EXPLORING THE USE OF THE IBOX WHEN TEACHING MATHEMATICS IN SELECTED KWAZULU-NATAL SECONDARY SCHOOLS

By

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DECLARATION

I, Sibongile Tsepiso Mthembu, declare that the research reported in this dissertation is my original work submitted in partial fulfilment of the requirements for the degree of Master of Education (Mathematics Education).

This dissertation has not been submitted for any degree or examination at any other tertiary institution/ university.

Where use has been made of the work of other people, such work has been duly acknowledged in the text and referenced.

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DEDICATION

This dissertation is dedicated to all my family, friends in need and peers.

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I would like to thank the Almighty God for his mercy and grace who gave me strength and courage throughout this study.

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ABSTRACT

Globally the use of technology is changing the face of the classroom. However, in South Africa, with the large numbers of schools with poor infrastructure, the technology that can be used in most schools is limited. In a bid to increase the technological resources available to disadvantaged schools, the Department of Basic Education (DBE) has introduced the iBox multimedia device. The iBox is a portable and durable technological tool that incorporates a laptop, a projector, built-in speakers and a hand-held interactive whiteboard.

The purpose of this study was to explore the ways in which secondary school mathematics teachers from one district in KwaZulu-Natal (KZN) incorporated the iBox into their lessons. The 35 teachers were selected from nine previously disadvantaged high schools. This purposive sampling was for the schools which were provided with the iBox. The data collection methods included a questionnaire, observations and semi-structured interviews. The study focused on three case studies of three mathematics teachers from three different schools.

The study is qualitative and was informed by the interpretive paradigm. The narrative report that was gathered from the data collection was observed with various limitations and shortcomings of the context of previously disadvantaged schools. The study took these into consideration. The use of the iBox multimedia device was used up against traditional instructional methods by the participants. The outcomes conclude that this multimedia device has a potential of being an integral part in mathematics education, as long as comprehensive classroom support is provided.

ACRONYMS

AMESA	- Association of Mathematics Educators in South Africa
AV	- Audio visual
CAPS	- Curriculum Assessment Policy Statement
CK	- Content knowledge
DBE	- Department of Basic Education
DVDROM	- Digital versatile disc-read only memory
ELITS	- Education Library Information and Technology Services
EMIS	- Education Management Information Systems
FDE	- Further Diploma in Education
HDMI	- High-Definition Multimedia Interface
HOD	- Head of Department
ICT	- Information and Communication Technology
IWB	- Interactive whiteboard
KZN	- KwaZulu-Natal
LURITS	- Learner Unit Record Information and Tracking System
MST	- Mathematics, Science and Technology
NSNP	- National School Nutritional Programme
PCK	- Pedagogic Content Knowledge
SASAMS	- South African Schools Administration and Management System
SMT	- School Management Team
STD	- Secondary Teachers' Diploma
TPCK	- Technical Pedagogical Content Knowledge

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Chapter 1
Overview and background

1.1 Introduction

The quality of education in schools needs to improve in order to bring about efficiency in education. There has been a need to have curriculum reform so that this proficiency is met. Pournara (2001) states that curriculum reform has driven teachers to move from the traditional methods of teacher centred teaching to learner participatory and inquiry-based education. The use of Information and Communication Technologies (ICTs) in education is expected to bring better access to quality education, equity and bridge the digital divide nationwide and globally (Department of Education, 2004). The *White Paper on e-Education* states that ICTs could be an answer to the new reform because they offer opportunities for higher-order thinking, creativity, critical and active lifelong learning (Department of Education, 2004). On the contrary the *Integrated Strategic Planning and Framework for Teacher Education and Development in South Africa* technical report (Department of Education, 2011) does not specify ICT involvement.

Mathematics is one of the subjects that demands and promotes higher-order thinking, creativity and critical thinking. The teaching of mathematics in secondary schools has been of concern because of their Grade 12 results which have been very low. Higher order thinking requires learners to have a relational understanding of mathematics concepts so that they know how to apply a rule of a concept and why a rule is used (Skemp, 1976). Relational understanding is weighed against instrumental understanding which is described as using 'rules without reasons' (Skemp, 1976). When learners use ICTs they develop a sense to invent new ways of performing procedures and therefore become critical and active learners (Department of Education, 2004). The Department of Basic Education, among other ventures, consequently provided a technological tool called the iBox to certain schools.

1.2 What is an iBox?

The iBox at the participating schools is a compact, interactive and portable teaching tool. It is comprised of a computer system, a projector and multimedia speakers with volume control all contained in a durable plastic casing that is available in a blue or green colour. It comes with a wireless mouse and keypad as well as a portable, also wireless, mini interactive whiteboard (IWB) called a Mobi-View. The iBox has USB ports which allow for 3G and Wi-Fi

connectivity through USB 3G dongles and USB Wi-Fi adapters respectively. A network port is available to connect the iBox to an existing cable network. Other multimedia features include an HDMI port and AV ports for external multimedia device integration, headphone and microphone jacks and a DVD ROM that is compatible with CD and DVD media. The subject matter content that comes preloaded on the iBox is predominantly focused on mathematics, physical sciences and technology. Although there is various subject related application software available, most of the content is in the form of prepared high-tech PowerPoint presentations. The iBox and its peripheral devices are stored in a convenient carry bag for easy transportation and storage. The iBox is powered by electricity mains.

1.3 Focus of the study

The researcher, as a mathematics teacher and an employee at the district office deployed to monitor and support the use of the iBox in the schools, thought it was of the utmost importance to have first-hand information of the iBox use. It was evident that the iBox was used in the schools, but the study was to gather to what extent the iBox was used. It was hoped that this study was going to help the researcher to understand the role played by the tool in the teaching of mathematics.

The focus of the study was to explore the use of the iBox in the teaching of mathematics in selected secondary schools. As a result the sample participants were mathematics teachers. The study focused on one of the twelve districts in KwaZulu-Natal (KZN). The selected schools were those that received the iBox as an intervention strategy to integrate technology in their teaching and learning.

1.4 Purpose of the study

The vision of the KwaZulu-Natal Department of Basic Education (KZN DBE) is to have a well-educated, skilled and highly developed citizenry (Department of Education, 2011). The mission to support this vision is by providing quality education to all learners. It is assumed that providing technological development may help to produce a skilled and highly developed citizenry.

The purpose of the study was to get an in depth exploration of the use of the iBox on the teaching of mathematics. The extent of the input of using technology is dependent on teacher knowledge and the use of different pedagogical strategies in the classroom which need to be

considered intensively (Motebang, 2009). Therefore it is important that the teachers know how to use and integrate technology in teaching.

It was hoped that, through the study, the researcher would identify various strategies for teaching thereby adding to the body of knowledge about the use of modern technological tools in schools.

1.5 Significance of the study

It has been the goal of the Department of Basic Education (DBE) to turn all schools to e-schools by 2013 (Department of Education, 2004). The study came at a time where the KZN DBE was ready for its second phase of rolling out iBoxes to schools. The findings of this study are of significance to influence the implementation strategies and the use of the tool as well as a further roll-out of technological tools.

The findings of this study might help to improve the support offered or even offer support where it never existed.

1.6 Rationale for the study

The iBox was the DBE's intervention strategy to integrate technology in teaching and learning. Each of the twelve districts in KZN received a certain number of iBoxes through the ELITS (Education Library Information and Technology Services) directorate. As an MST (Mathematics, Science and Technology) co-ordinator in the district, the researcher was tasked to monitor and support the iBox use in schools. The researcher was interested in the use of the iBox by the mathematics teachers in order to improve the pass rate in this gateway subject.

South Africa must develop and produce a pool of ICT-proficient youth, from which the country can draw trainee ICT engineers, programmers and software developers (Department of Education, 2004). e-Education seems to be a way to address ICT proficiency. The approach of e-Education is through ICT integration in schools. Motebang, (2009) stated that the reform of ICT integration would also adhere to the desires of society. The successful integration of ICT into teaching and learning will ensured through relevant skilling of teachers (Department of Education, 2007). The e-Education policy further states that the schools have to be developed into learning organisations by becoming e-Schools.

The EMIS (Education Management Information Systems) unit has managed to set up SASAMS (South African Schools Administration and Management System) and LURITS (Learner Unit Record Information and Tracking System) in order to take care of the administration and management of schools as postulated in the *White Paper on e-Education*. Teaching and learning has to be taken care of as well. It is the schools' responsibility to integrate technology in teaching and learning using the available resources. The researcher is therefore exploring the use of the iBox which could be used as an ICT integration tool.

1.7 Research questions

Research questions provide a position from which to initiate an exploration and to check against the findings that data reveals (Leedy & Ormrod, 2005). They also guide other subsequent tasks in the study process (Maxwell, 2005). The questions developed to accomplish the purpose of the study are:

1. Why do teachers use the iBox?
2. How do teachers use the iBox?
3. What are the challenges faced by the teachers when using the iBox?

1.8 Objectives of the study

1. To determine the extent to which teachers use the iBox.
2. To explore the experiences of teachers in mathematics.

1.9 Policy initiatives

1.9.1 e-Education policy goal

The *White Paper on e-Education* states that by 2013 all South African learners ought to be ICT skilled, that is, use ICTs confidently and creatively to help develop the skills and knowledge they need to achieve their full potential and to be competent contributors worldwide (Department of Education, 2004).

It is of utmost importance that schools are ahead of the process by identifying strategies of technology use (Lim & Khine, 2006). All this should be preceded by e-Learning in schools. e-Learning comprises of learning about ICTs (exploring), learning with ICTs (supplement normal learning and teaching) and learning through ICTs (support ways of teaching and learning) (Department of Education, 2004). The initiative to provide schools with the iBox was in line to promote the integration of ICTs.

1.9.2 Policy framework

The *White Paper on e-Education* states that the use of ICTs in teaching and learning should in no way hamper teachers, learners and learning organisations in creativity, problem solving and innovation (Department of Education, 2004). It cannot be overemphasised that equal access, equal competence and the influence to the whole school is maintained (Tondeur, Van Keer, van Braak, & Valcke, 2008). To do this, a technology baseline would be developed where all schools have proper infrastructure for connectivity. e-Learning is best achieved when ICT integration is used to promote learner-centred and activity-based approaches (Department of Education, 2004). Transformation of classrooms and strategies are therefore necessary. Technical support and support to staff is required. The Department of Education (2004) stipulates that there is a need to allocate norms and standards (funds allocation) for educational ICTs. This allocation would cater for all responsibilities, compliance requirements and implementation strategies.

1.10 Explanation of the key words used in the study

1.10.1 Technology

The word technology comes from two Greek words, *techne* and *logos*. *Techne* means art, expertise, or skill. *Logos* means to speak of or merely the practical application of *techne* (Merriam-Webster, 2013).

1.10.2 Information and Communication Technology (ICT)

Information and Communication Technologies are a combination of networks, hardware and software that enables processing, management and exchange of data information and knowledge to make teaching and learning effective (Department of Education, 2004; Sang & Frost, 2005).

1.10.3 Mathematical Content knowledge (CK) and Pedagogical content knowledge (PCK)

Mathematical CK is the mathematical knowledge for teachers (Bell, Wilson, Higgins, & McCoach, 2010). PCK is the form of representing CK ideas using analogies, illustrations, examples, explanations, demonstrations as well as the ways of representing and formulating the subject to make it comprehensible to the recipients (Shulman, 1987). Therefore CK will answer ‘what’ subject matter was covered and PCK will answer ‘how’ subject matter was delivered (Bell et al., 2010) and further PCK is the development of mathematical ideas.

1.10.4 Blended learning

A blended learning methodology is schooling which combines different types of education techniques and technologies, either face-to-face learning or with online coaching, including both traditional and modern tools.

1.11 Structure and direction of the study

This study has seven chapters. The first chapter serves as an introduction which is the overview and background of the study. The focus and purpose, the significance, rationale, research questions and the objectives of the study are highlighted. This study has a bearing on a policy; therefore the policy initiatives and policy framework are included in chapter 1. The iBox technological tool is also introduced in this chapter. Key terms used in the study are also explained.

Chapter 2 is the review of literature related to the study. The chapter highlights the uses of technology in general and in the teaching of mathematics, the benefits and pitfalls of technology use and opportunities for teacher learning are included. Chapter 3 is the theoretical framework that framed the study.

Chapter 4 is methodology under which the research design is discussed. This study is a qualitative case study which follows the interpretive paradigm. Additionally, the data collection techniques and the data generation plan are discussed. Sampling, ethical issues and the limitations of the study are also included in this chapter.

Chapter 5 focuses on the findings of the data collected. Chapter 6 focuses on the discussion and analysis of presented findings. The final chapter, Chapter 7 focuses on the concluding remarks based on the findings.

1.12 Conclusion

This chapter presented the background and an outline of the research. This study which was based on the use of the iBox took into consideration the *White Paper on e-Education* which spells out that teaching and learning should encompass the formation of learning spaces that use ICTs in their day-to-day endeavours. This chapter gave highlights on each component of the study. The next chapter presents the review of related literature on the use of modern technology in the teaching of mathematics, both locally and internationally.

Chapter 2
Review of literature

2.1 Introduction

In the previous chapter the background and an outline of the research was presented. In this chapter literature related to the uses of technology available as well as the benefits and limitations of using technology are discussed. Bester and Brand (2013) state that the time and effort used in the classroom are of no value if learners are not learning. Therefore in schools there are supposed to be teachers who teach so that learning is taking place through their teaching. The district officials and district support systems should be available to assist schools (Bloch, 2009) to uphold this. Literature which covers the uses and effects of technology, the uses of technology in the teaching of mathematics as well as the benefits and limitations of using technology in the classroom were also looked at.

2.2 Uses and effects of technology

Technology is used in the administrative and the management levels as well as in teaching and learning at schools. Cole (2006) says in management and administration, technology adds much improvement even beyond the classroom.

Teaching and learning at schools is transforming because society itself is changing (Stephenson, 2001). One such change is brought about by technology. Some learners construct their knowledge network and accumulate new meanings (Vygotsky, 1978) in the form of social networks like twitter and face book. Twitter and face book are technologically inclined. Learners love them. Social networks are a result of a changing society. Learners do not undergo any formal schooling to learn how to engage in social networks. They seem to be responsible because learners take an active role in the learning of what is of interest to them via social networks, thereby becoming aware of their cognitive processes (Vygotsky, 1978).

Social networks promote social interaction among people who use it. Monaghan (2003) stated that such interaction can be of a spoken or non-spoken form. Vygotsky (1978) goes on to say social interaction plays a vital role in the development of cognition and that learning is a social process. Social interaction (teacher-learner and learner-learner) plays a vital role in the in the fulfillment of the objectives of a lesson (Saxe, 1991; Monaghan, 2003) in a teaching and learning milieu. In his sociocultural theory of human learning Vygotsky (1978)

says, the origin of human intelligence is society and culture. Piaget (1970) also stated that cognitive development is based on biological maturation and environmental experience. Therefore learning that takes place in learners' social and cultural groupings, through social media, could improve their intelligence. The use of the iBox in school for teaching mathematics could assist general learning and the improvement of social interactions which play a role in the upliftment of cognition.

When learners come to school the information that they have varies from learner to learner because they come from different backgrounds and environments. It is therefore the Department of Basic Education (DBE) and the Government's responsibility to narrow the gap. Technological innovations are aimed at introducing schools to new ways of doing things (Department of Education, 2004). Schools need varied assistance, as stated earlier, to make learning possible. Policy involvement and low-level technology use (Ertmer, 2006) ought to be attended to.

To ensure empowerment, support and responsibility within a technological field, the South African DBE published a policy document in 2004 called the *White Paper on e-Education*. Naledi Pandor, the then Minister of Education, said it is anticipated that the document with all its endorsements would bridge the digital divide both internationally and domestically (Department of Education, 2004). Bloch (2009), a South African education analyst, states that there are huge backlogs on libraries, labs and computers in the South African schools. Therefore, backlogs on computers might hamper progress in bridging the digital gap. However with the iBox intervention strategy, it is hoped that the service delivery gap, especially on computers, will be lessened.

In a study done in the United States on the uses of technology by College of Education students, Lei and Zhao (2007) revealed that it is the quality of use rather than the quantity that should be ensured and found that some technology use is not constructive and helpful in meaningful and beneficial ways. Furthermore, the study revealed that there is a negative influence on results when students spend more time on technology which is of poor quality. Lastly, the study revealed that there is a notion that technology use in schools can improve the quality of teaching and learning if policy is focused on the quality of use rather than sheer integration of technology. The iBox is a user-friendly as well as all-in-one tool, more and more users might tend to make 'trial and error' use with it.

A South African study was conducted in 2013 by psychologists, Bester and Brand. The study focused on attention and concentration in education. The findings of Bester and Brand (2013) study suggested that technology can improve achievement and can assist in attention and if used over a long period of time concentration also ought to improve. The study also revealed that as technology increases the attention of learners', motivation becomes an important variable. Therefore there exists a correlation between motivation and concentration. It is yet to be established if the teachers that use technology in the sample schools of this study share the same sentiments. As a result, the effect of technology results in good attention behaviour and ultimately good achievement (Bester and Brand, 2013).

A study done in India on technology integration revealed that traditional technologies such as printed material, radio and television continue to be more effective and accessible for rural and disadvantaged groups. Other groups are exposed to modern technologies. To address equal access to learning a focus on basic and primary educational infrastructure to support low-cost, higher quality access in rural and deprived areas needs to be done (Gulati, 2008). Another developing African country, Rwanda, views ICT as a key tool for transforming the education sector. Existing policies seem to be disadvantaging particular groups, such as girls and those living in rural communities but there is a need to engage with ICT capabilities (Rubagiza, Were, & Sutherland, 2011). Therefore more attention need to be given to the less advantaged.

Technology might enhance learning if the teacher is cognisant of the demands of the content (Leask & Pachler, 2005). This suggests that a teacher's competency in content knowledge (CK) referred to as pedagogical content knowledge (PCK) by Bell et al., (2010) is important. Therefore a teacher must possess the appropriate pedagogical knowledge in order to deliver technologically and organisationally. Leask and Pachler, (2005) further highlighted the following: technology may not benefit schools if the teacher is not competent in content, technological and pedagogical knowledge as a result the lack of all three may inhibit learning.

Some studies have looked at teaching and learning tools such as computers, laptops, e-readers, MP3 players and electronic or interactive white boards. Ryan (2013) who studied technological tools used in the classroom stated that the use of chalkboard may never end even though technological tools seem to take over in new ways. The chalkboard is still used

in many institutions for subject matter presentations and this is echoed by Glover and Miller (2001). Vincent (2012) discussed hand-held mobile tools like Global Positioning Systems, electronic keyboards, digital cameras, scanners, cell phones, tablets, USB drives as well as notebooks and stated that these tools promote learning anywhere which can be dependent and interdependent thus enabling the learners to meet their individual needs.

Finally, technology use in schools has undergone many changes. It has moved from visual tools, such as overhead projectors, to audio-visual tools, such as films and videos and to computers which include interactive learning like using interactive white boards (Bester & Brand, 2013). A variety of modern technology which includes computer games and the use of calculators are used and are enjoyed by some learners. The use of such technology may motivate learners to do better.

2.3 The uses of technology in the teaching of mathematics

Some uses of technology in schools are to raise standards in literacy and numeracy, to foster creativity, bring teaching and learning to life and to tailor work to individual needs (Cole, 2006). Ashburn and Floden (2006) talk of meaningful learning which is characterised by, among other things, active inquiry and the mental model. Active inquiry is a four-step process; developing and exploring the investigative question, gathering and evaluating information, analysing and interpreting information and communicating new understanding. Mental model construction involves constructing knowledge that a learner is unaware of, sees diverse perspectives and thinks about complex ideas. Ashburn and Floden (2006) claim that technology is used in the classroom to manipulate, scaffold and develop such models.

Traditional ways of teaching could be supplemented by alternative techniques e.g. using technology in order to engage learners with different learning styles and abilities (Atteridge, 2010). An example is the use of a table function in a calculator which reduces arithmetic mistakes (for learners who have poor computing skills) when dealing with cubic functions. Virtual learning is another alternative technique and it mainly uses technology. Davis and Rose (2011) assert that virtual learning, which can also be used for mathematics learning, bridges the gap between traditional teaching and the 21st century types of teaching. Therefore, virtual learning is e-Learning which uses learning tools designed to enhance a student's learning experience by including computers in the learning process (Barab, Kling, & Gray, 2004).

