING RESEARCH IN GDE

1. *The District/Head Office Senior Manager/s concerned, the Principal/s and the chairperson/s of the School Governing Body (SGB.) must be presented with a copy of this letter.*
2. *The Researcher will make every effort to obtain the goodwill and co-operation of the GDE District officials, principals, SGBs, teachers, parents and learners involved. Participation is voluntary and additional remuneration will not be paid;*

2016/08/25

Making education a societal priority

Office of the Director: Education Research and Knowledge Management ER&KM)
9th Floor, 111 Commissioner Street, Johannesburg, 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0506

Sunward Park High School

Telephone : (011) 896-5114
Fax : (011) 913-3524
E-mail : sunwhs@mweb.co.za
Website : www.sphs.co.za

P. O. BOX 17233
SUNWARD PARK
1470

18 July 2016

Dear Miss Musonda Chalwe (Student Number: 1540378)

PERMISSION TO CONDUCT RESEARCH AT SPHS

As per our discussion earlier, the permission to conduct your Master's Research (The use of e-lessons to teach Mathematics: A case study at a secondary school) at Sunward Park High School in September 2016 is hereby confirmed.

I also want to confirm that the Head of Department you will be working is Mr T. Chivaviro

For any further information please do not hesitate to contact me.

Kind regards!

Mr Enoch Thango

Deputy Principal – Sunward Park High School

Appendix E- Initial decsriptive codes

positive attitude,	attitude towards technology
scared/nervous about technology	
easier teaching and learning	Improved teaching and learning
effective teaching	
smooth lesson,	
simpler teaching,	
abuse of tablets	teacher concerns
forgetting of tablets	
more work,	
tablet misuse,	
tablet misuse,	
training	Training and practice
training,	
in person training,	
video training,	
training times,	
on-going training,	
practice	
enhancing teachers skill,	
practice,	
training overcoming challenges,	
improved average	assessment based classroom goals,
better marks,	
test results,	
classroom interaction	interaction based classroom goals,
feedback,	
participation,	
interaction	
LMS for classroom management	Teaching technologies,
graphs,	

Geogebra,
visualising,
onsite technicians support,
whatsapps for support or in person requests,
immediate response
social technical support from peers,
onsite support from technician,
encouragement
peer influence
help from other teachers,
encouragement,
learner centric lesson,
integration,
personal development Benefits of technology,
discipline,
access to lessons anywhere,
absent learners Benefits of technology,
videos assisting teachers with their usual tasks
learner concentration
control the class Controlling the classroom,
Control ,
control of the classroom
Control,
control,
particular classroom setup classroom rules,
no social media,
classroom rules for all,
take out tablets vs take out books,
equality with learners,
monitoring,
New rules,
sections learners didn’t understand,
seldom use PowerPoint,

prior knowledge,	Prior Knowledge
homework,	
revisiting work,	
review of previous material,	
old school,	
strict	
individual perception,	
no shift in rules	
old teachers,	
technology ed school,	
principal maths teacher	
boss Role of the teacher,	
interaction	
not Redundant	
effective teaching and learning	
take out the best for the learner,	
students more responsible role of the student/benefit of technology	
responsibility	
walking around during lesson	
no change in teaching approach	