A study was done in South Africa, by Padayachee, Boshoff, Olivier and Harding in 2011, on the use of digital video disks (DVDs) in conjunction with other traditional methods of delivery in the teaching of mathematics in schools. Their study aimed at investigating the performance of Grade 12 learners using a blended learning approach which incorporated the use of DVD technology. A blended learning approach is schooling which combines different types of education techniques and technologies or even face-to-face learning combined with online tuition (Köse, 2010). For the purpose of this study, the blended learning system would mean the former.

It is therefore the inclusion of the traditional technologies and the modern technology. It is envisaged that the teachers in the iBox study would be using the chalkboard, textbooks, work sheets and off course the iBox. Who knows what else? The study on DVD teaching and learning was based at one school which is in the Nelson Mandela Metropolis. DVDs were developed and edited to check mathematical and technical errors and re-recording was done if necessary. Twenty DVDs were produced covering all the Grade 12 topics. DVD technology in a blended learning approach has a positive impact on the learning of mathematic s and it improved the learner performance in mathematics (Padayachee et al., 2011). Additionally, learners in that study mentioned that the method was refreshing, enjoyable and is better than the book because there is a voice explaining concepts.

Mathematics is often viewed as an abstract subject. Mudaly (2004) stated that through technology, mathematical problems even real world problems can be solved. Based on the findings of his study Mudaly (2004) stated that this kind of venture leads to new knowledge, and learners could do this assisted or unassisted. de Villiers (2004) contends that *Geometer's Sketchpad* can provide useful tools for understanding and constructing proofs in mathematics. Mudaly (2004) adds that with the use of *Geometer's Sketchpad* learners can display a better knowledge of what they had learned by easily constructing a logical argument after seeing images with technology and therefore make generalisations. *Geometer's Sketchpad* Software can be installed on the iBox tool, because it is a computer, and be used to get the benefits of understanding and making proofs, make conjectures and more.

Visual images, as those that can be created by technology, may form a specific response in the mind of the observer than words that are said verbally thereby making it easier to make conjectures (Mudaly, 2008). This is echoed by Ball and Ball (2007) who state that learning is

assisted by visual images. A further contribution on visualisation was made by Bansilal and Naidoo (2012) who claimed that a learner made a profound understanding of the concepts of transformation because of his skill in visual and analytic representations and this can also be displayed by technology. Whilst some teachers are still using traditional methods of teaching, technology could be infused through the use of tools like the iBox which is user friendly (see Table 5.1). The blended learning system (Köse, 2010) could even be adapted. There is a Chinese saying that goes like this: I hear and I forget I see and I remember I do and I understand. The Chinese saying approves of creating the visual images so that can they be understood and technology could be of good use.

However, Spencer-Smith and Hardman (2011) found a negative result in the relationship between the use of computer and mathematics attainment. For Spencer-Smith and Harding (2011) the use of technology to improve results proved to be a futile exercise. Their study further suggested that factors like the socio-economic contexts, teacher-pupil ratio and the use of mathematics software available are the contributing factors towards poor attainment in some schools. Most learners where the iBox was provided, who are taught by the participants of this study, come from low socio-economic contexts. Computers are visual tools and so is the iBox. Monaghan (2003), who looked at what could be the factors that affect the achievement of goals in a lesson, argued that when technology is involved, the goal could be more technologically focused, for instance getting the spread sheet right. If a teacher is not technologically competent, a lot of tome could be 'wasted' attending to a technological aspect than achieving the goals of a lesson. Nevertheless, Naidoo (2011) showed that visual tools made learning more accessible and understandable regardless of the context.

From experience, some learners have difficulty understanding the dynamic elements of algebra because they only experience them as static. Variables and functions involve changing quantities. Technology can be used to emphasise the role of variables as changing quantities as well as the concept of functions and their behaviour (Steketee, 2010). With *Geometer's Sketchpad* and geometric functions, the independent variable can be manipulated by dragging it whilst observing and recording the behaviour of the function through dragging. Thus technology can be used in mathematics classrooms to help learners understand abstract ideas by making conjectures. As mentioned earlier, software could be installed on the iBox thus making it further technological.

2.4 Benefits and limitations of using technology in the classroom

Even though there are many benefits of computers, computer technology has its benefits and limitations (Lai & Kritsonis, 2006). The confines should be taken into consideration in order to get the full benefit of computer technology. Cole (2006) stated that computers are a means to an end but not an end on their own. It should be noted that face to face human interaction is vital which does not crash (because computers do) and can make motivational gestures like smiling and nodding (because computers do not).

2.4.1 Benefits of using technology in the classroom

Some of the effects of technology are that achievement is likely to improve because the attention of learners is captured, their concentration is maintained and therefore learners are motivated to learn (Bester & Brand, 2013). The same study also concluded that learners become motivated in such a way that even class attendance improves where generally this is a problem. This is a huge advantage because even the disciplinary problems in a school may be minimised since learners are motivated to learn. In general, learners have a problem in understanding complex ideas in mathematics. Ashburn and Floden (2006) suggest that the learners' ability to attempt challenging content is increased because of their improved attention and concentration through the use of technology.

With dynamic sketches, a learner can make conjectures which lead to reasoning and understanding because real life situations are manipulated and solved (Mudaly, 2004) using the dynamic software. Using an example of *Geometer's Sketchpad*, dragging a point for a learner to make a conjecture makes the learners arrive at an understanding of a rather complex idea more easily. Using a *Geometer's Sketchpad* diagram illustrated in Figure 2.1, a conjecture can be made.

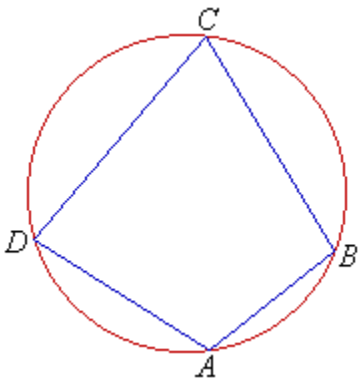

Figure 2.1: A cyclic quadrilateral ABCD

The learners measure angles labeled A, B, C and D. They calculate the sum of $\hat{A}$ and $\hat{C}$ as well as the sum of $\hat{D}$ and $\hat{B}$. Learners should be able to conjecture that the opposite angles of a cyclic quadrilateral add up to 180° (they are supplementary). When any point of the cyclic quadrilateral is dragged (because *Geometer's Sketchpad* allows this to happen*)* learners observe that the results do not change. If any of the lines is extended to form an exterior angle, learners are guided to make a conjecture through observation that the exterior angle of a cyclic quadrilateral is equal to the interior opposite angle. Learners can also be guided to prove that the exterior angle of a cyclic quadrilateral is equal to the interior opposite angle.

Another benefit of technology is the use of DVD technology in a blended (using different methods) environment which proved to be successful (Padayachee et al., (2011). From the study it was established that DVDs were easily accessible and affordable. Furthermore, DVDs can be used in the absence of a teacher. One other value of technology is that it helps reinforce mathematical concepts because of its practicality (Skinner, 2011). Technology allows for data to be presented in a variety of ways, thus, helping and engaging learners to develop their relational understanding.

The use of technology allows learning from feedback, observing patterns, noting connections, and working with dynamic imagery (Jones, 2010). When an explanation is dynamic (as dynamic software portrays ideas), learning is visual and so is the understanding. Words and explanations are not forced onto the learner but learners can make their own connections. Mudaly (2004) stated that with proper guidance in the use of dynamic *Geometer's Sketchpad*, learners could make conjectures and provide sensible explanations for their conjectures. Jones (2010) claims that results are direct and immediate, and then the paper and pen activity can follow.

Computers are one of the most important tools in technology but in some schools their use is limited to individual teachers (Matabane, 2010), because the skill of using them seems to be the key. A typing technique is one of the skills needed. This is followed by computer literacy or computer practice so that one is able to apply basic functions and programmes for an example, the spread sheet. Competency would then follow where one is able to go to applications. The introduction of new technologies in schools could have resulted in change for some teachers. Change can make some people become apprehensive; therefore the implementers of change should be aware of what the change is doing to the people and taking

ownership is essential for effective change (Pillay, 2005). If this and other factors that are influenced by change are not taken care of, the impact on the teaching and learning of mathematics could be negative.

2.4.2 Limitations of using technology in the classroom

Computers cannot handle unexpected situations, and are unable to diagnose learners' problems. Additionally, when computers are incorporated using school funds they will increase educational costs and harm the equity of education (Lai & Kritsonis, 2006). This may be a problem for disadvantaged schools.

Another limitation of using technology in the classroom is that of technical problems. Leask and Pachler (2005) identified the following technical problems; a computer may crash which means that it can stop working or cannot respond in the normal way, network failure which means that network or internet connection may be completely lost or be down, and lastly the problem with the projector which may fail because the bulb could be blown or caused by the failure to clean the filters.

Technology infrastructure is also a contributing factor. Some schools have not yet been technologically connected. From experience, if connectivity is available, internet connection is slow.

2.5 Conclusion

The review of relevant literature informed the researcher of previous findings and gaps in the field. The gap is the absence of studies on the iBox. Important aspects pertaining to the benefits and limitations of using technology to teach mathematics have been revealed. The next chapter focuses on the theoretical framework that was used to frame this study.

Chapter 3
Theoretical framework

3.1 Introduction

In the previous chapter literature related to the uses of technology was discussed. In this chapter the theoretical framework that framed the study is presented.

The pragmatic knowledge of this study is grounded within the theoretical framework of Saxe's four parameter model. The model focuses on three components; the analysis of practice-linked goals, form-function shifts in cognitive development and the interplay between learning across contexts. Of the three components, this study is aligned to the analysis of practice-linked goals. The other two components are not clarifies because they are of no importance to the study.

The analysis of practice linked goals as a focal component is a general analytical model targeting cultural practices (Saxe, 1991). Cultural practices in the context of this study are the practices stipulated by DBE. Goals, which are emergent occurrences in Saxe's model, are realised when individuals practise their skills and knowledge in a relationship with others in their immediate environment. These emergent goals in the study are the mathematical goals or the objectives of the mathematics curriculum and lessons.

The relationships are between the teachers and the learners as well as among the learners themselves. Further, the relationships could be among the teachers as well. Teachers in the same school and other schools share knowledge. So the pool of relationships could spill over to other schools as well. The intentions of a lesson(s) are realised when the four parameters are enacted when preparing to teach and to assess as well as when teaching and learning takes place. It should be considered that assessment can be done at home as well.

3.2 Saxe's four parameter model

The model claims that the emergent goals are associated with four parameters, hence the four parameter model as illustrated in Figure 3.1

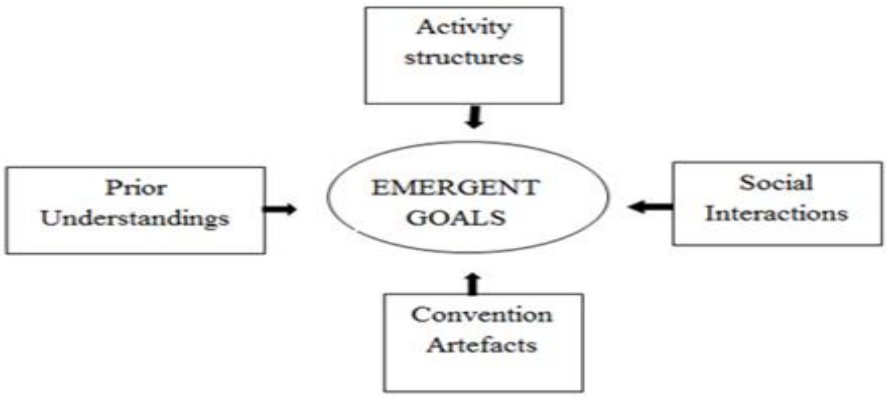

Figure 3.1: Four parameter model adopted from Saxe (1991, p. 17)

This study is concerned with using the iBox in the teaching of mathematics. The main aim of teaching is to achieve certain objectives. In a teaching and learning endeavour, there is a teacher who ought to teach, learners who ought to learn and the content knowledge (CK) that is meant to be transferred. Figure 3.1 indicates that in order for the intentions to be achieved there are activities that should be performed, social interactions may take place, prior influences might come to the forefront and all this is complemented by some objectives that help to complete the process.

3.2.1 Parameter 1 - Activity structures

Activity structures are all the activities or general responsibilities that must be performed in the practice (Saxe, 1991). These are the planned tasks to achieve the objectives of the curriculum. Therefore how activities are structured and performed are of utmost importance. Monaghan (2003) further states that activity structures could be organised in such a way that activities are arranged in what he calls activity cycles. An activity cycle is when a teacher makes an example or examples which are followed by a task or tasks performed by learners similar to the teacher's example. The teacher would then provide answers and further

explanations in the form of more examples or questions if it is apparent that the concept was not understood by a number of learners. The Saxe's theory therefore proposes that a lesson should consist of planned activities which are structured and performed efficiently.

3.2.2 Parameter 2 – Social interactions

Social interactions may be collaborations initiated by the teacher or by the learner then followed by a reply which may eventually be followed by an evaluation by the teacher (Saxe, 1991). Social interactions are therefore the interplay between the teacher and the learners as well as among learners themselves. These are the teacher-student discourses (Monaghan, 2003) which may include talking in general, giving instructions, facilitating, explaining, eliciting ideas and class explanations. It therefore depends on the scenario that is presented as to how the teacher interacts with the learners in order to achieve the goals of a lesson because the classroom environment changes all the time (Anthony & Walshaw, 2009). Consequently, classrooms activities affect the teaching practice in a way that suits the situation at hand. In addition, Vygotsky (1978) states that social interactions are shaped by social and historical influences and this might influence the study. Finally, social interactions may be verbal or non-verbal. For this study, social relationships within the classroom could be influenced by the presence of the iBox.

3.2.3 Parameter 3 – Convention artefacts

Convention artefacts are the objects that have been developed over time that have historical relevance to the practice (Saxe, 1991). Monaghan (2003), states that these artefacts may be technological software and hardware as well as the written resources such as textbooks and worksheets. For this study the artefacts, objects or tools that are used for the lesson would be the iBox or any other teaching and learning resource such as the chalkboard, textbooks, worksheets, calculators and charts. Over time materials evolve, this includes the tools used for teaching and learning. For example, the chalkboard could be replaced by the whiteboard or the interactive board. The four-parameter model claims that a lesson ought to have tools in order to realise its aims. One of the tools expected to be used in this study is the iBox.

3.2.4 Parameter 4 – Prior understandings

For Saxe (1991) prior understandings are the experiences that individuals bring as cultural practices in the enactment of a procedure. Prior understandings, for this study, may therefore include previous knowledge within or outside of mathematics, competencies, beliefs and

social practices which influence the mathematics being taught as well as the technological knowledge of both the teacher and the learners. Prior knowledge (of both the teachers and the learners) is of relevance to this study because most mathematics lessons draw from previous experience. In this study it is of importance to see how teaching draws on the iBox to achieve the outcomes of the lessons.

3.3 Monaghan's model

Monaghan adapted Saxe's model but linked all parameters to one another and to the emergent goals, as illustrated on Figure 3.2.

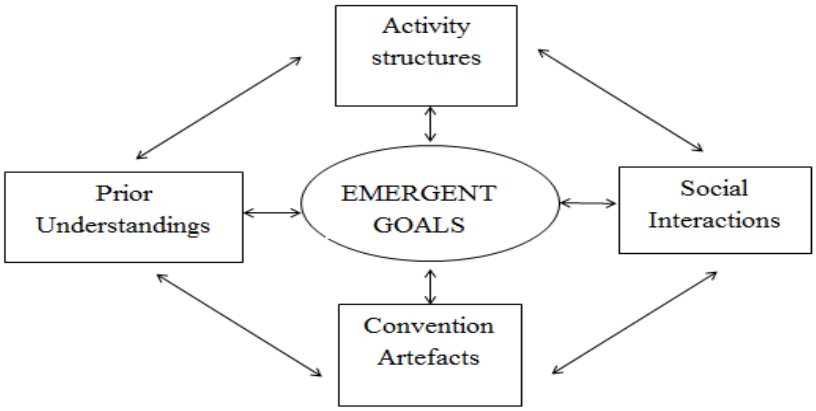

Figure 3.2: Monaghan's model adapted from Monaghan (2003, p.2)

The Monaghan's parameter structure is necessary in this iBox study. As emergent goals are in actual fact the emergent mathematical goals, these are the goal structures that ought to be accomplished by the end of a single practice, which is a lesson. For Monaghan (2003) the emergent goal could be more technologically focused, for instance being able to design a spread sheet. Hence, Saxe (1991) calls them the practice-linked goals. Therefore the Monaghan's model (Figure 3.2) which links all parameters ('parameters are intertwined') further assists the frame of the study for the achievement of the lesson's specific goals. Monaghan's study looked at the technology classes versus the non-technology classes.

Monaghan's model postulates that the social interactions parameter is linked more to other parameters in the technology classes even though the computer (a tool) is a focal point. When learners from a low socio-economic background are in school learning, they usually lack resources like a calculator or rulers. Sometimes they are forced to work in pairs or groups so that they share resources. Therefore the convention artefacts (tools) parameter is

automatically linked with the social interactions parameter to help achieve the objective(s) of a lesson.

Similarly, when learners do an activity in class or even at home, they might work together (not forced) for a common goal of achieving the best. They might share resources as mentioned earlier, thereby interacting (social interactions parameter) with one another. In this scenario three parameters again are linked in order to achieve the goal of a lesson. The prior understandings parameter can also be linked with others where an activity in structured to draw from previous work in order to accomplish the objectives of a particular lesson.

The model will therefore assist in looking if the goal structures are realised where there is an intertwining of parameters. For Monaghan (2003) the 'tool shift' is a necessity (that is moving from the text books, exercise books, worksheets to the more technologically advanced tools). Saxe (1991) studied a candy selling practice performed by young boys of school going age, some had schooling and some did not. The candy selling practice whose artefact is the merchandise is linked to the study's teaching of mathematics where the iBox is the artefact.

3.4 The candy selling practice and the link to this study

The candy selling analogue has four phases; prepare-to-purchase, purchase, prepare-to sell and selling phases. All candy selling stages are linked to the teaching pedagogy. The model hypothesises that in the prepare-to-purchase phase, the young merchant has a decision to make. He/she has to decide on what to buy, on the quantity to buy and where to buy. What is bought must be sold at a good profit. With regards to the teaching practice, the prepare to purchase phase would be deciding on and preparing what to teach (Curriculum based). Of course the Curriculum Assessment Policy Statement (CAPS) document would be used as a guide. The context is of utmost importance since it is depicted by the circumstances.

The candy selling analogy postulates that the next two phases are the purchase and prepare to sell phases. When coming to the purchase phase, the buyer has to negotiate a price with the retailer. The price that is agreed upon will affect the number of units bought of each type of merchandise. When teaching, the participant would decide on the subject matter, the topic and subtopics as well as the outcomes. Again here the CAPS document would become very handy. It spells out most of what is expected but the subject specialist puts more flesh. Then the next phase would be the prepare-to sell phase. The selling price should be decided on

linking it to the cost price and what other street sellers are charging. All marketing strategies ought to come to the forefront. For the participant, the prepare to sell phase would mean coming out with the strategy to approach the lesson, choosing the appropriate activities as well as pedagogy. It might also be necessary to have two plans, that is, should the iBox (technology) not work properly or the electrical power fails.

The last part is the selling phase. In the selling phase, the merchant has to be witty and fast thinking. If a planned strategy does not work, then the seller is supposed to quickly think of what else to do. Simultaneously he/she has to think and decide on what will sell next. Hence activity structures should be related to goal-directed activities (Saxe, 1991). For the participant this is the actual teaching time which might include bringing in prior knowledge, using activities to teach and assess and evaluating the outcomes of a lesson. It is when if the original plan does not work than plan B is executed.

In addition the original Saxe's model, all parameters contribute to the emergent goals. For Monaghan, all parameters are interwoven. Parameters 2 and 3 (social interactions and convention artefacts) should be seen to be interwoven in order to achieve the lesson objectives in the 'sell phase'. The social interactions are between the teacher and learners, among learners themselves and between the teachers' and the learners' knowledge of the content subject.

These social interactions are the sociocultural processes linked to instructional strategies between the actors in the teaching and learning process. Vygotsky (1978), states that social interactions are shaped by social and historical influences, hence parameter 2 is linked to parameter 4 (prior understandings). With the candy-selling practice the social interactions are between the sellers and the customers, between the peers and between the sellers and the mathematical transactions of buying and selling. This interwoven capability was postulated by Monaghan (2003) in his four parameter model showing interconnectedness as illustrated in the Figure 3.2. This linking also includes the other parameters.

As indicated above social interactions, convention artefacts are to be seen as interwoven during the teaching and learning process. The artefacts are the teaching and learning tools. The tool that is under investigation in this study is the iBox. Other tools could include the chalkboard, textbooks, exercise books, the lesson plan, calculators and whatever else the

participant has brought to class in order to assist in the teaching and learning process. In the candy-selling practice the main artefact was the merchandise.

The teaching and learning process which includes activity structures, social interactions and artefacts (three of Saxe's parameters) are affected by what the teachers and learners bring into the classroom or what they believe in (the fourth Saxe's parameter). In addition, what teachers and learners believe in is also affected by their environments. Prior understandings in this study include prior content knowledge, beliefs and competences. Prior understandings also include what Shulman (1987) calls knowledge of thinking and learning. The teacher's competencies include the command of the content knowledge, mannerisms, language, lesson planning, presentation and the use of technology. For the learners it is knowledge from previous mathematics learning. For both the teacher and learners, cultural, historical and social influences are taken into consideration.

Particularly for the teacher, professional identity and professional knowledge are of importance. Mishra and Koehler (2006) use a TPCK (Technical Pedagogical Content Knowledge) framework which underline that teaching is a multifaceted undertaking that draws from different kinds of knowledge. What Mishra and Koehler (2006) are proposing will be linked to the teachers' competencies mentioned in parameter 4 (prior understanding). In the candy selling concept the competency is the art of negotiating in the purchase phase and the art of marketing sweets which leads to fast sales and making a profit.

Pedagogy is about the curriculum and the systemic aims and objectives of education (Daher, 2012). Andrews (2007) adds that pedagogy is the broad and narrow views of the curriculum. It is therefore the science and the art of teaching or for teaching (Loughran, 2013). Harris and Hofer (2011) state that even before the teacher uses technology, it is important to check pedagogically if the content knowledge is appropriate for the knowledge of learners. Pedagogy is therefore the art of teaching.

Finally, the CK which is mostly drawn from the prior understandings in the prepare to buy and purchase stages and the PCK together with the TPCK which uses activity structures as well as the convention artefacts in the prepare to sell stage would be expedited in the selling stage. In the selling stage all parameters will be enacted in order to attain the goals of a lesson.

3.5 Conclusion

The Saxe's four parameter model as the theoretical framework was used for this study which assumes that the teacher's goal to achieve the objectives of a lesson when using technology are bound by (a) activity structures or tasks that a teacher sets out; (b) prior understandings or the teacher's and learners' beliefs and competencies; (c) convention artefacts or teaching aids to be used in conjunction with the technological tool and (d) social interactions which could be verbal and non-verbal (Monaghan, 2003).

Therefore the Saxe's model frames this study with respect to, to what extent the use of the iBox incorporates the activity structures, prior understandings, convention artefacts and social interventions in the classroom, and how this incorporation helps in achieving the intentions of the lesson.

Monaghan (2003) might also come to the fore, who claims that Saxe's parameters are interwoven. He further claims that with the inclusion of technology in teaching, the intertwining is even more. He also attributes that the goal of the lesson could be technologically directed, through the usage of modern technology tools, as well as due to the nature of a lesson. The iBox is a technological artefact therefore more linking is possible in classes where it is used for teaching mathematics.

The next chapter presents the research design and the selected methodology employed in the exploration of the use of the iBox that was adopted to collect and analyse data in order to answer the research questions.

Chapter 4
Research methodology and design

4.1 Introduction

The previous chapter discussed the theoretical framework of the study. This chapter discusses the position of the study in relation to the research design and methodology adopted. This is the plan of action laid down to guide the study (Terre Blanche, Durheim & Painter, 2006). The research methodology and the context of the study are explained followed by the sampling procedure. Thereafter techniques used to gather data are explained. Ethical issues and challenges are then discussed.

4.2 Research methodology

4.2.1 Introduction

The purpose of the study was to get an in depth exploration of the use of the iBox on the teaching of mathematics. This study was therefore grounded in a qualitative method of data collection. In order to complete the three case studies an interpretive paradigm was used.

4.2.2 The Interpretive paradigm

The study was conducted within an interpretive paradigm. The aim was to understand the phenomenon through the people who are directly involved and who make sense of their surroundings (Christiansen, Bertram & Land, 2010). Linking a case study with the interpretive paradigm allowed the study to seek to understand and interpret a phenomenon of teaching mathematics using the iBox through the eyes of its participants (Cohen et al., 2007). This was the reason why the sample of participants is mathematics teachers in schools that have an iBox. The interpretive paradigm allowed a researcher to move from the unknown to a place where the study led.

Cohen et al., (2007) state that the social world is understood by its citizens who are the active participants of the action being investigated and this is what interpretivism is about. Teachers who use the iBox were the participants of this study and the number of prospective participants dropped drastically because it was discovered that some teachers who filled in the questionnaire do not use the iBox. However, because a case study and an interprevist approach were used, events were made to speak for themselves, as well as to be interpreted and evaluated by the researcher.

Applying a qualitative, interpretivist case study approach to the context of this study enabled a deeper understanding of the way mathematics teachers respond to the technological tool given to their schools.

4.2.3 Qualitative methodology

The study employed the qualitative approach to gather information and report on the findings and conclusion for the study. The qualitative feature of this study shows the understanding and descriptive endeavour of the teachers' personal experiences (Johnson & Onwuegbuzie, 2004) in using the iBox. The study is a descriptive case because it provides narrative accounts (Cohen, Manion & Morrison, 2007), hence qualitative data was gathered. This study adopted the use of questionnaires, observations and interviews. Firstly, 35 mathematics teachers (sample of participants) in nine schools with the iBox tool were given a questionnaire in order to gather data on the teaching of mathematics whilst utilising the tool. Eventually three participants in three different schools were observed while using the iBox to teach in their classrooms. The three participants were identified on the basis of using the iBox, willingness and availability to carry on with the study by way of being observed whilst teaching. Each participant was also allowed to voice their views during individual interviews (Cohen et al, 2007).

In addition, qualitative research is about the individuals' perception of the world (Bell, 2005) which, in the case of this study, is the world of teaching mathematics using the iBox. Furthermore, this study was qualitative because it did not verify any existing theories and hypotheses but it was a discovery of ideas (Auerbach & Silverstein, 2003). The researcher went to the schools with an open mind to gather information on the extent at which the iBox was used.

4.2.4 The Case study approach

This study was delineated in three schools of one district in KZN. An intensive investigation of a single unit (Bertrand & Hughes, 2005) of teaching mathematics whilst using the iBox was done and hence a case study research design was followed. Case studies are the defining strategies for observation of phenomena as the researcher spends time on-site interacting with the people studied (Williams, 2011). A case study is a type of a qualitative research technique (Merriam, 2014). With this study the case study approach was appropriate in order to explore the use of the iBox at the schools by the teachers who were using the iBox for teaching.

Similarly, Yin (2004) states that with a case study it is most common to analyse evidence stating that earlier events could have led to later events. Consequently case studies would capture the dynamics of unfolding situations (Cohen et al., 2007). The exploration of different factors that affect teaching and the dynamics of different situations were done.

Some of the factors affecting teaching and learning are resources, school's infrastructure and qualifications of teachers which might link to teacher content knowledge and the culture of teaching and learning in schools (Reddy, 2004). Poor content knowledge and out-dated teaching practices (Mji & Makgato, 2006) are also factors affecting teaching and learning. The iBox was brought to schools in order to enhance the quality of teaching and learning (Barab et al., 2004; Department of Education, 2004). A case study is suitable in this research because a number of contexts and backgrounds are featured (Denzin & Lincoln, 2003) thereby offering the study the opportunity to advance its objectives.

Finally, Bertrand and Hughes (2005) describe a case study as a comprehensive and thorough study of a single case using a combination of methods to collect data to come up with a thick description.

4.3 Context of the study

The study initially took place in nine public, ordinary secondary schools, with 35 sample of participants, in one District in KwaZulu-Natal, South of Durban. The nine schools were the schools that received the iBox as an intervention strategy to provide technological tools schools in the district, provided by DBE. Of the nine schools in this district, 56% of the schools are peri-urban, 33% are rural and 11% are urban. The 35 sample of participants were the teachers that taught mathematics. Most learners in the schools under this study come from low socio-economic backgrounds but teachers come from different areas. Most learners come from poverty stricken households.

Ultimately, the study ended up with three participants (Nancy, Bruno and Pat, these are pseudo names) identified according to the fact that they responded in the questionnaire that they use the iBox when they teach mathematics. Twelve teachers from the sample of participants who indicated in the questionnaire that they use the iBox for teaching mathematics were approached. The three participants, when they were approached by the researcher, were willing and also available to be the participants of the study, at the time of

the study. The three participants were coincidentally from three different schools or research sites, which will be referred to here as schools A, B and C.

None of the three schools has the infrastructure technology. They all are low-socio cultural schools. Vandalism is rife. The iBox is kept in a strong room for safekeeping. School A, where Nancy teaches, is a rural school. It falls under the 33% of the schools in the study. Of the twenty two teachers in the school, ten use the iBox. School B where Bruno teaches is a township school contributing to the 56% of the sample. Eight of the thirty nine teachers use the iBox. In Pat's school is rural, four teachers use the iBox in a staff of twelve.

Collecting data in the schools was challenging because they are very far apart. In some days an appointment will be cancelled on arrival at the school because of some logistics in the school.

4.4 Sampling

Probability sampling and non-probability sampling are the two main methods of sampling; the former is random which is usually used in a survey where the researcher wants to draw conclusions about a wider population and the latter is purposive in that the researcher makes a specific choice on the sample size for convenience purposes (Bertram, 2003; Christiansen et al., 2010). This study used the purposive non-probability sampling because specific schools were chosen where iBoxes were available.

4.4.1 Non-probability, purposive selection of participants

The population of the study from which to draw the sample were all mathematics teachers in the nine secondary schools that were identified to have an iBox. This sample was a second consideration. The first one was to focus on the Grade 10 teachers only. After much deliberation, considering the fact that there might be no Grade 10 teachers who use the iBox, the researcher then decided to extend the sampling to all mathematics teachers. A total number of 35 teachers were a sample of participants as well as the initial pool for this study. Cohen and Manion (2000) suggest that the four key factors of sampling be considered, i.e. the sample size, the representativeness and parameters of the sample, accessibility to the sample and the sampling strategy.

This purposive, convenient selection of participants was adopted because it was strictly the teachers of those schools that have the iBox that were targeted. This is a sampling strategy

which is non-probable because the researcher used personal judgement and took advantage of professional traits (Burton, Brundrett & Jones, 2008). This purposive selection makes specific choices about which to choose, where the researcher targeted a specific group (Christiansen et al., 2010). The number of participants (sample size) was determined by the number of mathematics teachers that were using the iBox in each school. As far as the accessibility to the sample is concerned, the schools were accessible and convenient for the researcher.

The selection of schools had been purposive in that the secondary schools known to be in possession of the iBox were the sample schools. Using the researcher's judgement (Cohen et al, 2007) the selection may suit the researcher's needs but not represent the wider population, which "is deliberate and unashamedly selective and biased" p. 104. The wider population for the study could have been all mathematics teachers in secondary schools in KZN.

Since the nine schools had 37 identified mathematics teachers in total, this was the total population of the study. However, 35 teachers (2 teachers from one school had gone for moderation of marks on the day) were addressed and ultimately the study started with this sample of participants. Mathematics teachers in each of the schools were invited to a meeting through the Principal and the Head of Department. The purpose and procedures of the study were explained. Each school had an average of four teachers even though the number of teachers in each school ranged from two to seven. Letters asking the teachers to be the participants of the study were also given to the teachers. Thirty five questionnaires were handed out and 30 teachers completed them. Of the 30 teachers 12 indicated that they used the iBox. The researcher needed to observe lessons taught whilst the participant was using the iBox. Three participants were identified who were willing and available at the time of the study. Three lessons were observed, followed by two sets of interviews for each of the three participants.

4.4.2 Description of the participants

This study focused on three participants. The participants have been named Nancy, Bruno and Pat for confidentiality purposes.

4.4.2.1 Nancy

Nancy is a middle aged married lady with children. She started her career as a mathematics teacher at a township secondary school. After seven years she moved to a semi-rural popular secondary school on a promotional post. She became Head of Department (HOD) for science for approximately five years, while keeping her focus on teaching mathematics from Grade 8 to 12 learners. The next progressive step in Nancy's career was to the school where she is currently teaching. The position she was promoted to was Deputy Principal still teaching mathematics in Grades 10, 11 and 12. It is critical to note that of the twenty five years of her teaching experience, this participant has been on two promotional positions (as HOD and Deputy Principal) but her teaching career has never diverted from the mathematics field. Nancy's mathematics teaching experience falls in the 50% category see Figure 5.1.

The participant's qualifications are: Secondary Teachers' Diploma (STD), Bachelor of Arts (BA) and Bachelor of Education (BEd). The participant is qualified to teach mathematics, physical science and economics. Her desire to learn is shown by being a member of the Association of Mathematics Educators in South Africa (AMESA). AMESA is a professional body used as a platform to network and share information on subject matter. Nancy also demonstrates her interest and commitment to learners' performance in mathematics by teaching Saturday classes. She engages herself in marking the external Grade 12 examination. She assists in conducting departmental workshops as a lead teacher. Continuation of Nancy's professional development is revealed by the taking her own initiative to know about the iBox.

Nancy is in a school where there is a principal, a deputy principal and a science HOD who shares the mathematics school load with other teachers including Nancy. Administrative duties in the school are done by a state paid administration officer. Nancy teaches at a school which is in the area where there is crime, poverty and unemployment. The school has been burgled several times and signs of vandalism are evident especially in the administration area where valuables like computers are kept and locked in for security purposes. The school has a quintile 3 ranking. About 800 learners are fed by the Department of Basic Education on all school days because the school is under the National School Nutritional Programme (NSNP).

When Nancy was approached to participate in the study because she was a mathematics teacher who was using the iBox to teach mathematics, she showed interest and enthusiasm to be observed teaching.

4.4.2.2 Bruno

Bruno is a gentleman of about 40 years of age. He is married with children. He has taught mathematics for eighteen years and is currently a Deputy Principal in the same school where he started his teaching career. Prior to being a deputy principal, he was the HOD of mathematics and sciences for six years. The professional growth path of Bruno has been limited to School B as he has not taught at any other school throughout his career. He has taught mathematics for Grades 8 – 12. Bruno's mathematics teaching experience is also in the 50% zone as seen in Figure 5.1.

His qualifications include the Secondary Teachers' Diploma and a Further Diploma in Education (FDE) certificate. Both in the STD and FDE qualifications Bruno had mathematics as a major subject. Bruno is currently studying towards a Bachelor of Education Honours (BEd Hons) degree. He is a member of AMESA which further contributes to his professional and personal development. His commitment as a mathematics teacher is proved by his involvement as a lead teacher in the Saturday and the holiday classes offered at his school. Because of his interest and knowledge in Information and Communication Technology (ICT), Bruno was chosen by the school to be trained by the iBox suppliers. As a result, Bruno received first-hand information about the tool. He was then expected to cascade the information by training his colleagues at school through workshops, which he did.

Bruno's school has a principal, two deputy principals and four HODs in the school's management team (SMT). There are 40 teachers who teach about 1 240 learners; on average. There is also no evidence of over-enrolment or under-enrolment. The school also has an administration official, two general assistance staff and a security guard at the gate who serves as a support system to the school. There is no evidence of vandalism in the school, though general crime levels are considered high in the area where the school is located. School B is ranked quintile level 4, in turn eliminating the need to implement the NSNP.

Bruno showed much enthusiasm about this research project. He was very cooperative in filling in the questionnaire and he returned it timeously. When the participant was approached for him to be observed teaching, he was keen to participate further. When arrangements were made for lesson observation, the participant agreed without any hesitation.

4.4.2.3 Pat

Pat is a married male with children. He is a Post Level 1 teacher who has taught mathematics for 21 years. He first taught mathematics from Grade 8 to Grade 12 in a boarding secondary school where he taught for sixteen years. He then moved to the present school. The school has an HOD for science who does not teach mathematics. As a result at the present school Pat is a mathematics senior teacher for mathematics. He teaches Grades 8 to 12, depending on the curriculum needs of a school in a particular year. The school has only two mathematics teachers who may be involved in teaching other subjects as well. Pat has taught natural sciences and technology to Grades 8 and 9 as well as physical sciences to Grades 10 to 12 over the past five years in the present school. His mathematics teaching experience is in the 50% classification (see Figure 5.1).

Pat holds a Diploma in Education and a Bachelor in Education degree qualification with mathematics as a specialisation. He would like to pursue an honours degree in mathematics in the future. For professional and personal development, Pat is a member and attends conferences of AMESA. Pat shows his passion and commitment to teach mathematics by teaching on Saturdays in the cluster of schools where he teaches. He also does extra morning and afternoon classes in his own school. He is also a lead teacher who teaches holiday classes. A lead teacher is an expert teacher who is skilled to train other teachers to teach learners. One of his hobbies is playing chess.

The school where Pat teaches is a quintile 3 school. Learners do not pay school fees because their school in a no-fee school. Most learners come from low socio-economic homes where poverty and unemployment are rife. The school shows signs of being vandalised. The school has a principal, a deputy principal, two HODs and twelve teachers. The enrolment at the school is about three hundred (300). These learners are provided with a meal by the Department of Basic Education every school day because the school is in a NSNP.

The questionnaire revealed that only half of the total number of teachers in the sample was using the iBox to teach mathematics. Pat showed an interest and was keen to participate in the study by allowing the researcher to observe him teaching a mathematics lesson using the iBox.

4.5 Data collection techniques and data analysis

Relevant gatekeepers were approached; DBE for the permission to undertake a study in the schools, school principals and mathematics teachers in the nine schools because access to the people in the plan should be negotiated (Cohen et al, 2007). Permission was granted. Data was then collected to answer the research questions which provided an analysis and the researcher came up with findings.

4.5.1 Data Sources

This study used a questionnaire for the generation of baseline information (McMillan & Schumacher, 2006) to find out which teachers use the iBox. The researcher also used observations and interviews in order to generate thick data by analysing teachers' understanding (Koshy, 2005) of the tool and the effect the tool has on teaching.

4.5.1.1 Structured/open and closed ended questionnaire

A questionnaire (Appendix D) with both open and closed ended questions was used. It was designed in such a way that it did not suggest response (Cohen et al, 2007). The questionnaire had 23 questions. The first three questions requested the personal information of the participant. The next question focussed on the type of learners taught by the participant if they are generally attentive or not. This question was testing the hypothesis set. Earlier on it was mentioned that qualitative studies do not test the hypothesis. However this question had to be asked in order to have a well sorted analysis linked to literature.

The subsequent questions focussed on the implementation procedures of the iBox, how much access the participant had to the iBox and the literal use of the tool including the challenges if any. For those teachers who did not use the iBox it became impossible to continue involving them in this study because the study could not get the required data from them. The researcher did not let the sample of participants complete the questionnaire at the time it was handed to them in front of everyone but to complete in their own time. The researcher was allowing for anonymity, right to privacy and time and space for reflection (Burton et al., 2008).

On the day of the meeting it was asked from the sample of participants that they initial their responses by putting their first initial and the first letter of their surname so that the researcher was able to contact them should a need arise. The main need would be to ask if the

respondent was willing to go on with the study. Some respondents were not happy about that but a plea was put forth.

The researcher made an appointment for the collections of responses from the sample of participants for the different schools. On the day of collection, which was different for schools as they were far apart, the researcher completed the coding. A new and first letter of a code was put which was for a specific school. This letter was the first alphabet of the school's name. The second letter was the first initial of a particular respondent and the last letter was for the respondent's name. These responses were filed according to the first letter of the alphabet. ICD would be followed by IFB. All this information was entered into a spread sheet for easy access. This coding made it easy for the researcher to follow up on the respondent that was to be contacted. Contact details of all respondents were gathered from the heads of department on the day of the meeting. The researcher avoided asking for the phone at the time when there was a need to contact the respondent in order to cater for anonymity and confidentiality.