Appendix F-Extract of Collated Transcripts

	Section 1 (AT-S)Activity theory subject(The teacher)	Interview 1-Chauke , Male, 19yrs exp,using e-lessons, very positive attitude, was not using technology previously but no is-recurring personal theme is discipline and control	Interview 2-Vivian, Female, 33yrs exp,using e-lessons,very postive attitude and experience with both using and devloping techology, recurring theme is equality "being part of" the students
2	*1. Can you briefly describe how you teach mathematics , from the moment you get into the class just describe the first things, a typical lesson in your specific class (AT-S-PED) Emerging theme-structure*	What I do is, um I start with a flashback of the previous lesson,Because i give my learners class work and homework everyday So in the homework questions um.. I'll give a little bit of the.work, the concept they're gonna cover the following day maybe one or two,that they can see what its gonna look like[in audible] Then we start from there just for about uh 5 to 10 minutes.Okay, that's the.. going over uh the last stuff. and then I give another 10 minutes of presenting the lesson. if ive got a new concept that I'm explaining.	okay, firstly what is importnat for me is that my learners line up and then im visible that im so i want them to see me and then see maths so that helps them to focus then they walk into the class,i stand and they stand, its like what i do they are allowed to do if i eat in my class they can eat,if i smoke, if i swear they can do the same,if im unprepared they can be unprepared, what goes for me goes for them.then we greet each other, they sit down they immediately take out their tablets and they [background open up their homework. while they are doing that, im checking the register and delaing with demerits of late comers, that kind of stuff, very quickly, takes me five minutes, okay. Then they start to mark their homework, my learners, ive only been here about a month,not even a month..i feel that irrespective of whether you are in grade 8,9,10, 11 or 12 you need structure because if you are not structured how can you expect your learners to be structured..then we, we mark the homework.
3	*2. can you comment on your attitude towards using technology to teach (AT-S-ATT)*	no its, its positive, and its very interesting...and it's much easier and learners can easily understand	Oh i think its absolutely awesome
4	*3. do you have any concerns towards using technology to teach? (AT-S-CON) -emerging theme social media-tabet misuse*	No,its fine. Its actually, I need to learn more, because i..you see with the little that I have, I even find it very very interesting. its very very interesting, and actually I think it limits our times that we always talk and preach in class. There a lot of preaching going on... you know what my concern is on maths or on learners changing from maths to maths lit and I feel that if this is--if these e-lessons are actually dealt with correctly from lower grades	No i do not look at the concerns right now, for me its pure implementation getting the knowledge accross as effectively and i think it is an absolute wonderful thing..: for me technology is there, lets use it
	4. can you comment on what you believe you are comfortable using a	no remember even in our training as educators we never used an technical stuff right.. but we would learn because the generation we living in. You know is just technologically inclined..you just have to be on-hands so actually it makes you to look	yes, awesomeness, awesomeness!! theres still alot to learn

Appendix G-Sample Interview Transcript

Interview 1

Interviewer: researcher ®

Interviewee: Maths teacher (T)

[Background noise of chairs moving]

R: So, the interview is divided into.. um.. [sound of pages flipping] ..how many sections here… into seven sections. The first section is just um.. some personal information, well demographic stuff about you

T: mhhm

R: Please may you indicate your gender,[slight laugh], well there's male, female or prefer not to say/

T: [laughs] that's Male

R: [sounds of pages flipping] okay that would be that..And then please indicate the number of years you've been teaching for

T: umm.. This is my nineteenth year

R: Okay so that's 11-20 ..and then do you currently make use of e-lessons or um.. the technology that has been introduced to sunward park?

T: [Breathes heavily], ya actually we—I, have to say I'm getting into it [people talking in background] because when I came here in June then I found that they do have that in place [people talking in background] my previous school we never used to have that/

R: Okay..

T: Ya

R: Okay so you're just—you're getting used to../

T: We are going through processes of e-lessons and ya

R: Okay

T: Currently, um.. [pages flipping] currently, we are having some workshops on that, like yesterday we had one and now there is now scribbler that we are introduced to

R: okay, Scribbler?

T: Ya

R: Okay, whats that?

T: um Scribbler its the, the..the teaching of ..when you present your lessons but you're doing.. you controlling the lesson during the [in audible] /

R: /oh oh I think I saw, Mr Thango had shown me something like that ok

T: /Yes its very interesting

R: So you say you're just getting.. you're sort of Getting used to using them

T:Ya

R: ok, and then um, so now we move on to section two, it's just uh, it's a focus on any benefits you see and also on the re… initial reluctance to using them, coz I hear there was initial reluctance.um Can you briefly describe how you teach mathematics , like from the moment you get into the class just describe the first things.uh,the... a typical lesson in your specific class

T: Okay,In specific class my class/

R: Yeah..