From the spread sheet that was created, graphs (Figures 5.1 to Figure 5.12) were created for the presentation of the first twelve close-ended questions. There were thirteen close-ended questions but at the time of data analysis only twelve were relevant and that is what data analysis was based on. The rest of the ten open ended questions, four tables were drawn to present the data. Table 5.1 presented data for questions on experiences, assistance and opportunities. The reason was that most responses were overlapping. Table 5.3 presented data for challenges, ways to address challenges and ways to address them. Table 5.4 presented data on opinions on how the iBox has added value and on how it can add value. The other question was leading to another question.

4.5.1.2 Non-participatory observations

Of the thirty responses from the questionnaires, twelve were using the iBox to teach mathematics. One observation session was scheduled for each participant. All twelve respondents were called by the researcher to ask for permission to be observed. Four responded positively. On the day of observation, one respondent started teaching a science lesson. The respondent taught both mathematics and science in her school. She thought that the researcher did not mind whether it was a science or a mathematics lesson. A second appointment could not be arranged with that respondent. The researcher was therefore a

successful non-participant observer to three participants. The researcher tried to avoid eye contact, sat back, did not participate in activities and used an unstructured observation schedule (Cohen et al., 2007). Appendix E was used to capture some notes for future reference. Cohen et al., (2007) further warned against selective observation and the neglect of significant contexts in non-participant observation. However, the researcher did not neglect the significant contexts because field notes were taken and an observation schedule was used. Field notes are an account of what went on in the classroom (Christiansen et al., 2010). A few photographs were taken none of which were of the participants or the learners (for anonymity and confidentiality purposes) but of what was written on the chalkboard. Also, a voice recorder was set up to capture verbal activities. Non-participant observation was therefore well suited for this study.

Non-participatory observation as a research method was adopted to furnish the study with the essential information in order to allow for a complete piece of work (Bell, 2005). Although the researcher was present in the classroom, there was no interaction between her and the participants and consequently the observation remained non-participatory (Neuman (2000) and Denzin & Lincoln (2003). The researcher was able to observe movement, body language, tone of voice, time management, confidence and competency in both content and technology use, attentiveness involvement of learners, the reliability of the technological tool and whether the objectives of the lesson were achieved or not. Furthermore, non-participant observation as a data collecting tool was used to verify and confirm information gathered from other tools (Lankshear & Knobel, 2004), for instance attentiveness of learners. Observations were also used to gather new information and capture specific events (Molefe & Brodie, 2010).

Observations were the researcher's biggest challenge, in getting the participants, getting appointments to observe lessons and transcribing them. The observations could have been videotaped but the researcher felt that a camera would somewhat disturb the natural setting of the classroom. However, the lessons were voice recorded. Audio recording was a good choice because the recorded data can be played repeatedly (Neuman, 2000).

Unstructured non-participant observations were planned to illustrate the evidence of what was explained in the questionnaire and therefore triangulate because description on its own is not sufficient to find the cause and effect (Cohen et al, 2007) which is one of the strengths of

a case study. Observations verify the self-reported data (Lankshear & Knobel, 2004) from the questionnaire and sometimes they do not. More information was gathered other than verifying reported information.

The designed observation schedule was to observe the participant, learners and the iBox itself. As far as the participants were concerned, the researcher wanted to check confidence and competency in the subject matter content knowledge and the use of the technological tool. Regarding the learner, the study wanted to trace attentiveness, attitude and involvement. The iBox was being observed to see if it was reliable in the teaching and learning scenario. All observation was linked to the three segments of the lesson i.e. the introduction, during the lesson and at the end of the lesson. It must be noted that, the observations were challenging because they were the only tool to give evidence that iBoxes are used in schools. However triangulation was achieved in the form of interviews.

Recordings together with the observation schedules were used to compile observation notes. Recordings were listened to several times in order to compile the notes. Each of those notes was more than ten pages. It would have been a wiser decision if a video recording was done on the days of observation.

4.5.1.3 Semi-structured interviews

There were two sets of interviews (Appendices F and G):

1) The first set of interviews performed with the participants was a follow up on the observation as they were performed immediately after the lesson observation.

2) The second set of interviews were with the same participants after having looked at their responses in all three ways of data collection i.e. after questionnaires, observations and the first set of interviews.

Both sets of interviews were planned to be no longer than one hour each. However some interviews were allowed to be more than an hour in order to produce rich data. Opdenakker (2006) says interviews are used to gather descriptions of phenomena, as a result participants were expected to give a clearer picture of what was going on during the observed lesson and in their practice. A suitable place and time was used to eliminate disturbances. The researcher also took notes during the recording of each interview. Field notes became a key source of data (Bloor & Woods, 2006).

A voice recorder was used in order to capture all that was communicated during the interviews. Patience was also exercised since there was no pressure or anxiety to remember the conversation. These interviews were conducted at the participants' schools. The venue and time was agreed upon by both the participant and the interviewer. These face-to-face interviews have advantages and disadvantages (Opdenakker, 2006). The main advantage of a semi-structured interview is the opportunity to respond to the answers given by the participant (Bell, 2005).

Arrangements to interview the participants were made well in advance but last minute changes were accommodated. The study collected qualitative data because there were many discussions during the recorded interviews. Merriam (2014), states that verbatim text of recorded interviews offer a good database when analysis is conducted. Recorded data minimised distortion, thereby qualifying objectivity (Rubin & Rubin 2012). During the interviews, participants were able to describe and narrate freely in a venue agreed upon by them and the researcher. It must be noted that the second set of interviews were not all conducted within the school. However, the decision was agreed upon.

The interview transcripts were written after a long time of transcribing. The recordings were listened to over and over again in order to come up with clear transcription.

4.6 Ethical considerations

Qualitative research contains many issues of credibility (Denzin & Lincoln, 2003) which are validity, reliability and generalisation. Over and above validity, reliability and generalisation, (Cresswell, 2005) states that trustworthiness in a qualitative case study means that the study is accurate and the findings together with interpretation are a true reflection of a situation that was investigated.

4.6.1 Validity and reliability

Validity is how well a variable measures what it is supposed to measure and reliability is the test of how well the findings can be reproduced (Cohen et al., 2007). This study has engaged a series of questions in the form of a questionnaire and interviews in order to check whether the responses are the same or not. What was supposed to be measured by the study was if the participants use the iBox and how is it used. The study has managed to measure and test (using the class observation tool) and was able to formulate a descriptive analysis. These descriptions are valid because they are a true reflection of what the participants have

indicated (Cresswell, 2005) and of the people who are directly involved (Christiansen et al., 2010).

Both validity and reliability are a measure of the study which should allow for generalisation. To allow for generalisation to take place, the study engaged different styles of collecting data to see if the responses are the same. The fact that the study has used different tools i.e. the questionnaires and interviews means that is has used a triangulation strategy. Denzin and Lincoln (2003), state that triangulation is a combination of data drawn from different sources at different places and in different times and sometimes from different people, and this is a validation strategy. So, triangulation has been used to validate the findings.

4.6.2 Trustworthiness

Trustworthiness is the accuracy and truthfulness of the findings and interpretation of the study (Cresswell, 2005). The researcher had to use multiple data sources in order to triangulate. The different tools used were a questionnaire, non-participant class observation and interviews. Cohen et al., (2007), state that in qualitative research triangulation is a powerful tool. This is in line with what the researcher has done in order to get truthful findings. For Merriam (2014) credibility in triangulation is guaranteed. The information collected using different data collection tools used in the study has resulted in a product that is a responsible reflection of the participants. To enhance research rigour the researcher took the data interpretations to the participants for 'member checking' to assist in accuracy, credibility, validity and transferability (Denzin & Lincoln, 2003).

Data that was collected in this study was confirmed and validated in more than one way. The results are therefore trustworthy and reliable. In this way generalisation was possible.

4.6.3 Consent

Permission was granted by the Department of Basic Education to work in schools to gather information, by principals to use contact time to observe teaching by the participants to fill in the questionnaire, observe them teaching using the iBox and be interviewed. Participants were provided with an informed consent form and they were given a clear explanation of all the research procedures so that they participate voluntarily in the study (Christiansen et al., 2010).

4.6.4 Confidentiality

The names of the teachers, the schools and the district were not mentioned in the study in order to cater for privacy and anonymity as ethical dilemmas of a research. Pseudonyms were used to protect the identity of each participant. The researcher tried to be sensitive to the participants' rights to privacy (Christiansen et al., 2010), hence interviews were conducted at a venue and time agreed upon by both parties i.e. the participant and the researcher.

4.6.5 Limitations

Data gathering was limited because the researcher had chosen only those schools which have the iBox as an intervention programme from the KZN DBE. The researcher did not look for schools that have the tool maybe donated by Non-Governmental Organisations (NGOs) or that bought it themselves. The schools that have the iBox through DBE as an intervention strategy might feel obliged to co-operate because the researcher is a district official. However, these schools were therefore chosen on the basis of convenience.

Also about 100 schools received the iBox in KZN. Therefore the selection seems to be small when it comes to generalisation. To alleviate this restriction the study targeted all mathematics teachers from the nine schools as a sample. Another limitation is that the teachers might have seen the researcher as an authority figure because the researcher is a Departmental official.

An application was made to the KZN Department of Basic Education asking for permission to conduct research and was granted permission to go ahead with the study. The ethical clearance was also obtained from the University (see Appendix A).

4.7 Challenges

The researcher's observation data collection technique could have yielded better results if it was video recorded. A video recording could have captured the sequencing of the lesson in a better way. Burton et al., (2008) state that videos offer an opportunity to be viewed over and over again. These authors also indicate that those being observed may change behaviour when they are observed and it is not possible to capture everything. These are some of the issues that might have affected this study thereby yielding poorer results.

It was challenging in the manner that suitable times had to be agreed upon where a participant would be using the tool. It must also be noted that participants do not use iBoxes every day.

Accessibility of the technological tool is another factor to consider. 67% of the sample of participants have very little or no access to the tool (see Figure 5.6). In one of the schools the iBox had not been working in the past eight months, and this decreased the number of participants available for observing.

The researcher experienced some disturbances; it was agreed that the classroom was to be at break time but some learners kept on coming in, as a result one audio recording is unclear.

4.8 Conclusion

Due to the fact that some teachers do not incorporate the use of the iBox in their teaching, the study ended up with a small sample of participants. However, Merriam (2014), states that the qualitative approach allows the use of small group of people if there is a current focus within a real-life context. The qualitative approach provided insight of the underlying issues around the use of the iBox that are significant (Eckstein, 2002) to the teaching fraternity. This qualitative methodology enabled the researcher to collect textual and verbal data (Christiansen et al., 2010) which was a deep and detailed description of teachers' views in the questionnaires, interviews and observation of class activities. In the next chapter the analysis of the data that was collected will be discussed.

Chapter 5
Findings

5.1 Introduction

In the previous chapter all methods and techniques of data collection were discussed. In this chapter the process of data analysis for this study will be focussed on.

Data analysis was done in order to organise, explain and find quality data from all the data collected. The organisation and explanation of data allowed the researcher to note patterns, themes and some categories. The study adopted seven steps of analysis as proposed by Rubin and Rubin (2012) in order to produce a report. The seven steps are; transcriptions of observations and interviews, summaries of questionnaires, observations and interviews, followed by coding of relevant concepts and themes, synthesis**,** comparison and combination. Each case was explored to discover commonalities, differences and similarities (Cohen et al., 2007) by looking at the questionnaire, observations and both interviews.

The research questions were a guide to identify crucial areas for analysis. Taylor-Powell & Renner (2003) refer to this as focussing the analysis, and they further suggest that the questions that the researcher wants answered may also change as the researcher engages with data analysis. Indeed when transcribing, the voice recordings were played more than once in order to provide transcription notes, the summary of data collected help in data analysis and the research questions were altered.

5.2 Responses from the questionnaires

5.2.1 Introduction

Mathematics teachers in each of the nine schools were invited to a meeting during which the purpose and procedures of the study were explained to them as a group. Thereafter 35 questionnaires comprising of closed-ended and open-ended questions were distributed to be collected in a week's time. Thirty (30) completed questionnaires were returned. Not all of them were returned on the first collection date that was negotiated initially.

5.2.2 Closed-ended questions

Closed-ended questions were summarised by drawing graphs. Even though the study was qualitative, graphs were drawn for a better analysis of data. Figure 5.1 illustrates the number of years that the participants have spent teaching mathematics.

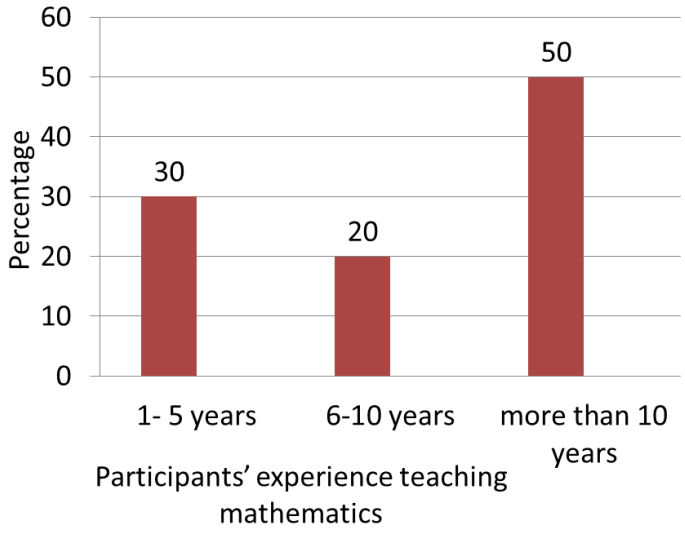

Figure 5.1: Participants' mathematics teaching experience

Figure 5.1 shows the disproportionately high percentage of 50% of the sample of participants who have more than ten years of experience teaching mathematics, followed by those who are between 1-5 years (30%) and 20 % to those who are between 6-10 years. This implies that half of the sample of participants is more experienced and the participants of the study fall in this category.

The researcher was interested to know how the participants rate their own teaching of mathematics which is illustrated in Figure 5.2.

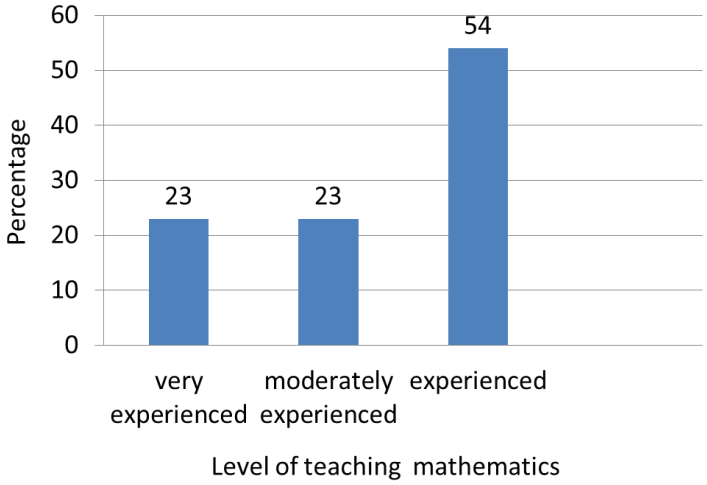

Figure 5.2: Participants' perception of experience of teaching mathematics

Figure 5.2 reflects that 53.3% of the sample of participants viewed themselves as experienced teachers followed by 23.3% who believed that they were moderately experienced and very experienced respectively. This tells us that a larger percentage of the sample of participants see themselves as experienced teachers. Participants fall in this category. Teaching needs a certain amount of competency in, for instance, content knowledge. This competency is accompanied by skills, content knowledge, experience and special abilities (Bell, 2006). Therefore experience might be linked to competency.

The use of technology in schools improves the attentiveness of learners and ultimately their concentration (Bester & Brand, 2013). The researcher was therefore interested to know how participants rate their learners' attentiveness in class. This is illustrated in Figure 5.3.

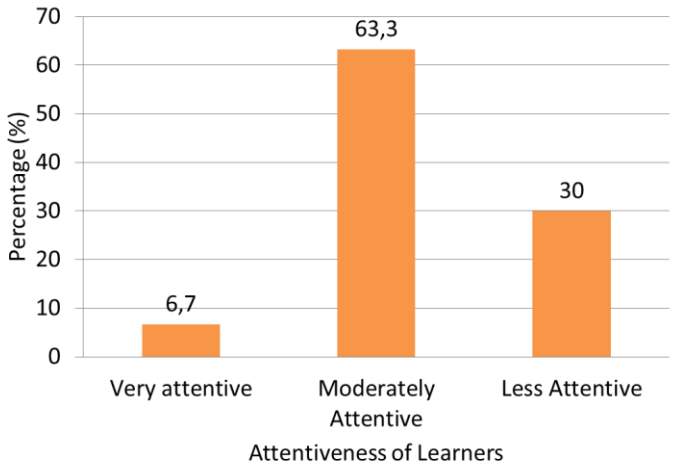

Figure 5.3: Attentiveness of learners

Figure 5.3 reflects that the majority (63.3%) of the sample of participants believed that their learners were moderately attentive while 30% viewed their learners as less attentive and 6.7% viewed their learners as very attentive. To contend psychologists Bester and Brand (2013) stated that the use of technology in schools improves the attentiveness of learners and ultimately their concentration. Data revealed that a very small percentage of learners are viewed by the sample of participants as very attentive. Participants' learners are moderate.

At the time when the questionnaire was administered, the researcher wanted to know when and how the iBox was introduced to the sample of participants who were mathematics

teachers in the nine targeted schools. Figure 5.4 illustrates when the iBox was introduced and Figure 5.5 illustrates how the iBox was introduced.

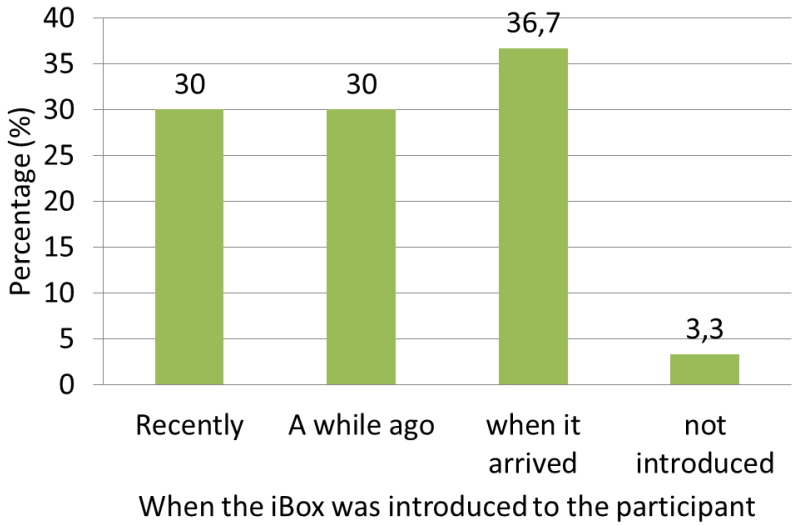

Figure 5.4: When the iBox was intrdouced to teachers at schools

Figure 5.4 reveals a small percentage of 36.7% of the sample of participants who knew about the iBox when it arrived. 60% of the participants knew about it recently and a while ago respectively, while 3.3 % were undecided. It is noted that the effects of any given technology depend on implementation techniques (Johnson, 2014). Data given in Figure 5.4 indicates that the implementation strategy relating to the iBox has much to be desired.

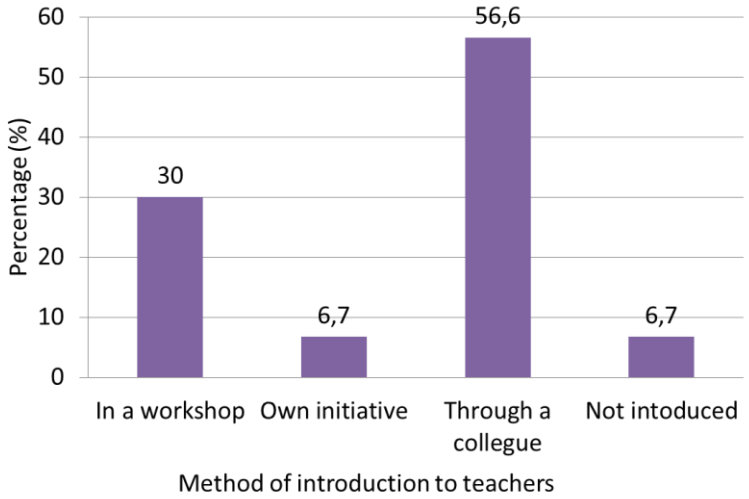

Figure 5.5: How was the iBox introduced?

Figure 5.5 indicates that the iBox was introduced through a colleague to 56.6% of the sample of participants, whilst 30% were introduced to the iBox in a workshop. The graph exhibits that 6.7% used their own initiative to become aware of the iBox and 6.7 % did not know about the iBox. It was not possible for the study to establish why the iBox was not introduced in an initial workshop to all teachers in a school. The plan was that teachers in a school were to be work shopped by the suppliers, but the data presented in Figure 5.5 illustrates that the training procedure did not go according to plan. Pat and Bruno attended a work shopped but Nancy had her own initiative to know about the tool.

Accessibility of the iBox to the participants was one of the variables included in the exploration of the use of the tool by the participants. Responses from the questionnaire are illustrated in Figure 5.6.

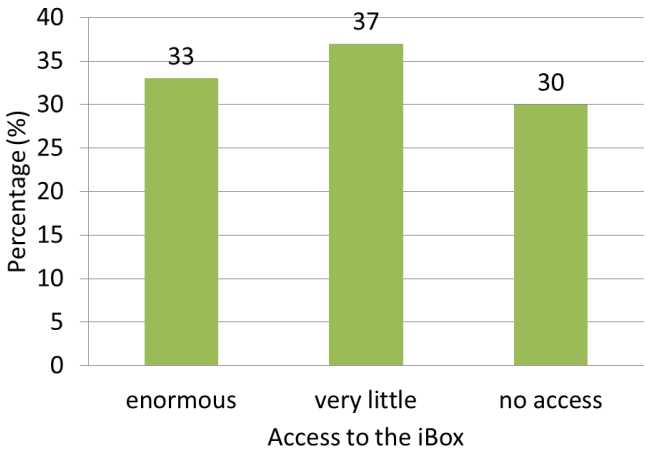

Figure 5.6: Access to the iBox

Figure 5.6 reveals that most of the sample of participants had little or no access to the iBox. However, 70% of the participants do have access of which 33% indicated that they do not have a problem with access. The questionnaire was used to generate baseline information (McMillan & Schumacher, 2006). It was necessary to find out if mathematics teachers use the iBox in order to conduct the study. Data presented implies that few teachers are using the iBox due to the fact that it is not easily accessible to them. One of the three participants has enormous access to the tool.

In order to explore the use of the iBox, the frequency of the use was also of interest to the researcher. Figure 5.7 illustrates the responses obtained from the questionnaire.

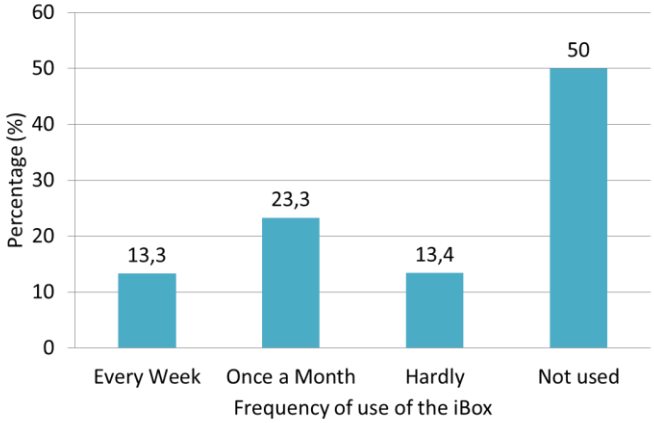

Figure 5.7: Frequency of using the iBox

Figure 5.7 reveals that 13.3% of the sample of participants was frequent users of the iBox. This data indicates that the iBox might not be a popular tool in the schools.

The iBox comes with PowerPoint presentations of lessons which could be used as a resource for lesson preparation or as a teaching aid in class as well as both uses. The findings for such use are presented in Figure 5.8.

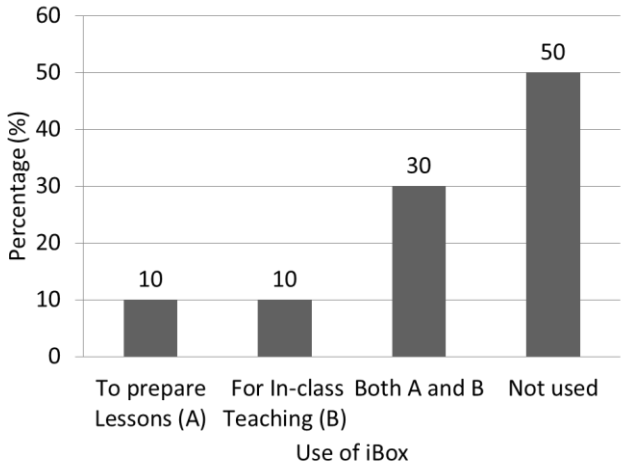

Figure 5.8: How is the iBox used?

Figure 5.8 revealed that 50% of the sample of participants used the iBox even though 70% have access to the tool as shown in Figure 5.6. This information tells us that the iBox might not be serving the purpose of enhancing teaching and learning. The participants fall in the 30% range.

The iBox can be used as a computer in conjunction with its portable interactive board or on its own. The researcher wanted to explore such use. Figure 5.9 illustrates the findings.

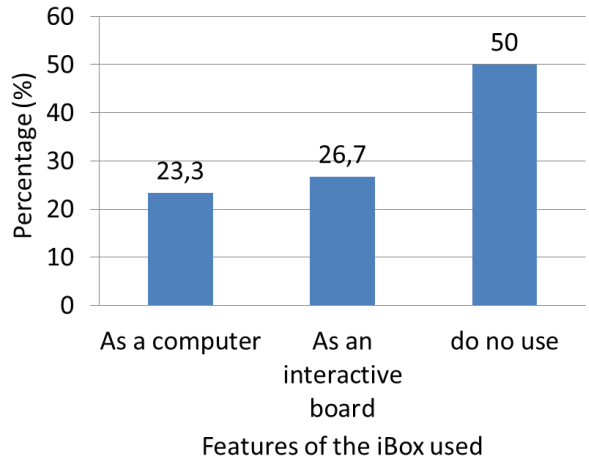

Figure 5.9: Features of the iBox used

Figure 5.9 shows that even though 50% of the sample of participants used the iBox, only 26.7% uses an interactive whiteboard (IWB). The IWB makes the tool even more interactive. The information indicates that the more interactive quality of the iBox is not explored as much as it should. The participants do not use the IWB.

The researcher was interested to know if the sample of participants knew of any other teachers in their school who were using the iBox as a way of exploring if the iBox was a well-used tool at the school. Figure 5.10 demonstrates the results.

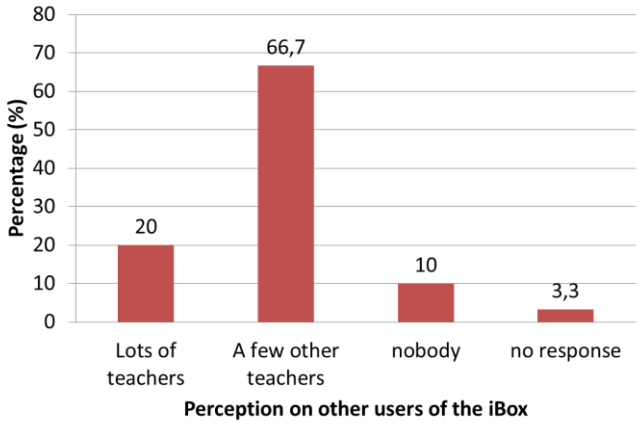

Figure 5.10: Perception on other users of using the iBox

Figure 5.10 shows that 86.7% of the participants knew of other teachers who were using the iBox. There are 20% of teachers who know many people who use the iBox but there is another 10% who did not know anyone who uses the iBox. This data is in line with what Figure 5.7 showed that the iBox is not a popular tool in the schools. The participants know a few other teachers who use the iBox.

Through the questionnaire, the researcher wanted to know if the sample of participants faced any challenges when using the iBox. The results are demonstrated in Figure 5.11.

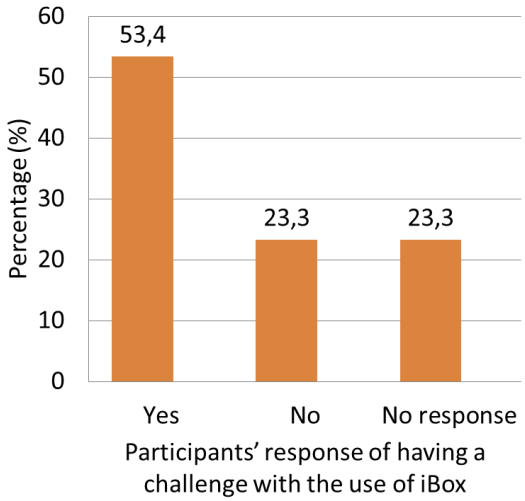

Figure 5.11: Challenges when using the iBox

Figure 5.11 indicates that 53.4% of the sample of participants faced challenges when using the iBox. These participants include those who do not use the iBox and it could be such challenges that prevent the participants from using this technological tool.

It was anticipated by the researcher that some mathematics teachers might not be using the iBox to teach mathematics. The researcher wanted to know if the participants would recommend the iBox to other teachers. This information is illustrated in Figure 5.12.

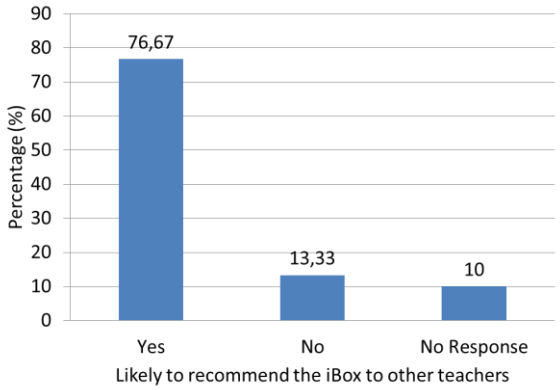

Figure 5.12: Recommending the iBox

Figure 5.12 reveals that 76.67% of the sample of participants would recommend the iBox to other teachers even though only 50% of them are using it as illustrated in Figure 5.8 and Figure 5.9. Additionally, although some participants do not use the iBox, they would recommend the tool to other teachers because they know the value of the technological tool.

5.2.3 Open-ended questions

Some open-ended questions were summarised using tables and some were summarised by using narratives. The two methods were suitable for displaying data in a compressed way to permit the researcher to draw conclusions (Christiansen et al., 2010). Table 5.1 reveals what the participants had to say about their experiences in using the iBox

Table 5.1

Experiences in using the iBox

Teachers' experiences in using the iBox use
It saves time because learners are attentive and more interested
It has PowerPoint presentations and a DVD slot for watching and teaching through videos
It is an added resource for lesson preparation and delivery to assist in curriculum coverage
It is more detailed yet user friendly
It enhances quality education because it is a convenient, efficient and a portable tool
Saw my strengths and weaknesses when using frequently

It is problematic because it does not have programmes that I need
I have a problem with using the white board provided with it

These are the experiences that some of the participants shared with respect to using the iBox. This data means that the iBox was used in the preparation of lessons, teaching new concepts, doing revision, enhancing teaching and for more curriculum coverage. Open ended questionnaires were analysed with respect to the content coverage by participants when using the iBox and Table 5.2 illustrates the results.

Table 5.2

Content Covered using the iBox

Content covered by teachers who were using the iBox	
Transformation	Trigonometry
Financial mathematics	Geometry
Data handling	Exponents
Graphs/functions especially effects of changing variables	Algebraic equations

Table 5.2 indicates content covered using the iBox but the majority of participants used the iBox for data handling. This information could mean that the participants found data handling coverage by the iBox more interesting.

Technology use comes with some challenges (Chigona et al., 2014). The interview transcripts revealed some of the challenges as listed in Table 5.3 together with the participants' views on how to address the challenges.

Table 5.3

Challenges Faced when using the iBox and Ways to address them

Type of challenge	How to address the challenge
Sometimes it would not switch on if it was used a short while ago and switched off	Report to the iBox co-ordinator for repairs and have a time-table to allow for a cool-off time
The sound on speakers is low for big classrooms	Improvise/use other sound system or divide learners into two groups/smaller classes
Electric power is a problem	Talk to the school management to address challenges related to infrastructure
There are no plugs in some of the classrooms	Provide an extension cord
For security reasons the iBox is stored where it is not easily accessible	Security is needed
Not trained on how to use the iBox	More workshops needed
Do not know how to use the interactive board	More workshops needed or avoid using it
Viruses	Need somebody experienced to come and help with technical support
It takes a lot of time to set up the iBox	Set the iBox properly before the lesson starts
Computer literacy	By using it again and again to gain experience and pursing computer literacy classes
Internet access	By using 3G cards or Wi-Fi dongles

The challenges cited by the participants showed that some participants were using the tool and some were not. The information given on how to address the challenges meant that a way forward was available given enough support and intervention strategies are applied.

Interview transcripts confirmed that the iBox has added value in the teaching of mathematics in the nine schools involved in the study. Table 5.4 provides this evidence.

Table 5.4

Opinions on how the iBox can or has Added Value to Teaching and Learning

Ways in which the iBox has shown improved quality of teaching and learning	
It may improve results	It saves time
Enhances quality of teaching and learning	Captures learners' attention
It serves as another resource for lesson preparation	It helps in introducing new concepts
Assists in curriculum coverage and in revision	Lessons are more interesting and detailed

Even though some of the participants were not using the iBox they said they would still recommend the tool to other teachers. They said they would do so because the iBox is an innovative, user friendly, good and versatile teaching aid which captures learners' interest. They said they would also recommend it because it boosted their confidence in teaching new content knowledge and when doing revision, it actually improved teaching and learning.

5.3 Responses from classroom observations

5.3.1 Introduction

The study focused on three participants who were selected on the basis that they use the iBox, they were willing to be observed teaching and that they were available for the observation. Three participants were observed and all three observations were voice-recorded and a few photographs were taken during the observation. An observation schedule was completed for each lesson observed; it pertained to the attitude of the participant and learners, the body language of each participant, attentiveness of the learners, time management and content delivery of the participant, the involvement and interaction of learners as well as the reliability of the iBox (Appendix E).

5.3.2 Nancy's lesson – Grade 10, Measures of spread of grouped and ungrouped data

At the beginning of the lesson the participant's attitude, body language, and tone of voice conveyed confidence and competence. The learners also conveyed positive attitudes, involvement and active interaction. It seemed, however, that as the lesson progressed the learners' attention diminished; this could be due to the fact that the lesson was more than an hour. Six activities were done, five of which were from the iBox PowerPoint lesson.

The introduction of the lesson was done on the chalkboard. Chalk and talk, as well as the question and answer methods were used. Nancy was dealing with basic information concluding that statistics may be used for scientific research to make concise conclusions and predictions.

The participant then opened the iBox, projecting a PowerPoint iBox prepared lesson. The PowerPoint lesson showed that 'measures of spread of grouped and ungrouped data' was to be covered. The Curriculum Assessment Policy Statement (CAPS) document which is a subject policy document also states that revision of 'measures of central tendency in ungrouped and grouped data' should be done. The iBox information aided Nancy to ask:

> Nancy: "*Who can tell me, what is the difference between grouped and ungrouped data?"*
>
> Learner: "*Ungrouped data is the data that is scattered and grouped data is the one that is ready to be used."*

Nancy was not happy with the answer. She then discussed what is meant by grouped and ungrouped data. She then revised terms i.e. the mean, mode, median and the $\bar{x}$ (x bar). Anthony and Walshaw (2009) state that teachers who start where learners are at with their learning are able to apply appropriate levels of challenges for their learners.

Nancy then moved to the second task of the lesson which was an iBox exercise on frequency. A three-column table (Table 5.5) with marks obtained, frequency and f.x was drawn on the chalkboard. It was the first two columns that were reproduced from the iBox exercise.

Table 5.5

Portion of the Frequency Table used for a Class Activity

Marks Obtained (x)	Frequency (f)	f.x
0	10	

Note. Adapted from the iBox PowerPoint lesson

The class filled in the third column, step-by-step using a class discussion method. Whole class discussion can provide an opportunity for broader interpretations and a chance for learners to clarify their understanding (Anthony & Walshaw, 2009). Eventually the whole table was completed [Table 6.1 (b)].

Four more activities were done as classwork for reinforcement:

Question 1: What is the mean of 20 + 18 + 19 + 23 + 20?

Question 2: The mean of six numbers 20, 18, x, 24, 23 and 13 is 20. What is the value of x?

Question 3: Table 5.6

Question 4: Table 5.7

With question 3 Nancy focused the learners' attention on the meaning of the phrase 'one decimal place'. She let learners work on their own. One learner gave 5.85 as an answer. When she asked the learner to show how he/she arrived at the answer, the learner was silent. Nancy then asked another group for their answer. After that a group of learners gave 85.3 as an answer. Nancy said she agreed with their answer because she was also doing the sum and moved to question 4 which is Table 5.7.

Table 5.6

Question 3 which was adapted from the iBox lesson

Given the table, determine the mean (Approximate your answer to one decimal place).

Car number	1	2	3	4	5	6
Number of people in each car	46	200	122	77	53	14

Table 5.7

Question 4 taken from the iBox PowerPoint lesson.

Given the table, determine the modal class and mean (Approximate your answer to one decimal place).

Class – interval	Frequency f Class Midpoint	F(x)
1 – 10	4	
11 – 20	7	
21 – 30	9	
31 – 40	3	
41 – 50	2	

The participant pointed out that the questions were getting tougher. Question 4 was written on the board, both Nancy and learners worked together.

The lesson moved to the discussion of the five number summary (projected) whose graphical representation is called the box and whisker. Terminology with its abbreviations was revised. Learners agreed that they had drawn the box and whisker before. Nancy discussed the skewed nature of the diagram towards the left or right referring to the data on the performance of a class in the test Another option is when the box is symmetrical i.e. the median and mean are the same.

At the end of the lesson Nancy asked learners to copy an assessment task from the iBox lesson to be done as homework.

5.3.3 Bruno's lesson – Grade 12, Lines of best fit

The participant showed full control of the lesson in both content knowledge and in using the iBox. Throughout the lesson his tone of voice, attitude, and body language confirmed this. The chalkboard and the iBox were used to teach the lesson. The question and answer, teacher-tell, and the discussion methods were used throughout the lesson. The iBox was used as a DVD player to teach using a video recorded lesson.

To introduce the lesson, Bruno announced that the lesson was a revision exercise intended to clear misconceptions that were discovered during the marking of a test written by the learners. The misconceptions were related to the lines of best fit and correlation of data with the use of a scatter plot. Misconceptions in mathematics are tightly held mistaken beliefs (Wetzel, 2008 & Swan 2001) which cannot be avoided but can be minimised. The participant drew a table on the chalkboard: Table 5.8

Table 5.8

Table that was used to Illustrate x and y Values of a Graph.

No. of plates				
No. of people				

Bruno explained that when a table of values is given what is on the first row represents the x-axis and what is on the second row represents the y-axis. He drew another table with values

of x and of y. He then revised plotting the points which was done as a class discussion. The following orders pairs were plotted: (20; 15), (18; 10), (23; 11) and (25; 40*)*.