[Sound of door opening] [Sound of people talking]

T: What I do is, um I start with a flashback of the previous lesson,/

R: Okay

T: Because i give my learners class work and homework everyday

R: Okay [People talking in background]

T: So in the homework questions um.. [Background noise] I'll give a little bit of the.. [pause][people talking in background]work, the concept they're gonna cover the following day maybe one or two/

R: Okay/

T: that they can see what its gonna look like[in audible]

R: Okay

T: Then we start from there just for about uh 5 to 10 minutes

R: Okay, that's the.. going over uh the last stuff

T: ya, Yes, [people talking in background] and then I give another 10 minutes of presenting the lesson [people talking in background] if ive got a new concept that I'm explaining [loud talking in background]

R: Okay and how long is a lesson

T: {loud beep from school speaker] Its um [Loud announcement on school speaker] 55 minutes, unless on a day that we've cycle tests then its 45 minutes

R: Okay, um and then can you comment on your attitude towards using technology to teach, coz I know previously you said you didn't use it so how do you feel about it? [Background noise]

T: no its, its positive, and its very interesting, remember we were introduced to geogebra before

R: Okay..

T: Its something that you show learners especially when they have to visualise like for instance functions

R: Yes

T: You know when you are dealing with functions the.. you talk about the parameters say of a parabola

R: Yes..

T: as A increases A is Negative

R: Mhmm

T: you see its just shown. It shows how the graph changes in terms of that

R: Okay..

T: and it's much easier and learners can easily understand that. More than me drawing to them that if A is negative then the graph goes like that then I must compare to that. This is where this is advantageous

R: Okay So especially for graphing/

T: Ya

R: or is there anything else?

T: Just for graphing

T: Yes they do have some audio lessons or videos which shows maybe [pause] when they are solving say some trig functions, you can present to the learners

R:okay

T: whilst you watch and [background noise] they see it first. Especially, its very nice if a concept is—that they view

R: mhm

T: [papers flipping] maybe how the trigonometry is done then after that you come in

R: Okay

T: Ya [papers flipping]

R: okay so you say you show them [cellphone beep] videos as well of of of, someone else teaching

T: ya

T: Someone else presenting something

R: Okay.

T: which we download [background noise] there is the maths and science dot com that even Mrs Pierce [inaudiable] uh when I came here said "you there is quite a lot of these things" she was explaining to me and Mrs.. Mr Thango

R: Okay

T: And then I could see that they are very useful

R: so you say, where do you get the…which..um is there a specific site or..

T: Ya its Maths and science.com, its another one,

R: Okay

T: [pause] but there are so many

R: oh Okay/

T: /and then I found that in.. they do have some e-lessons which are presented already

R: Oh okay

T: Which are done, so it's a matter of clicking on the lesson you see what you want/

R: Yeah and then you get/

T: and then you show your learners if you feel like if you want to edit yours and then that is it

R: okay

T: But then I think it hasn't been done, I think that is the challenge that the previous teachers weren't using it to that effect

R: oh okay, so did they not know how it use it or..

T: you know this [inaudible] thing,

R: Yes

T: say when you say solve the equation you can show the learners the steps

[sound of door opening]

R: Yes

T: but then methodologies differs as you present

R: Yes

T: Say something is already recorded

R: Ya

T: And it shows it. You see there are these channels on television

R: Yes

T: Where the lessons are presented where learners ask and they show that/

R:Yea..

T: And if i always tell my learners to go and watch such things

R: Yes

T: So that they can compare and see how it is done [sound of person coughing in background]

R:Okay

T: Otherwise, you not the best on your own

R: Okay [sound of door opening in background] [pause]

R: Okay, thanks very much for that one, lets move on to question 3. So okay, I think you addressed this, but do you have any concerns regarding using e-lessons or technology, as much as you've highlighted the benefits, is there anything that you can say you worry or worry about or just any concerns?

T: Ya, you know what my concern is on maths or on learners changing from maths to maths lit and I feel that if this is—if these e-lessons are actually dealt with correctly from lower grades

R: mmhm

T: you know it.. it also motivates learners. It brings them.. you know these learners of ours, they are technically sharp

R: mmm

T: That they need that sort of exposure

R: Ok..

T: Such that you find that maybe learners are battling to adapt some concept

R: Okay because they didn't start it earlier?

T: Yes, coz I believe it is not your way that you teach that can always be the best

R: Yes

T: So if they are exposed to this and then you come in, I think it will reduce the number of learners changing from that because\

R: So you think they should be exposed at an erlier stage rather than\
T: at a earlier stage.. even go down to primary
R: okay
T: right, move down to primary then grade 8 we must push it hard
R: [pause] I see
T: and then\
R: and then for you as a teacher is there anything that concerns you because that's the regarding the students. Now for your teaching are you comfortable or do you have any concerns does it..is there anything that when using an e-lesson disrupts your teaching or anything like that? [pause] or do you think its fine?

T: No,its fine. Its actually, I need to learn more
R: okay
T: because i..you see with the little that I have, I even find it very very interesting.
R: okay
T: its very very interesting, and actually I think it limits our times that we always talk and preach in class. There a lot of preaching going on

R: Oh yes
T: ya you see this.. because you.. look now this saves your time,
R: mm
T: such that you engage in learners [pause] say you've got thirty minutes left
R: yes
T: and your learners are busy writing,
R: oh ya
T: now you can engage in learners
R: ok..
T: right through the whole lesson and imagine with uh..all these learners who are struggling I don't think they'd be having a need for afternoon interventions because you can do thee intervention in the class.

R: oh I see. Ok [sound of pages flipping] um.. we move on to question [pause] question four [sound of pages flipping]. So um I think we just addressed this but can you comment on whether you believe you are comfortable using e-lessons, and if you're not that comfortable, do you believe it affects your use of technology, for example, lets say you don't have much experience using them, would you not want to use them? Like, I remember you said you didn't have much experience

T: Ya

R: did it make you a bit reluctant or did you go straight to using/

T: no remember even in our training as educators we never used an technical stuff

R: yes,yes it's a new concept

T: right.. but we would learn because the generation we living in

R: mmhm

T: You know is just technologically inclined

R: Yes

T: you just have to be on-hands so actually it makes you to look more before you go and present

R: ok

T: But what I liked is that I'm coming at a time whereby [pause] the e-lessons in maths department has not been effectively used

R: ok

T: and seemingly the school has put in some training in place which is an advantage to me now that I leave with those ones

R: oh I see okay

T: and I also.. there are some learners (meant to say teachers)who are just graduates at the.. graduated three years back four years back who graduated from maybe during this say at wits and all these other\

R: oh I see

T: then we lean on them

R: okay like the student.. the student teachers?

T: no, no ,no, the qualified teachers but who have gone through some e-teaching you know

R: oh I see, okay

T: ya. yes, we do have people like that, like Van eden, sengu. They've been doing this, and normally they.. we go to them they show you they present and .. see the only thing is you don't..

if you need something you show up that ‘guys this were I need assistance’ and when you go to class it makes a difference because even the learners wont realise that\

R: so is that a set.. do they have those set roles that they’re set there to help you or is it just informal you just go to them and\

T: no you go to them and you know the people that /
R: oh you know the people
T: coz sometimes they present for us\
R: oh they even hold presentations\
T: say, say some training needs to be done, they are, they do first then they come to us. Like what happened on Saturday

R: mm
T: when we were doing this smart training
R: Okay
T: they went in they were explaining coz they were involved in this thing
R: Oh okay
T: then they come and help us
R: okay
T: in groups now, like in smaller groups
R: okay [pages flipping] then we can move on to the next question now, um what would you consider a successful maths class, like when your goal is achieved..what is your goal for a maths clas and at the end of the class when do you consider it successful [pause] for you personally?

T: Right. No, personally if [pause] [pages flipping], if , if I assess my learners at the end of the day

R: Yea..
T: and I get the expected results, I get a better average, an improved average, it is only through assessment
R: okay
T: that I am satisfied to say no, okay this learner has done this
R: okay
T:ya
R: okay so its based on assessment [pages flipping] okay
T: ya

R: and [pause] lets see.. and oh you said you have received training.coz the next question is regarding, ‘please explain the type and amount of training you have received’

T: No we still going on

R: okay

T: because remember we.. we are going to.. there is a software that we’ll be using for maths uh.. this uh.. maths lessons that we’ll be uh going through and we are still going on, like the scribbler

R: Okay

T: we still, the guys coming presenting so that we know how to record yourself also

R: oh to conduct your own e-lesson

T: yes to conduct your own lesson, and then to prepare lessons online there are putting so that when you put lessons in our timetables we just click and then it shows you all the lessons that you have, they are prepared actually\

R: Okay

T: Then they’ve got videos aside, we can use them as well

R: oh for guidance

T: yea

R: okay so who prepares these training materials or is it just provided?