The participant then opened a DVD lesson which started with a voice introducing the lesson. He stopped the video and echoed what was said by the video. Now that Bruno had drawn the learners' attention to the fact that the lesson was based on the line of best fit, he then continued with the video lesson. The voice from the video lesson had stopped and two facilitators appeared who took turns to teach. The first facilitator compared the terms; bivariate and univariate or monovariate data. As the DVD lesson continued the facilitators presented a problem of a company which was interested in knowing about its sales. Scatter information of products in a certain period of time in weeks was presented. At that point Bruno stopped the video saying:

> "*When you are supposed to draw the line of best fit, you are going to be given a table. In that table, it is your coordinates where you have the weeks and the number of products. The number of products will be in the second row of your table and the number of weeks will be in your first row."*

The video lesson was interrupted by Bruno highlighting what he thought was important allowing for facilitator discussion (Padayachee et al., 2011) which included addressing some misconceptions. To address the misconception about the outlier the following conversation ensued:

> Teacher: *"…and they said something about this point (point (4;40). What do you notice about this point? It is outside of those points right?"*
>
> Learners: (in unison) "*Yes*"
>
> Teacher*: "So can we just say it is an outlier? By just looking at it, as they (points) are plotted in that fashion therefore you will just find it there. Is it an outlier?*"

The video lesson also addressed the gradient of line AB; m(AB) = $\frac{y_B - y_A}{x_B - x_A}$ where Bruno pointed out that any two points on the line could be used. Together with the class they chose the points (1;10) and (2;20) and found that the equation was: y = 10x. Later the video lesson used the points (2;20) and (6;60) and also found the equation to be y = 10x. The following conversation encroached:

Learner: "…*what happens if we only find one point on the line of best fit?"*

Bruno: "*Can you use one point to draw your line of best fit?"*

Other learners: *You can't do that…"* (Other learners joined in arguing the same issue. The participant let the conversation go on for a while).

Using the visual graph to assist learning (Ball & Ball, 2007; Naidoo, 2011; Naidoo, 2012) that was projected, learners were able to see the points that formed the line. Bruno ended the lesson by telling the learners that they were not supposed to lose marks on the test because of their lack of understanding of the points that were highlighted during the lesson.

5.3.4 Pat's lesson – Grade 10, Distance between two points

Pat's class was of about 40 learners seated in groups of four or five. Pat settled the learners who were a bit rowdy and asked them to sit in groups. The arrangement was almost automatic but slow because learners arranged themselves. Learners were seated on either sides of the classroom. The iBox was placed in such a way that it was to project on the wall opposite the chalkboard wall. The main objective of the lesson was to derive and apply, for any two points in the form $(x_1; y_1)$ and $(x_2; y_2)$, a formula for calculating the distance between two points.

After stating that the lesson would be on the analytical geometry Pat then said:

> "*Just before we start, maybe, in your exercise books, I want you to draw a right-angled triangle and state the Pythagoras theorem. Do you still remember it? Those of you who do not remember, it is not a crime. (Learners laughed) Do not forget to label your triangle. "*

Pat engaged the learners using the iBox PowerPoint lesson and the traditional tools available on the day. A right-angled triangle Figure 5.13 was drawn and labelled on the chalkboard which was followed by stating the theorem of Pythagoras: $a^2 + b^2 = c^2$ (in words).

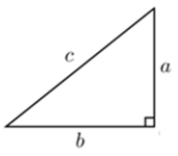

Figure 5.13: A right angled triangle

The next activity was to identify coordinates of points in a Cartesian plane using the iBox PowerPoint lesson Figure 5.14. For the next activity the participant provided learners with graph paper which is another traditional teaching aid.

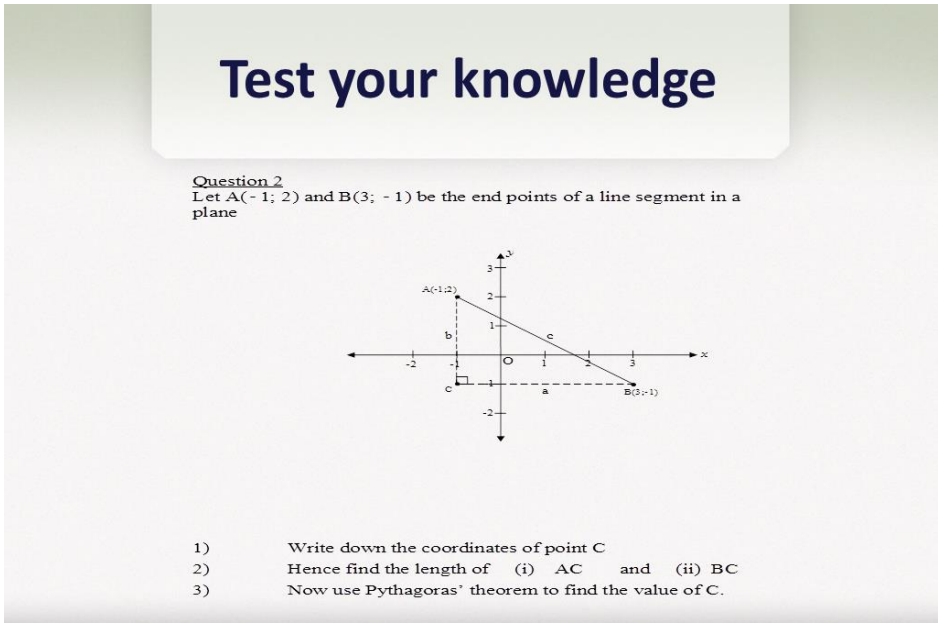

Figure 5.14: Classroom activity (source: Unit 10 Analytical Geometry, iBox content)

For finding the length of AC and deriving the distance formula, Pat said:

> "*I do not want you to use Pythagoras. Do you understand? Just count the spaces between A and C because that will be our distance AC.*"

After counting spaces using the diagram already drawn on the board, Pat then said,

"*We found the distance from A to C. We just used the spaces didn't we, where we counted the spaces in between, which was 3. Then for finding BC we counted the spaces again which 4 was. Now we don't want to count spaces because we won't always have the diagrams, we may just have the coordinates so we should be able to find the length without counting (spaces). We are trying to find a formula here.* (The participant and learners arrived at a formula d = $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$ then used the provided example from the iBox lesson for reinforcement). *Therefore* d = $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$ *is our formula for calculating distance.*"

Using the iBox, the chalkboard, learners' exercise books and other tools Pat derived the distance formula. One more iBox activity was used to solve a problem by using the distance formula.

5.4 Responses obtained for each semi-structured interview

5.4.1 Introduction

For the study two sets of interviews were conducted with each of the three participants who were observed teaching. Cohen et al. (2007) say more interviews provide an in-depth data in order to gain a range of responses. All interviews were transcribed.

5.4.2 Use of the iBox

The iBox was used as an effective resource within the participants' teaching milieus. Franz and Hopper (2007) also established that users of technology as a key resource would be better in understanding the mathematical principles. How teachers used the iBox is presented as comparisons among the participants. The cross-case exploration assisted in determining the differences and common perspectives.

All participants seemed to have a plan of incorporating the iBox and not just teaching using technology.

> Researcher: *"What do you use the iBox for?"*
>
> Participants: (All three participants) *"As a resource to prepare lessons and in class teaching".*
>
> Researcher: *"I noticed on the day of lesson observation that when you had opened the iBox lesson/DVD lesson you continued to use your own explanation, why did you do that?"*
>
> Nancy: *"I want to make lessons more practical by citing examples with which learners are familiar."*
>
> Bruno: *"I wanted to highlight some concepts."*
>
> Pat: *"The iBox is a supplementary item and not the main tool that is delivering the lesson."*

It also emerged in interviews that the iBox saves time. The participants indicated that:

> Nancy: *"... it saves time therefore more work is covered than before."*
>
> Bruno: *"... If a lesson is taught for four hours, the iBox lesson will be two hours"*

Pat: *"The iBox shortens the lesson because it goes straight to the point examples are: Data handling ogive curve, histograms and scatter plots."*

The iBox has its hand-held whiteboard (IWB) which makes the tool even more interactive. None of the participants know how to use it. This is validated by the following excerpts:

Nancy: "…*Not a single teacher in our school uses the whiteboard.*"

Bruno: "… *I just need time to master it.*"

Pat: "…*I am not comfortable with its usage."*

Pat added: "…*but I have a limitation of not being able to use it."*

One can install most type of software in the iBox in order to make conjectures or engage in rational opinions after seeing images (Mudaly, 2004; de Villiers, 2004; Ball & Ball). No software use was displayed by the participants.

5.4.2.1 Content coverage and activities

The participants stated that the iBox has helped them with better content coverage because it saves time. Table 5.2 represents the responses in the questionnaire. However, during the interviews the list included more information i.e. probability, inverse functions and statistics. During interviews financial mathematics seemed to be the most popular topic covered as opposed to data handling in the questionnaire.

Also the participants indicated some content knowledge that they found, in their opinion, to be better covered in the iBox than others.

Nancy: "…T*rigonometric graphs and Statistics."*

Bruno: "…*it is functions…"*

Pat: "… it is financial mathematics."

Participants were asked if the iBox covered adequate content knowledge:

Nancy: *"…there is enough content, but it could have more features. For instance it could have more topic explanations."*

Bruno: *"It has limited information. Hence you have to supplement it with other tools/resources."*

Pat: *"It depends on a particular topic. Other topics are well covered by the iBox, but others need more clarification and practice. That's when I supplement it. It has a lot*

of information. However, like any other technology, it has its limitations. And that's where you supplement it."

The participants manipulated the iBox for other benefits than just to deliver content knowledge. Nancy elaborated in the interview saying:

"*…it is easy to pause and make explanations and also allows learners to take salient points."*

5.4.2.2 The iBox was used in conjunction with traditional teaching aids

Even though the iBox is an innovative technological tool the participants used it with traditional tools like the chalkboard, text books, exercise books and the graph paper (see Figure 5.14 to be answered on the graph paper). Participants were asked if they would still use the chalkboard in the future:

Nancy*: "I cannot do away with the chalkboard …"*

Bruno: "*Yes the chalkboard is necessary to be able to explain or give more clarity to learners by writing on the chalkboard*"

Pat: "*It can be done away with. I used the chalkboard because I noticed that it takes time to switch the programmes. With Geogebra or other dynamic software one does not need the board."*

The participants further pointed out that other resources that they use to teach are study guides, hand-outs and other traditional resources.

5.4.3 Challenges when using the iBox

The participants were also asked if they had any challenges when using the iBox. Chigona et al. (2014) stated that technical challenges are common when using technology; therefore, technical support should be readily available. Table 5.3 indicates the challenges mentioned during the interviews.

5.5 Conclusion

This descriptive qualitative case study was aimed at exploring the use of the iBox. The study used guided analysis because it is flexible as it uses data as it emerges from the framework used (Samuel, 2005). This type of analysis has allowed the researcher to modify principles of

theories to accommodate important issues resulting from data: questionnaires, observation notes as well as the interviews and this informed the themes and findings of the study.

The findings that emerged will be dealt with in the next chapter. The findings respond to the three research questions for this study:

- Why do teachers use the iBox?
- How do teachers use the iBox?
- What are the challenges faced by the teachers when using the iBox?

Chapter 6

Discussion and analysis of findings

6.1 Introduction

The process of data analysis which informed the findings of the study was discussed in the previous chapter. This chapter discusses the main findings of the study.

The vision and mission of the KZN Department of Basic Education is to have well educated, skilled and highly developed people (Department of Education, 2011) by providing quality education to all learners in schools. Providing technological development is one of the means to achieve this objective. The purpose of the study was to get an in depth exploration of the use of the iBox on the teaching and learning of mathematics. The data presented in Chapter 5 was used to present results, with respect to the three participants in the study. This chapter aims to discuss the findings with respect to the three research questions:

- Why do teachers use the iBox?
- How do teachers use the iBox?
- What are the challenges faced by the teachers when using the iBox?

The three participants who constitute the case study used the iBox for teaching in their schools. They however, did not use it on a daily basis. Below are some of the reasons why they used the iBox, how they used it and what encounters did they come across that constitute the themes of the study:

6.2 Theme 1: Faster progression of lesson content delivery

6.2.1 The iBox saves time

The participants mentioned that the iBox saves time. In the interview transcripts provides the evidence.

Nancy said:

> "…*to cover a lot of content in a short space of time, less writing and less talking*".

Pat said:

> "*The iBox shortens the lesson because it goes straight to the point*."

Bruno stated:

> "*When using a DVD or any iBox prepared lesson they have drawings and pictures therefore less time is taken to teach a lesson. Sometimes I let learners watch a lesson undisturbed, I then consolidate on the work that they have already visualised*."

Pat mentioned at the beginning of the observed lesson that he chose to use the iBox because:

> "*... so that the lesson may be quicker*."

For this reason teachers need to get acquainted with the use technology to enable them to save even more time when using technology. Harris and Hofer (2011) mention that before teachers use technology, it is significant to check if the content knowledge suits the knowledge of learners. During the observed lessons, participants used relevant technology involvement for the subject matter presented. For Niess (2005) content knowledge linked with technology is referred to as technological pedagogical content knowledge (TPCK) and this type of knowledge needs to be of an approved standard for the teacher to save time whilst using technology. There was an amazingly huge amount of work done in each observed lesson.

6.2.2 More content coverage

Closely linked to saving time, a lot of content knowledge was covered. Pat used the iBox PowerPoint presentation to teach his observed lesson. He first asked his learners to draw a right-angled triangle and state the theorem of Pythagoras and opened a slide with a model answer as represented in Figure 6.2. This activity structure (model answer was provided by the iBox lesson) was performed to achieve (Saxe, 1991) part of the lesson objective.

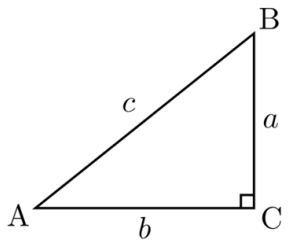

Figure 6.2: a right angled triangle - Adapted from the iBox PowerPoint lesson, unit 10, Analytical Geometry

The theorem of Pythagoras states that if the triangle has an angle of 90˚ the length of the hypotenuse squared equals the sum of the squares of the lengths of the other two sides – model answer also provided in the iBox lesson as well, which led to this equation: $c^2 = a^2 + b^2$

Pat used the iBox activity to make learners plot the points to build up for the lesson on 'the distance between two points'. The next task from the iBox was to write coordinates of points given in the iBox exercise to emphasise the importance of plotting points using the coordinates. The importance of coordinates is echoed by Burton (2011) who stated that coordinates are the basis of analytical geometry. The model answer was provided in the iBox PowerPoint lesson as represented in Figure 6.3.

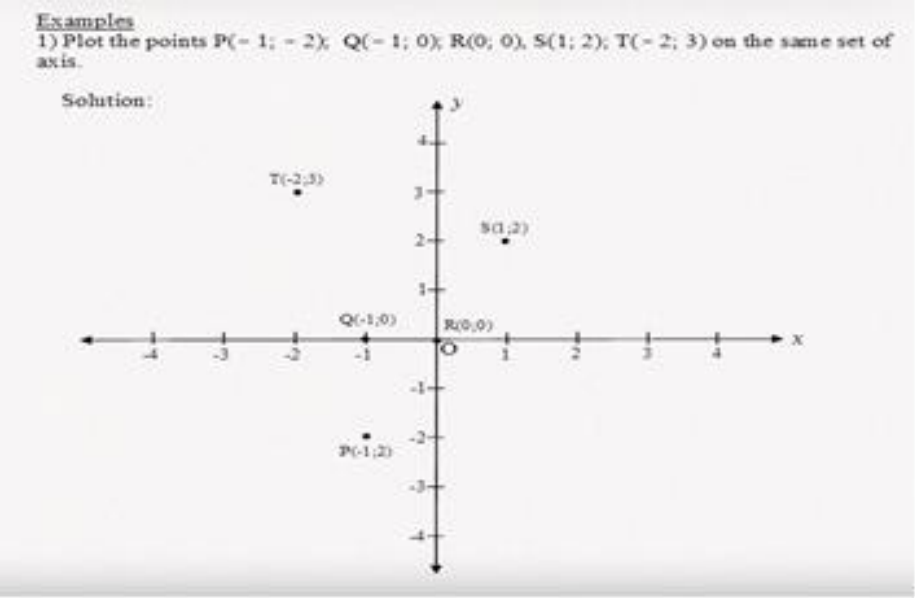

Figure 6.3: assessment task - Adapted from the iBox PowerPoint lesson, unit 10, Analytical Geometry

The next iBox task was for learners to plot the points which would eventually be used to determine the distance formula. The participant did not follow the instruction of the iBox lesson per se. Pat instructed his learners to use graph paper to plot points as in Figure 5.14. Learners would eventually count the number of spaces between the points to find the distance between those two points. Pat then emphasised saying:

> "*I do not want you to use Pythagoras. Do you understand? Just count the spaces between A and C because that will be our distance AC."*

(See Figure 5.14)

Eventually the class arrived at the distance formula using part of the activity from the iBox lesson where Pat used discussion and the chalkboard. Pat then used the iBox question to apply the distance formula that was derived. The iBox slide displayed Figure 6.5:

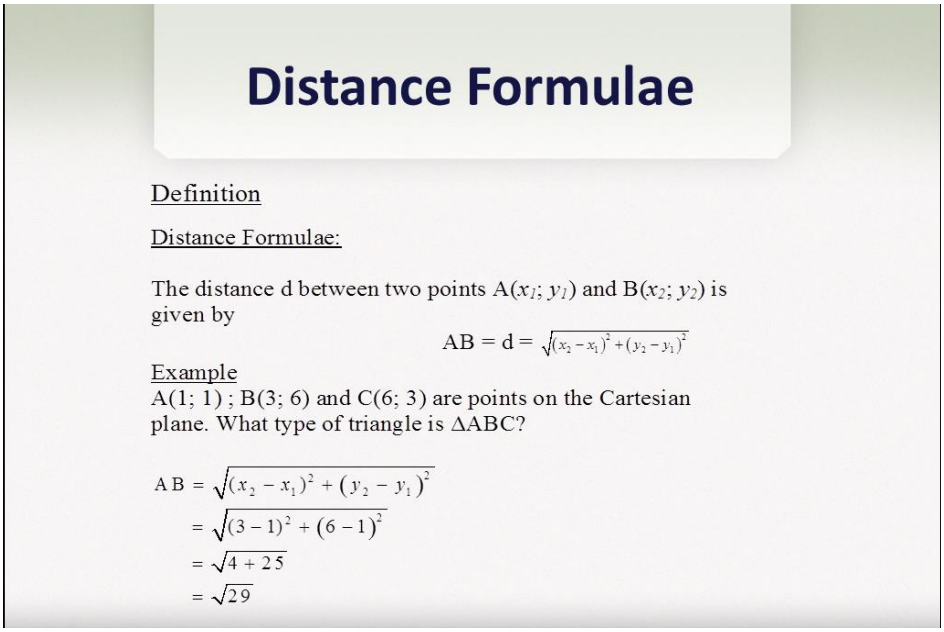

Figure 6.5: Adapted from the iBox PowerPoint lesson, unit 10, Analytical Geometry

The activity was to decide the type of triangle. With the application of the distance formula through individual work, learners arrived at the answer. The participant asked a learner to write the answer on the board as a way of learner involvement.

Nancy and Pat used a series of linked activities to achieve the objectives of the lessons which were the mathematical goals. This resonates with what Monaghan (2003) calls the activity cycle of a lesson where activity structures parameter is linked to social interactions. However Bruno had his activities used for exposition thereby clearing the misconceptions that learners had about lines of best fit. Pat managed to get learners to present their answers of the last activity on the chalkboard. Bruno tried it but in vain. The objectives of the lessons were achieved by all participants.

6.3 Theme 2: Enhanced learner participation and interaction

6.3.1 The iBox promotes teacher-learner interaction

Nancy, Bruno and Pat asked questions, elicited ideas and gave instructions for the learners to engage with the activities provided throughout their lessons. These are some of the interview transcripts in Nancy's class:

> Nancy: "*What could be the mean? [Pointing at a learner] Yes my girl?"*
>
> Learner 1: "*The mean is the sum of the number of the scores divided by the number of the scores"*
>
> Nancy: "*So it means that for those pupils who wrote the test, I look at the sum of their scores and divide it by the number of pupils, so that would be my mean. And what is the mode?"*
>
> Learner 2: "*I think the mode is the number that is repeated the most*.

The conversation above would not have been easy because most learners in under privileged schools do not have text books for them to see the scores.

Some of the questions came directly from or were initiated by the iBox and DVD lessons (see Figure 6.2) and some were probed by the teachers as follow up from what was presented in class (see Table 5.8 and Figure 5.13). The iBox played a vital role in providing the outcomes of lessons, content knowledge, context and activities (see Tables 5.5 to 5.7 as well as Tables 6.1 (a) and (b) and Table 6.2) which were a source of interaction.

Most classwork activities used by the participants came from the iBox lessons. In Nancy's and Pat's lessons learners were given tasks to do and time to write their work. The participant would later check by way of evaluating the work that was done. Similarly, the participants did the question and answer method of teaching. It was also noted that there were times during all three lessons where it would be the learners who ask a question as he/she needed clarity. The teacher would reply but would then follow by further explanation as a way of evaluation to check if the clarity was clear enough. Nancy and Pat followed this sequence of initiating an interaction of giving a task, followed by a reply by a learner and then the evaluation by teacher. Social interaction, what Monaghan (2003) calls a 'commonality' which is a structure where a teacher gives work that is followed by a reply by a learner and then a review by the teacher, is connected to activity structures.

For Monaghan (2003) commonality ensures that there is interaction between teachers and learners (see Figures 3.1 and 3.2). On the contrary this 'commonality' was less observed in the DVD lesson by Bruno because it was the DVD facilitators who taught the learners. However, in all lessons the iBox affected the interaction positively because technology motivates learners and improves their attention (Bester & Brand, 2013) and this was echoed by teachers as well (see Tables 5.1 and 5.4). Interaction was also seen among learners. The 'improved' interaction resulted in the goals of the lessons being achieved.

The availability of the iBox added value to the 'normal' teaching. Social interactions which help in the achievement of the lesson's goal (Saxe, 1991) were affected positively by the presence of the technological tool. Vygotsky (1978), states that social interactions are indeed shaped by the social and historical influences around the situation. In Bruno's lesson, after getting the equation for the line of best fit using two points from the line, the following conversation ensued;

> Learner: "… *what happens if we only find one point on the line of best fit?*
>
> Bruno: "*Can you use one point to draw your line of best fit?"*
>
> Other learners: *You can't do that…"* (Other learners joined in arguing the same issue. The participant let the conversation go on for a while).

The social interaction above was initiated by the learner. It can be imagined that it could have been the presence of the iBox tool that got more learners involved. From observation, learners were very relaxed and maybe more attentive.

6.3.2 The iBox captures learners' interest and attention

It was evident in the questionnaire that the iBox captures interest and attention in learners. Evidence was also collected from the interviews.

Pat stated:

> "… *captivates interest from learners…"*

Nancy stated:

> "… *it captures learners' attention and lessens the stress of going to class*."

Bruno said:

"*When learners hear and see something they get interested because it's different…*"

Bester and Brand (2013) revealed that technology improves attention of learners and motivation also becomes an important variable. The study also revealed that there is a high correlation between motivation and concentration. Therefore the effect of technology results in good attention behaviour and ultimately good achievement.

In all lessons, the participants did not use the iBox for the introduction yet it was there in the class connected but not switched on. At the time when the iBox was switched on, most learners were alert waiting to see what was about to be viewed. As an observation, learners were eager to see and listen what was about to come from the projected images. The iBox therefore is viewed as an element of surprise thereby capturing learners' interest and attention. Ashburn and Floden (2006), states that the learners' ability to attempt challenging content is increased because of their improved attention and concentration. From the field notes it was noted that learners' behaviour was improved in technology sessions of the lessons when comparing it to non- technology sessions. This is what was claimed earlier by Bester and Brand (2013) that attention leads to good motivation which in turn leads to better concentration.

One of the reasons stated by Nancy is that the iBox made the concepts clearer and easier for learners to grasp the intended objectives of the lesson. Bruno also added that:

"*…simplifies difficult concepts".*

This is evident in Bruno's interview transcript that follows:

> *"I consider the nature of the lesson. Some parts are easy to for learners to grasp; others require more clarification which is when I use the iBox. Sometimes the easier parts come with some misconceptions so I use the iBox to clear those misconceptions."*

Bruno's lesson was revision exercise to clear misconception around the line of best fit and its equation. During the lesson, this conversation took place:

Learner*: What happens if we only find one point on the line of best fit?*

> Teacher*: If you only use one point to draw your line of best fit? It becomes a line because it has gone through a certain number of points.*
>
> Learners*: You can't do that (Other learners joined in arguing the same issue. The teacher let the conversation go on for a while).*

For the teacher the misconception was cleared because at the end of the lesson he said:

> *"Is there still any confusion or questions? (Silence) So we understand each other then. Can you see that there was no reason for you to lose those 8 marks?"*

It was interesting to learn that the iBox had enabled teachers to grow and had assisted in capacity building. In an interview Bruno said this about the iBox:

> "…*boosts the confidence in teaching*".

It is crucial that a mathematics teacher is confident when teaching (Graven, 2004). This view is also echoed by Nancy who stated in the interview that with the help of the iBox she has no stress when she has to go to class and teach. Nancy went further in saying even learner participation in class has improved. For Pat the iBox uses examples that he never thought of which could be the cause of improved attention and participation in class.

6.4 Theme 3: Effective clarification of concepts and misconceptions

6.4.1 Subject matter delivery

All participants stated both in the questionnaire and interviews that the iBox has helped them with better content coverage. Participants seem to have used the tool even more. The time of the questionnaire and interviews were about six months apart.

At the time when the questionnaire was administered Nancy was using the iBox to teach financial mathematics but when she was observed teaching she used it to teach statistics in Grade 10 (measures of spread of grouped and ungrouped data). When finally asked in the interview as to what content knowledge had she covered, she mentioned financial mathematics, graphs/functions, trigonometry – general functions and statistics. Bruno indicated in the interview that he has used the iBox to teach functions (inverses and calculus), probability and financial mathematics. During class observation Bruno taught drawing the line of best fit as a revision lesson. The reasoning behind this was that when the question on

the line of best fit was asked in a test that was written recently, it was not attempted well. Bruno said:

> "*… the question that was there (in the test) was on the scatter plot*."

With the aid of the iBox Bruno wanted to make the concept clearer.

Pat's lesson was to derive the distance formula. However, in the interview he said he had used the iBox mostly on data handling and, as he added:

> "*… drawing graphs, the parabola, the hyperbola and the exponential graph*".

In the interview transcripts, the participants indicated some content knowledge, covered by the iBox, that they found, in their opinion, to be better than others. For Nancy

> "*The best topics in the iBox are Trigonometric graphs and Statistics*".

For Bruno the best topic covered is functions and for Pat it is financial mathematics. When participants were asked if the iBox has enough content knowledge, Nancy said:

> "*There is enough content, but it could have more features. For instance it could have more topic explanations*". Bruno said "*It has limited information. Hence you have to supplement it with other tools/resources*." Pat had this to say "*It depends on a particular topic. Other topics are well covered by the iBox, but others need more clarification and practice. That's when I supplement it. It has a lot of information. However, like any other technology, it has its limitations. And that's where you supplement it.*"
>
> Pat said:
>
> *"With Technology the animations make the lesson practical. With the prepared mathematics lessons, I found that they use examples that I never thought of."*

The participants manipulated the iBox for other benefit than just to deliver content knowledge. Nancy elaborated in the interview transcript saying

> "*It is easy to pause and make explanations and also allows learners to take salient points."*

During lesson observation Bruno paused the DVD lesson several times. When he was asked as why he did that he said:

> "*… to highlight some concepts…*"

Participants made the best use of the presence of the iBox in class. Finally, when the three participants were asked in the interview if they were to teach the same lessons again, would they teach it the same way, both Nancy and Pat said that they would improve a lot on their strategies. Bruno said he would improve a little because the strategy that he applied worked for him. This shows that the iBox presented room for improvement for the teachers and hence room for development.

6.4.2 Revision and addressing misconceptions

Bruno's lesson was a revision to iron out misconceptions when drawing the line of best fit. Misconceptions in mathematics are tightly held mistaken beliefs (Wetzel, 2008 & Swan 2001) which cannot be avoided but can be minimised. All activities in Bruno's lesson were tackled using whole class discussions. Whole class discussion can provide an opportunity for broader interpretations and a chance for learners to clarify their understanding (Anthony & Walshaw, 2009).

To address this, Bruno used scatter information of a company selling a certain type of a product in a period of two weeks as presented in Table 6.2. After some revision using Table 5.8, Bruno said:

> *…when you are supposed to draw the line of best fit, you are going to be given a table. In that table, it's your coordinates which are the weeks and the number of products.*

Bruno then produced the table on the chalkboard: (He was using a Learning Channel video where two facilitators were teaching a lesson)

Table 6.2

Table of Values for the Line of Best Fit

No. of weeks	1	2	3	4	5	6	7	8	9	10	11	12
No of products	10	20	35	90	55	60	65	70	95	90	110	118

Note. Reproduced from the Learning Channel Video

Bruno said:

> *So this is what is going to be checked. They are going to record the information that has been obtained which is the number of products that have been sold in a certain number of weeks and check the trend. What trend does it follow, using the line of best fit?*

He was revising the concept and correcting a misconception. The misconception was that some learners thought they need to have an equation in order to draw the graph.

Bruno continued:

> *In that table, there are coordinates where you have the weeks and the number of products. … and therefore you have 1 up to 16 and then you have 10 up to 120 and therefore your first coordinate is 1 and 10 up until that one (*points at the last coordinates in the table)

Bruno let the facilitators teach but paused the lesson after the points were plotted but before the graph was drawn. He asked the learners if they know for real that there was an outlier. He was also correcting a misconception that learners thought they need to draw a graph first before they can start looking for an outlier.

Bruno asked:

> *…and they said something about this point. What do you notice about this point? It is outside of those points right?*
>
> The outlier was discussed. Then the graph represented by Figure 6.1 was projected from the video lesson. A further discussion of the outlier took place.

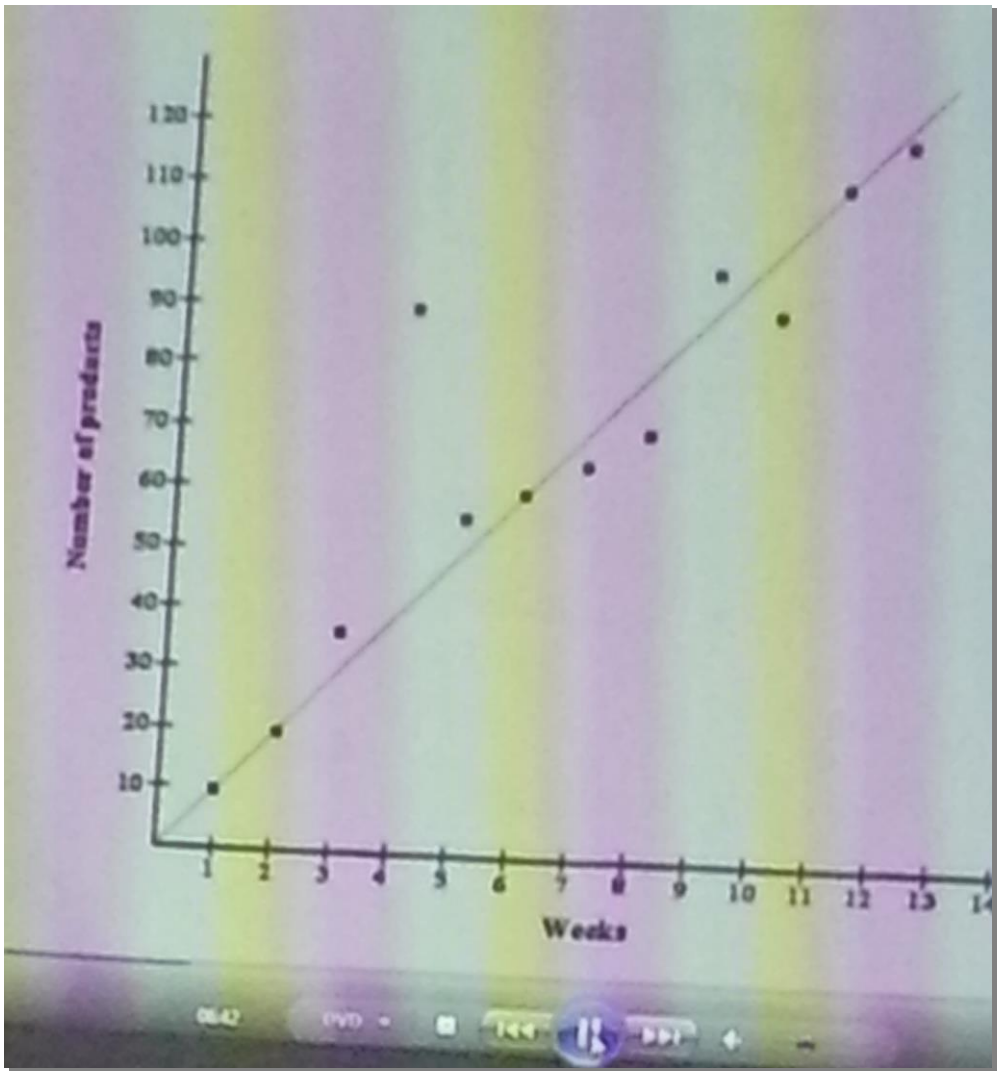

Figure 6.1: Line of best fit graph - A picture that was taken during the lesson

Bruno finally paused the iBox lesson before the facilitators started to calculate the equation for the line of best fit. The participant was doing his part in building the solution with his learners (Ruggieri, 2005). The DVD lesson arrived at the same answer as the teacher using points (2; 20) and (6; 60) whereas the teacher used (1; 10) and (2; 20), which proves that any two points (on the line of best fit) can be chosen at random.

Pat also used the iBox to tackle 'the confusion' when graphs are drawn. When Pat was asked in an interview why he did a lot of revision on work done in the previous grade, he said:

> "*I had anticipated the confusion, from experience of course. More emphasis and follow-up is needed I do follow-up lessons*".

Pat chose an activity from the iBox lesson to highlight some concepts. Nancy's revision of the preliminary concepts made use of the activities from the iBox lesson. Swan (2001) contends that some learners seem to create their own alternative meanings for mathematics in spite of what they are taught. Therefore it is imperative that means and strategies are put in place to deal with misconceptions. The iBox helped the participants to deal with misconceptions that occur in mathematics.

The presence of 'an element of surprise', the iBox, helped Pat's teaching in addressing a misconception. Pat said:

> *I wanted to consolidate the concept of the Cartesian plane. Remember, learners were confusing the x and a y value, therefore more practice was necessary even though this was a GET aspect. I had anticipated the confusion, from experience of course.*

Previous knowledge or prior understandings as Saxe (1991) calls previous experiences, needs to be addressed because it contributes largely in shaping what is about to be encoded. They contribute to the emergent goals, off course when mainly experienced with other parameters (Monaghan, 2003) because parameters are interwoven.

6.5 Theme 4: Enhanced teacher competence and confidence

6.5.1 Structuring of a lesson

All participants seemed to have a plan of incorporating the iBox and not just teaching using technology. Both Nancy and Pat did not just have a slide show at the beginning of their lessons but introduced their lessons using the chalk and talk method. In both lessons the participants dealt with learners' prior knowledge. Bruno also introduced his lesson by revising the basics of drawing a graph which is prior knowledge to drawing a line of best fit without using the DVD lesson projected by the iBox. In the questionnaire, Bruno indicated that he uses the iBox as a DVD player. Anthony and Walshaw (2009) state that teachers who start with learners' existing knowledge are capable to relate appropriate levels of challenges for their learners. Prior understandings help with the achievement of the objective of a lesson (Saxe, 1991; Monaghan, 2003) when they are drawn from, in a lesson.

Nancy introduced her lesson by discussing some preliminary concepts on measures of central tendency and dispersion. For example, she asked "What is statistics?" and "Who can tell me, what the difference between grouped and ungrouped data is?" Pat asked learners to write an

activity i.e. drawing a right-angled triangle and state the theorem of Pythagoras in their exercise books for him to get to the lesson on the distance between two points. Bruno deviated from this in that he did not let learners watch the video but introduced his lesson by doing an exercise on the board as an example. He created a scenario with two values and drew a table of x and y values, Figure 5.8.

Bruno reminded learners by stating:

> "*What is on the first row represents your x-axis and what is on the second row represents your y-axis*".

In all lessons the iBox was used to further establish the objectives of the lessons. The lessons were interrupted now and again with further explanations, questions and discussions. When asked in the interview why they interrupted their lessons they all said they were putting emphasis and clarity on what was explained. The iBox activities formed part of their lessons. The participants had planned strategies to manage student learning when using technology (ISTE, 2002). Nancy concluded her lesson by allowing learners to copy a homework exercise from the iBox lesson.

During lesson observations all participants displayed that they had prepared their lessons and had a plan in hand on how they were going to incorporate the use of an iBox to enhance teaching and learning. Lesson structures were not haphazard.

6.5.2 Frequency of the use of the iBox

The participants indicated in the questionnaire and during the interviews that they used the iBox as a resource to prepare lessons and in class teaching.

Nancy stated that she used the iBox every week. Both Bruno and Pat stated that they use the iBox, at least, once a month. Pat's interview transcript confirmed this:

> "*A plan is that I use it to introduce a new topic*".

> Nancy said: "…*once a week"*

Indeed in the lesson Pat introduced and taught 'the distance between the two points'. Nancy and Pat indicated in the questionnaire that they had little access to the iBox whilst Bruno indicated that he has unrestricted access to the tool. Cuban, Kirkpatrick & Peck (2001) found that access to technology is not directly proportional to computer use and frequency on

computer use is directly proportional to instructional technology. Instructional technology for Cuban et al. (2001) is concerned with improving efficiency and effectiveness in the use of technology in innovation and design.

Both in the questionnaire and during interviews it showed that mathematics teachers are not frequent users of the iBox. The cause could be accessibility, computer illiteracy, the schools' infrastructure and other challenges associated with the use of the computer.

6.5.3 Technology as a resource

An iBox is a tool that may be used as a resource for lesson preparation or as a tool in class teaching. Franz and Hopper (2007) state that technology is available in numerous websites designed to enhance instruction, provide tutoring, or serve as resources to teachers and learners. Indeed the participants stated in the questionnaire that they used the iBox to prepare lessons and they take it to class to present a lesson.

> Nancy: "*It has made me more interested in using technology. Learners too help to assemble the iBox. It helps teachers and learners to work together and teaching has become more pleasant."*
>
> Pat: "…*there are animations and simulations that are practically used in industries that I use … make teaching and learning very easy."*
>
> Bruno: "*If a lesson is taught for four hours, the iBox lesson will be two hours. If learners watch the DVD they can check all their workings and consolidate the work that they have done after visualising it.*

During class observations both Nancy and Pat used the iBox's PowerPoint presentations (prepared lessons in the iBox). However, Bruno used the iBox as a DVD player to show a Learning Channel video. Both PowerPoint presentations included the learning outcomes of the lessons, followed by the assessment standards, the table of contents, and the lesson presentation. The lesson presentation has an introduction, the body and conclusion. Each section of the lesson has questions or activities with answers or solutions. The presentation also has examples where necessary. The DVD showed a video where a lesson was presented by two facilitators who took turns to present sections of a lesson.

Using technology as a main resource helps to understand the mathematical principles (Franz & Hopper, 2007). The iBox was not used as a primary resource but it helped a lot.

6.5.4 The tasks provided with the iBox lessons

Tasks provided by the iBox lessons were used in all lessons. However, not all tasks or activities done during the lessons were from the iBox tuition. (For this study the words tasks and activities are used interchangeably). Also, not all activities provided in the iBox lessons were used for teaching and learning during the lessons because others were not applicable. It is therefore not an easy undertaking to select appropriate activities and tools to use in a mathematical lesson (Monaghan, 2003). Participants chose activities to include in their lessons in order to achieve the objectives of the lessons. Saxe (1991) claims that activity structures, for his model in Figure 3.1, involve tasks that must be performed in order to achieve the goals of any undertaking.

In one of the tasks, the iBox presented a ready-made solution but Nancy broke down the solution using what Ruggieri (2005) proposes as building up a solution with the learners. The exercise was based on a general knowledge quiz which was marked out of 10. A two-column table, Table 6.1 (a) was produced on the board by Nancy. The first column was read out as it was from the iBox activity. The second column was also called out by learners using the information from the iBox activity. The blank places (as shown below) were purposely omitted. Later on Table 6.1 (b), which is a follow-up from Table 5.5, was also produced on the chalkboard.