T: we do have the technicians

R: oh the technicians

T: Ya

R: Okay

T:[inaudible] they are going through it and installing software in our laptops[background noise] hence the maths department will get tablets

R:oh oh you guys don’t?..and the other departments do have hey?

T: no it will start with maths and physics department

R: Oh okay

T: so that they can now use the tablets for controlling the class that’s the smart screen

R: so they students have tablets

T: yes they do

R: oh the teachers don’t..

T: Ya to teach from, we are using our laptops

R: I see

T: yes
[pages flipping]
R: okay so has, [laughs] I think I've already asked you this..has your experience with e-lessons affected your attitude towards using e-lessons to teach, I think you had mentioned you have a positive attitude

T: ya its actually positive

R: okay that's fine, and then can you comment how your skill using e-lessons has affected your attitude, for example maybe when you were less skilled did you have a negative attitude and then when you got more experience with them did you have a more positive attitude or was it not\

T: you know what those are..like now , im the kind of a person who can walk into the class[pause], I know the concept that I need to present and the how and using maybe different forms of assessment

R: ya
T: it's like with my experience that I have
R: ya
T: and then I really know what is needed in terms of that so that thing alone was then enhanced the e-learning

R: ok

T: it is now coming as a plus [pause] [people talking in background] so it's easy for me to add it and say let me use this, or let me include this and find this

R: ok, so it basically enhanced your already existing skills
T: ya, it actually enhanced the skills, you even become a more better teacher
R: oh I see
T: ya because we continue learning and learning and learning [sound of door opening] you are not best yet, I'lll be best when my average is eighty [slight laugh] for my learners that I teach at the time\

R: okay but it's really…okay, So we can move on to section three and now this one is..the focus is on the technology itself and we'll also address if there was any reluctance and any benefits addressed uhm any benefits gained from the technology. So can you just.I know you've described them in some of your answers, just some of the technology that the school uses, can

you just.you can list them or describe them I know there's um LMS, I think you guys used to use Moodle as well\

T: Ya, moodle, LMS those are the ones that we,I,came in and they've been using moodle and now they are introducing LMS. So they moved from Moodle to LMS

R: Okay so are those the only..do you use power point slides, anything else?
T: Yea of course in some presentations,
R: okay
T: because remember some of these lessons are already recorded [sound of cutlery from staff kitchen in background]

T: Most of them are in power point
R: Okay
T: so it's just the slide show that you show
R: okay
[sound of cutlery from staff kitchen in background]
T: and then you pause you explain whatever and..
R: okay, and then do you use youtube videos?
T: ya oh definitely! yoh Youtube videos [laughs]
R: Okay [laughs]
T: definitely!
R: okay that's fine, so and then do you think any of these tools that you have listed, do you think any of them are more advantageous than others for your maths teaching, for example is youtube better [sound of gardening tools outside] or is Moodle better , Powerpoint do you see any advantages from the specific software [sound of cutlery form staff kitchen] that you use?

T: yea, but I think it depends
R: mmm
T: on what you are presenting
R: oh I see
T: yes, it depends on what you are presenting because I think of each of them work together, like Moodle they just want more for presenting, no, on the portal remember we just upload [sound of cutlery from staff kitchen] all the tasks that we need, past papers, learners download at school here so that when they are at home they view offline\

R: Okay

T: and its easy for them to work [sound of door opening]

R: oh okay

T: theres also for grade 8 and 9, there is, but I think the teachers will talk about it coz im not, they say there there is uh,uh the siyavula\

R: oh yes I heard about that aswell\

T: ya, its actually a sim card it has a lot of [pause] uh.. it has a lot of questions for learners to practice, where they put In the sim card and then automatically it allows them to be able to access a lot of questions [background noise][noise from cutlery in kitchen]and the learners are using that, so I found it in place

R: okay

T: so I asked to control it, to say guys [pause] uh they must continue using this technology [people talking in background]

R: Okay [people talking in background]coz it assists them

T: Because it assist learners to practice

R: okay, and then um is there any support structure, for example if there is a glitch or a malfunction on the technology who\

T: oh definitely we have\

R: comes in and fixes it—do you have/

R: do you have people on site

T: yea we do have Technicians that are aligned to each department

R:Okay

T: and also Melanie you just run to her or whatsapp,"there is a problem in class", immediately she respods or sends the technician to come in

R: oh Okay so the technicians come from other companies or are they based on\

T: no they are based here

R:oh okay

T: yea we have a lot of technicians, they are based here

R: [breathes heavily] okay then we can move on to section four, which is uh, about actually conducting the e-lesson and the focus will be the benefits, we've sort of already addressed them so,lets just see. So when you're conducting an e-lesson are there different sections, for example you know how you were describing your class, you said you start with um,going over what you

did the last time, then class work, then homework, so with an e-lesson, is it.. what sections do you actually,, is it different from how you described your typical maths lesson?

T: ya but basically, it all depends [sound of door opening] on what learners did not understand [sound of door opening] and whether you need to play the video again

R: okay

T: or you need to [sound of door opening][sound of cutlery in staff kitchen] explain it before you introduce a new concept which you want to show them, something which you want to present maybe as a slideshow [sound of cutlery in staff kitchen] or maybe you are using from the videos or whatever [sound of cutlery in staff kitchen]

R: okay

T: so it all depends, but then remember now the smart teaching that we are doing now it makes now us to record [sound of cutlery in staff kitchen] how we taught each lesson that you are teaching\

R: so you record a video\

T: such that

T : yes

R: of yourself

T: video, audio, ya so that you can now [sound of cutlery in staff kitchen] the learner when they go home [sound of cutlery in staff kitchen] they can play it on their own

R: Oh okay

T: For better understanding

R: okay

T: because they still need you as their teacher to explain something\

R: yes

T: that was previously recorded

R: yes

T: Because when you play something that was previously recorded, they listen, you ask questions, they can hear

R: they can hear

T: you give them something to work on, and then you explain where they misunderstand [sound of [people talking in background] it is that explanation now that will assist them. Or say a child was absent

R: ya

T: now they can go through them

R: oh they can listen to the recording

T: yes that's where we are moving that's now\

R: okay, and how are these made available, on the students tablets or? How do they access the recordings?

T: Ya remember you controlling the lesson

R: okay

T: when you record that is when it is automatically uploaded on students tablets

R: okay

[sound of chairs moving] [brief pause as researcher takes notes]

R: Okay so in terms of um these sections of the e-lessons where they can record, so what you believe is the benefit is that even when they are absent they can\

T: they can playback

R: okay

T: so many times even if they move to the next grade, remember these concepts for [inaudible] are aligned

R: mhmm

T: the functions for example they start in grade 10

R: okay

T: then a bit more in grade 11 and then it comes back in grade 12 so every concept for the FET is connected from grade 10 so now a learner has an advantage that its unlike a text book. When you're using a textbook and then you leave it

R: yes

T: for the next grade,so its one and the same thing now, which is much better because it makes them to go over their work unitl they prepare, if something they have missed [inaudible] they can go back. Say im teaching a grade 12 class

R: mmhm

T: then the concept was introduced in grade 10 or 11

R: yes

T: so I can easily go back and just play that just to remind them [pause] or they can do it on their own then.. this thing has got so much advanatges im telling you

R: yes so the teacher can replay past material,

T: ya

R: okay and then are they any other benefits from.. so far as you've been using them, just any other benefits specifically regarding technology\

T: okay ya so they also make you to be technologically advanced, so it's a plus on my side

R: okay ya so like personal, sort've like personal development

T: ya, its apersonal development such that when there are promotions you can always use that\

R: you'll have an advantage

T: ya

R: okay, then we can move to section five. We've got two more sections don't worry we'll be done soon. Um, so this, section five is gonna focus on classroom rules, [background noise] so I know techers tend to have specific rules in their classrooms, can you describe yours, like in your maths class are there any rules, like I don't know, don't um\

T: ah you cant operate without rule

R: [laughs] yes

T: that's the first, you see you need to control your class and the controlling of your class depending on what you layout for the learner [inadudible], so like [sound of pages flipping] generally when learners come into class [sound of pages flipping] it's a norm that they stand up, make sure that every desk is aligned

R: okay

T:just tidiness is part of that, it enhances your learning

R: okay

T: right, and then they know that they take out, with instructions, I have to say "take out your tablets"

R: okay

T: Because with this technology some of them have got cellphones and all that stuff

R: yea

T: then you have to instruct them to say "I don't want to see any cellphones"

R: okay

T: “take out your tablet” and they know the first thing we are looking at is your homework
R: mmhm
T: so you, it becomes a routine that\
R: ya
T: they master it, hence uh, if those rules are in place and you follow them accordingly it then you’ve got a well behaved class and it will also promote on their listening 1. you don’t waste time , then 2. They know exacty that you do this, you don’t change at any other day

R: okay ya so it’s a set rule, and then do you, if your;e using e-lessons, do you think this has affected yourclassroom rules,obviously, I heard you said a rule where you have remove your tablests” are there any other, like your original rules before you used to use e-lessons, have they been changed since you started

T: no, theres no rule that has been changed
R:okay
T: ya
R: but you just added new rules
T: yea…actually because they are using technology stuff
R:yea
T: Its alike with saying take your textbook and putit on the table
R: oh okay okay so its the same rule but just different\
T:ya ya differet way to apply it
R: terminology
T: ya remember, we allow them to have cellphones [background noise] and then in some lessons they even use them as , if they don’t have.. but now you know what the students do they put on their own videos and other stuff

R: oh are those not blocked
T:From
R: on their devices?
T: no, no,no its like they save the video on their devices
R: ohhh then they can play it
T: they can play it in class whilst you think a learner is doing that
R:okay

T: so where you need now to say “guys you’re on your tablets you are now doing this, they take it out,you continue

R:yes

T: but now this coming of this smart lesson that we are going to have

R: mmhm

T: it will make it easy, because I control their tablet

R: oh okay

T: because I will say we are now on this

R: and then they cant do anything?

T: they cant do anything, you see how technology is bringing discipline now

R: yes

T: so the more technology is advanced the more discipline

[school speaker beep and person speaking]

[pause till announcement on speaker is done]

[25:47}

R:okay we can move on to section 6, and this is, its called the community section so here we’re just going to talk aa bout how your surroundings, other teachers, the school, has actually had an influence on you, we’ll start with your teachers. So do you think the opinion of other teachers actually influenced your attitude towards technology [sound of doors opening in background], for example if most teachers were reluctant, do you think that also influenced your\

T: you see that was my cry because I’m coming from a school that was not using technology, remember Panyanza is trying to, yes with the grade 12s

R: mmm

T: and I remember that the smart boards now installed they starting them[inaudible]

R: yea

T: the you come to a school that already had the setup

R: okay

T: so you feel like [papers flipping] this thing was [pause] I mean done correctly from the beginning

R: yeah

T: we wouldn’t be complaining of so many disadvantages that we have in maths and all that stuff

R: mmh, ok

T: but then you find that if something comes in and you've got your own way of teaching that thing, now what did I need to solve for x

R: mm

T: because I can write the statement solve for X and then I show the learners these are the [inaudible]

R: yes

T: but then If they view that as a video to explain that and then it shows how hes done,[sound of door opening] and then you just come and then it makes a very big change

R: yes

[sound of door opening]

T: A very big change

R: okay, then the attitude here at Sunward park of uh specifically maths teachers do you think it was all positive or was it negative like did people maybe influence each other to not use it or were people keen\

T:no I cant say they influenced each other to not use it

R: mm

T: but there are some old teachers in the department who would say "ah, ah we don't think", yes they need it in some sections\

R: but not all

T: but not all

R: okay, and then in terms of the schools commitment to providing you support [sound of papers flipping] I think you mentioned there's those training workshops and you said there's those teachers, is there any other support that's provided by the school, specifically for the, for e-lessons?

T: ya of course, like we are being prioritised maths and science department we are being given tablets that is support

R: oh okay

T: and the fact that our principal is a maths teacher

R: [laughs]

T: [laughs] he is a former maths

R: oh yes he mentioned that

T:yes so its, its already there, its very very positive , Mr Thango hes a deputy hes a science teacher

R: yea

T: mrs pierns the principal is a maths teacher [sound of door opening]

R: yea

T: so you see they just want to move with that

R:yea

T: so actually they would, that's what they said that we would like this done more in these two subjects, more than in any other subject

R: okay, oh so is that why they are starting with tablets from maths and science

T: ya, and then they say its like uh, then it depends on the postiviness from the department

R: okay

T: right, and then the then HOD who was there, they say he was anti this

R; oh okay and then you're the new one[laughs] okay

T: ya so then I say ok its fine that we need to have it

R: okay and the students parents if its applicable to students parents also affect the teachers use or non-use of technology or do they not have any.. say in it?

T: No, remember the parents are aware already

R: okay

T: they buy the gadgets for the learners

R: oh I see

T: yea and then is only to know that learners are doing their work

R: okay

T: they download here at school

R: ok

T: and then when they go home they are always working on their work offline , so it not

R: oh ya so they don't really have much of an influence, and then this we've already addressed, the key facilitators designed to assist you with technology

T: ya

R: you mentioned those teachers who already have experience, and then the last question of section 6, ok so I think we've already addressed this. How would you say your school, the peers and families affect your use of technology, that's fine I think [sound of door opening] we

addressed that as well so we can move on to section 7.[sound of pages flipping] I think this is the last section[mumbles] ya it is[sound of pages flipping]. Okay, so this section is about division of duties in the classroom, so what is expected of the student, and what is expected of the teacher so in relation to your student, in your classroom, how would you describe your role as the teacher?

T: Right, remember I said, the use of, of these models, you need to control

R: okay

T: The learners are using the tablets, you are using the laptop, as of for now

R: Yea

T: but now, you don't know what is it that the learner is engaging in is

R: ok

T: you find that they are busy doing this and you say maybe open a certain, we are doing a particular paper that is uploaded

R: yea

T: or say download from the portal, then you find learners are busy doing other stuff

R: ya

T: in class, so you need to control the use of that, these are kids

R:ya

T:so you just to make sure that you control them whenever they are working on the gadgets

R:ok

T: and then also when they encounter problems, you find someone says I don't have a tablet, so you say it advance that guys I need you to have a tablet or something in place because we will be operating with this and that,but it means they know, it's a daily thing now.[sound of door opening]

R: okay so tablets must be brought to class

T: ya and it should be fully charged because you don't want such

R: mm

T: that's what you controlling now

R: oh okay

T: because they can say that my tablet is flat, but however we do have a system in the school for demertiting

R: okay

T: if your tablet is flat, it's a demerit

R: okay

T: so it means the school has supported this cotrolling to say

R: yes

T: before the learner comes to school they must make sure that the tablet is charged

R: okay

R:okay so that's support , and then ok do you think your role is different compared to when you weren't actually using technology in the classroom.. previously? Do you think your role has changed now that theres technology\

T: no,nothing has changed

R: ok

T: nothing has changed its actually you're in control

[school speaker beeping and someone speaking] [phone ringing in background]

and you know what it's the same thing we are telling these learners that we're gonna record you. Im being recorded as I teach and you are also being recorded. So if you are naughty you misbehave, it means we'll pick you up that its you whose been doing that

R:Okay

T: so you see how it maintains the discipline

R: okay so how are the students record.. so you are recorded on audio and the students\

T: ya

R: is it also an audio

T: the class is quiet, then whoever says something\

R: ohh you can hear them

T: then you can say "patricia can you stop what you are doing", because this thing is recorded

R: mmm

T: so, there is nothing to hide from myself because im also being recorded teaching, and you are being recorded listening as well

R: okay

T: so I'd actually mention that\

R: so you'd just say as\

T: and that is what the learners don't want

R: oh I see okay

T: you understand that

R: okay coz theres more control, so its just amplified the previous control you had [sound of pages flipping]

T: ya

R: okay and then that's the, the last question is if you believe your role changes can you comment on whether this is beneficial or detrimental, I think you've already answered that

T: yes

R: you say the control is more amplified, so that beneficial

T: yes, that's right

R: and we are finished thank you for your time

T: thank you

R: its actually been shorter than I thought, I planned an hour

T: [laughs]

R: thank you