Table 6.1 (a)
Frequency Table of the Marks of Learners

Marks Obtained (X)	Frequency (F)
0	10
1	20
2	40
3	50
4	30
5	
6	

Table 6.1 (b)
Frequency Table of the Marks of Learners

Marks Obtained (x)	Frequency (f)	f.x
0	10	0
1	20	20
2	40	80
3	50	150
4	30	
5		
6		

7			7		
8	10		8	10	
9			9		
10	10		10	10 N – 250	100 ∑ fx = 1050

Note. Adapted from the iBox PowerPoint lesson

The second iBox activity consisted of four revision questions. Two revision questions were done by learners working independently and the other two were completed as a whole class discussion; What is the mean of 20+18+19+23+20?; The mean of six numbers 20, 18, x, 24, 23 and 13 is 20. What is the value of x?; Table 5.6 and Table: Table 5.7

In each case answers provided by the iBox lesson were checked before going to the next activity. Learners were seated in groups therefore learner activities were done as 'group work'. Group work worked well because some learners did not have calculators therefore calculating individually could have been problematic. At some stage Nancy encouraged learners to use the calculator in order to avoid computing errors (Atteridge, 2010). The lesson ended by the teacher instructing learners to copy an activity from the iBox lesson for homework.

Bruno used a DVD lesson using the iBox to project it. The lesson was on 'the lines of best fit'. The use of DVD's within a blended learning mathematics teaching, improved learner performance in the subject (Padayachee et al., 2011). Of the three activities that were performed, two were from the DVD lesson. Those two activities were discussed by the two DVD lesson facilitators. The first DVD activity was when the facilitators differentiated between univariate and bivariate data. This was a discussion activity which the participant did not interrupt.

The presenter differentiated between univariate and bivariate data e.g. learners' marks in a test where there is only one value and information with two variables or two things e.g. time in seconds and the cost in Rands. The facilitator explained further:

> In medical sciences research, they may want to know about smoking. For instance, has the information of how smoking affects life expectancy been proved? How long do people live and how many cigarettes do they smoke? The research would ask such questions. Another example would be on HIV and Aids. With the use of statistics it can be predicted if the HIV and Aids victims would increase or decrease in the near future. (The lesson has been paraphrased)

It was noticed that the learners were more attentive when other voices (DVD facilitators) spoke.

6.6 Theme 5: Embracing traditional teaching methods

6.6.1 Chalkboard and exercise books use

The participants used the chalkboard during the classroom observations. Nancy and Bruno revealed in the interview that the chalkboard is a necessary tool that they cannot discard even in the future. However Pat revealed in the interview that the chalkboard can be discarded but during classroom observation he used it. Nancy and Pat allowed learners to use the exercise books during the lessons.

The classroom setup in Nancy's lesson was that the middle third of the chalkboard could not be used because the iBox is situated in the middle of the class to be viewed by the whole class. As a result when Nancy first used the chalkboard in her first activity she was careful to use the sides of the chalkboard to write on. As a second activity of the lesson she wrote ungrouped values on the chalkboard and a discussion ensued. The next activity which was the iBox lesson activity was to calculate the mean. Ruggieri (2005) also mentioned learners should be engaged in building up a solution. Chigona et al. (2014) stated that technical challenges are to be expected with technology use therefore support in this regard should be obtainable. Of the four questions, two were done through discussion, question and answer and chalkboard use methods. The rest of the lesson was completed through chalk and talk and discussion methods. The chalkboard was used quite extensively by Nancy.

Bruno's classroom setup was almost similar to Nancy's that was discussed above. Bruno used the chalkboard to introduce his lesson. He drew two tables of values on the chalkboard to show learners how information leading to drawing the line of best fit could be presented to them. Bruno then switched on the DVD lesson which was played on the iBox. However I will refer to this lesson as the iBox lesson. For the first activity from the iBox lesson, Bruno

produced the table of values on the chalkboard. The table was there on the board and when the graph was later drawn from the iBox lesson the class could refer to it. The chalkboard was next used by Bruno when the lesson came to a point where the equation of the line of best fit was to be calculated. Bruno went ahead of the iBox lesson by choosing two points, different from the ones chosen by the lesson, and together with the learners using the chalkboard, they calculated the equation which was: $y = 10x$. Bruno then continued the iBox lesson which chose two different points but arrived at the same answer. Bruno simultaneously used the iBox and the chalkboard to carry out the lesson. The chalkboard was used specifically to elaborate what was presented in the DVD lesson. A study by Padayachee et al (2011) found that DVD technology has a positive impact when teaching mathematics which could be the case with Bruno's lesson.

Pat's classroom setup was such that the projection was on the wall opposite the chalkboard wall. He therefore did not have to worry to leave space on the chalkboard for the iBox projection as was the case with the other two participants. Pat allowed the learners to draw the triangle in their exercise books before developing the intended triangle and the distance formula on the chalkboard. Pat then continued the slide on the iBox lesson that showed what was already drawn out on the chalkboard. Ruggieri (2005) likes working out the answer with the learners instead of showing off a completed solution.

The chalkboard was used alongside the projected images in all three case studies. Ruggieri (2005) said she enjoys teaching using PowerPoint slides whilst demonstrating explanations on the chalkboard because this is not possible when using a Smart Board or an Interactive White Board. So the chalkboard has some benefits as opposed to some technological tools. Also when the electrical power is not available at a certain time and place, traditional tools are a solution.

It was noted that Nancy and Pat accommodated the use of learners' exercise books for writing answers to tasks. Learners used their exercise books to copy the chalkboard summaries and make their own notes. It was also noticed that even in Bruno's class, learners were using exercise books to make their own notes or copy the chalkboard summary.

Nancy instructed learners to do 2 of the 4 tasks presented in the iBox lesson in their exercise books. Nancy asked any learner to write the answer from the exercise book on the board but no one came forth. However it was seen that exercise books use became an obstacle in

Nancy's lesson because at one stage she said learners should stop writing and concentrate. That occurred when learners were either copying the chalkboard summary or making their own notes.

At the beginning of the lesson Pat asked his class to take out exercise books because they were going to use them. Pat introduced his lesson by asking learners to draw a right-angled triangle and state the theorem of Pythagoras in their exercise books. As learners were writing, Pat was going around checking the learners' work and marking. Learners' exercise books were also used by learners to do an iBox lesson activity of stating the type of triangle. The activity needed learners to apply the distance formula.

In Bruno's class, the learners did not use the exercise books as per the participant's instruction. Bruno was more interesting in engaging with the learners with lessons on what was presented on the iBox and the chalkboard. The learners were given the opportunity to ask questions as they panned out. Even though exercise books were not used in the lesson, the goals of the lessons were achieved.

Learners in poor performing schools do not spend time doing tasks (which are at different levels) in their work books (Stols, 2013). It is therefore necessary to allow learners to do tasks and perhaps make their own notes about the content and the tasks presented. In this technological era a blended learning approach which is schooling that combines different types of education techniques and technologies (Köse, 2010) can be employed by teachers. Stols (2013) further states that learners are not afforded enough opportunity to learn if they are not given time to practice what they learn.

The participants were still very reliant on conventional tools of teaching in carrying out the lesson in spite of the advanced tool at their disposal. The chalkboard was used frequently. Nancy and Pat intentionally created space for learning (Stols, 2013) by letting learners use the exercise books. Pat was the only participant who had a textbook and a lesson plan. Professor Ruggieri (2005) who used advanced technology in her practice stated that low-tech tricks like chalk, hard copies of PowerPoint presentations, textbooks and lecture notes, are still significant and sometimes necessary to effective as well as successful teaching and learning.

At times during the lessons, learners had to work as individuals or as groups. Working in groups was sometimes not intended. Some learners had to share resources like stationery and calculators. Social interaction occurs more when working in groups as learners share ideas whether they agree or not. When the iBox is one of the tools used, learners and the teacher share it as a resource where there is even more social interaction in class.

6.6.2 Question and answer and teacher tell methods

With the use of technology one would expect that facilitation would go with it. The participants did not use any high-tech mode of teaching. It was a face-to-face type of teaching even though technology was used.

Students reported that they had a better comprehension of concepts in mathematics when some technology was used with other traditional methods (Padayachee et al, 2011). For this study the iBox was used together with a lot of question and answer method, chalk and talk and teacher tell methods. Even when group or class discussion was embarked on, they were dominated by teacher leading the way.

With blended learning, it is possible to have a mode where a facilitator is not anywhere to be seen. The DVD used by Bruno could have been played without any intervention of a teacher on a face-to-face basis.

6.7 Theme 6: Lack of technical and pedagogical support

6.7.1 Challenges with the iBox

When the iBox was introduced to the nine schools of this particular district, principals of these schools were informed. Principals had to bring teachers to a common venue so that at least one teacher per school was trained in how to use the iBox. Some schools sent two teachers to be trained; however, not all trained teachers were mathematics teachers. Teachers who were trained by the suppliers were asked to train fellow colleagues at their respective schools. When the iBox was distributed to schools it was evident that its use was accompanied with some challenges.

Figure 5.11 indicates that 53.4% of the sample of participants faced challenges with using the iBox yet 23.3% did not have any challenges and another 23.3% are in the no response category. Of the latter 23.3% which translates to seven of the sample of participants either gave a not applicable (N/A) response or claimed that they never used the iBox. The further

seven of the sample of participants stated that they did not experience any challenges at all with the iBox. The former represents sixteen of the sample of participants who said they experienced technical challenges, associated with competency, accessibility and the infrastructure of the school. Lai and Kritsonis (2006) state that challenges will always be evident, therefore new technological environments require teachers to apply new management styles of time and the ability to create new learning spaces.

During interviews the participants cited different challenges when using the iBox. Even though there are many benefits to computer use, computer technology also has limitations (Lai & Kritsonis, 2006). The shortcomings ought to be attended to in order to obtain the full benefit of computer technology. Cole (2006) reminds us that computers are a means to an end but not an end on their own. Challenges experienced with the use of the iBox can be grouped as technical, accessibility, competency, and infrastructural.

6.7.1.1 Technical challenges of using the iBox

The questionnaire and the interviews conducted with the three participants revealed that iBox created technical challenges in Nancy's and Bruno's schools. For the challenges identified, participants pointed out that there may be short-term ways to address them; however the long-term solution is repair.

Nancy mentioned that when the iBox is switched off it cannot be switched on again for immediate use. However, as a school they had a short-term solution; it needs to be allowed to cool off in order to be reused. This technical issue was a challenge to the school because teachers could not use the iBox as they wished. The interview transcript provides evidence that in order to address such a challenge there is a need to

> "*...have a timetable for use to give it time to cool off*."

The participant noted that a possible long-term solution to this challenge is to have it repaired, therefore calling for technical support. The district officials and district support systems must be accessible to schools (Bloch, 2009). Similarly, Chigona et al. (2014) stated that technical support should be available as well.

The iBox challenge in Bruno's school was that the sound is not audible for the required range. Bruno said he has to divide a class into two and teach them separately. An alternative approach applied, to overcome the challenge, is using the speakers from the sound system

that is available in the school. However, from experience it can be said that dividing a class into two could pose another challenge to normal teaching and learning in the school due to time constraint issues. These technical challenges experienced by the teachers' impact on the quality of technology use. A study conducted on technology use by Lei and Zhao (2007), in the United States, revealed that the quality as opposed to the quantity of use must be ensured.

Even if the iBox is available at schools, if it is broken or poses mechanical issues, this will impact on its accessibility. It would be ideal if schools get the backing they need.

6.7.1.2 Accessibility

The accessibility of the iBox in the schools was one of most important aspects for the tool to enhance teaching and learning as it is expected to do. Results from the questionnaire from 30 mathematics teachers revealed that 70% of the sample of participants has access to the iBox as indicated in Figure 5.6.

Bruno mentioned in the questionnaire that he has great access to the iBox. The interview transcripts, however, revealed that he extends this access to other teachers by training them and continues to do so even to the newly appointed teachers in his school. Bruno mentioned that he has great access to the iBox but would appreciate and welcome a second iBox in the school. Bruno conducted his lesson in the laboratory. In the interview he mentioned that:

> "*The venue was convenient because the room had a plug point, lights and curtains.*"

Other rooms in the school do not have these. During the lesson the curtains were closed and the lights were adjusted (switched on and off) to suit the lighting needed at any specific moment. Bruno switched off the lights if he wanted the room to be darker for a clearer vision of the projected material and switch them on again. However, the lights were switched off for the most part of the lesson and the curtains remained closed. Some learners were seated in high laboratory chairs and this posed a challenge because they did writing using their laps instead of using desktops. Both Nancy and Pat reported in the interview and the questionnaire that they have little access to the iBox. All three schools have one iBox available to them.

Pat mentioned further both in the questionnaire and the interview that the greatest challenge for him was accessibility caused by regular electrical power shortages in the area where the school is built and used by other colleagues in the school. It is of interest to mention that one

appointment to the school had to be cancelled because there was no electrical power in the school, not as a result of load-shedding which is experienced by all South Africans. Pat said

"*With electricity, it happens every week. Cable theft is very common in the area*."

Pat conducted his lesson in a mathematics classroom where learners took turns to come and learn mathematics. Even though Nancy had said she has little access to the iBox, in an interview she said

"*I plan to use the iBox for all my work*."

When asked: For which part of the lesson do you use the iBox the most? Nancy answered

"… use the iBox at the beginning of the lesson because it captures learners' interest."

The same notion is shared by Bester and Brand (2013) who state that some of the effects of technology are that achievement is likely to improve because the attention of learners is captured. Further, when Nancy conducted the lesson the connection of the iBox was from another room because (from observation) the classroom where the lesson was conducted did not have the plug point. In actual fact it was there but vandalised. This factor also impacted on the accessibility of the iBox.

6.7.2 Competency in the use of technology

Competency is one of the challenges cited by teachers as the reason why they do not use the iBox or some of the features of the iBox. One teacher in the questionnaire gave a reason for not using the iBox as it takes a lot of time to set it up.

In the questionnaire one respondent from the sample of participants mentioned that she would rather avoid using the interactive whiteboard as a feature of the iBox because she does not know how to use it. All participants had a challenge in using the IWB. As a result all three did not use it. In an interview Pat mentioned that he seeks help from other colleagues or uses trial and error when confronted with competency issues around using the iBox. Pat also mentioned in the interview that in his opinion some teachers do not use the iBox because they are not computer literate and therefore not comfortable to use technology. This shows a lack of teacher development in computer literacy

Pat mentioned that he had a challenge with some icons of the iBox and mentioned that he was prepared to familiarise himself with them. He also mentioned that he gets help from the colleague who was trained by the suppliers when he gets stuck. The participants mentioned in the interview that they would appreciate re-training with respect to the uses of the interactive

whiteboard. However, to help learners enhance the initial and original initiatives, teachers need, among other things, to master new technologies (Stephenson, 2001). Bruno mentioned in the interview that he just needed time and space to figure out how to use the interactive whiteboard and that external help would be appreciated.

Introducing technological innovations in schools and enabling teachers with ICT skills creates new ways of doing things and it is a form of empowerment (The Department of Education, 2007), and needs to be practiced.

6.7.3 Infrastructure

An analysis of data collected showed that infrastructural challenges also influence the use of technology in the schools. Some infrastructural issues include security, electrical power, conditions of the classrooms and overcrowding. It was also evident that security issues lead to limited access to the iBox because the tool is stored where it is not easily accessible for everyday use.

When asked in the questionnaire how to combat security and accessibility issues for the iBox in the school one teacher said he/she would rather have an iBox per class secured in a locked cupboard. It was observed that in Nancy's classroom, the plug point was vandalised; she was forced to make use of an extension cord plugged in from the neighbouring classroom. Chigona et al. (2014), in her study of technology use in disadvantaged areas, stated that electricity problems impose some of the challenges with the use of computers.

Other challenges noticed include the lack of smooth or solid surfaces. In Pat's classroom a green wall surface was used, whereas white is a suitable colour for projection (screens or walls). The motivation behind the green surface in Pat's classroom was probably to delay the effects of dust exposure, thereby necessitating repainting. Furthermore, the chalkboard in Pat's classroom needed repair as it drastically impaired the projected image from iBox. The most suitable venue for the observation in Bruno's school was the laboratory. This, however, forced the learners to be seated at desks that were not compatible for the lesson; for example the use of high chairs with desks was not appropriate for note taking.

As is evident there is a correlating relationship between the challenges and the optimisation of use. Thus an environment that limits challenges increases the use of the iBox. Difficulty of access may negatively influence some teachers' attitudes towards integrating the technology

into their day-to-day way of teaching (Chigona et al., 2014). However, the data that was collected revealed that 70% of the sample of participants had access to the iBox (Figure 5.6) and 50% are using the tool (Figure 5.9). The teachers advised, both in the questionnaire and interviews, that they need to talk to the school management to address challenges related to infrastructure, report to the iBox co-ordinator for repairs and that more training or follow-up training is necessary (Table 5.3).

6.8 Conclusion

The participants' use of the iBox has been found to be minimal as compared to what was revealed by the literature. This lack of technology use might be linked to teacher professional beliefs (Ertmer, 2006). Even when the iBox is used, the frequency of use is low as well (see Figure 5.7). However, their technological use does enhance the teaching of mathematics. The iBox posed different challenges to participants which influenced the use of the iBox. The participants suggested ways to address the challenges in Table 5.3. These findings may not be generalised because the limits of this study. The next chapter focuses on the concluding remarks of the study.

Chapter 7
Conclusion and limitations

7.1 Introduction

In the previous chapter the main findings of the study were explored. In this chapter the concluding remarks will be presented.

The objective of the study was to explore the use of the iBox when teaching mathematics in selected KwaZulu-Natal Secondary Schools. The data collected was used to present answers to the three research questions, with respect to three participants in the study. The three research questions are:

- Why do teachers use the iBox?
- How do teachers use the iBox?
- What are the challenges faced by the teachers when using the iBox?

The objectives of the study were:

- To determine the extent to which teachers use the iBox.
- To explore the experiences of teachers in mathematics.

Three research instruments were used in the study to collect data. The first research instrument was a questionnaire which was used to gather baseline information about the use of the iBox in nine schools. The main objective of the questionnaire was to identify the teachers who are using the iBox for teaching mathematics in their schools. Other information collected was related to why and how teachers use the iBox. In addition, the study also focussed on the challenges experienced when teachers used the iBox.

The second research instrument was an observation schedule. At least one mathematics lesson in three different schools was observed. The researcher was a non-participant observer. This research instrument focussed on collecting information on how the three participants used the iBox.

The third instrument was a semi structured interview schedule. Each participant was interviewed twice. The first interview was conducted immediately after the observation. The second interview was administered with the participants once having looked at the

observation schedules and at the participants' responses on the questionnaire and when the first interview recording was listened to. Themes that emerged from data collected and analysed are concluded below.

7.2 Faster progression of lesson content delivery

The aim of the study was to explore the use of the iBox by teachers, in selected schools, when teaching mathematics. All participants mentioned that the iBox was not used regularly, on a daily basis, but the frequency of use ranges from once a week to once a month depending on the accessibility of the tool and the need to use it.

All participants stated that they enjoyed the use of the iBox because much work was covered in a short space of time therefore the lessons are quicker. Teachers echoed that they do not have content coverage frustrations. Further, the findings that emanated from the observation revealed that the iBox motivates learners to be more attentive as this was one of the reasons why participants choose to use the iBox when teaching. Bester and Brand (2013) couples improved attention with motivation which eventually results in better concentration and good achievement.

The participants stated that they are encouraged to use the iBox because it makes the lessons interesting. For them teaching too becomes interesting. The iBox also captivates interest in the learners. If lessons are interesting and learners are interested to learn, learning, which is the core business of teaching, is improved.

With the use of the iBox participants noticed improved behaviour, improved learner participation and more teacher-learner interaction. These are some of the reasons why participants chose to use the iBox to introduce a new concept or as a supplementary tool to deliver a lesson.

Participants are still very fond of the traditional tools because they identify more with them than they do with technology. However, through using the iBox more explanations are done on the chalkboard and assessment tasks are written in learners’ exercise books. Even though the iBox comes with a hand-held interactive board, participants were not comfortable to use this. Teachers said more time and assistance is needed for them to use the interactive board.

Participants would produce interactive graphs, model answers and worked examples which saved them time and writing. In some schools with poor infrastructure, boards are worn out

so inscription on them was badly displayed. The iBox projected images would serve the purpose of showing such writing much better.

7.3 Enhanced learner participation and interaction

Teaching is incomplete if no learning is taking place. Bloch (2009) was worried about the backlogs that exist in education service delivery including the technology integration when teaching. The iBox intervention strategy was answering to such a call.

Participants believed that technology has added value to teaching because learners were more interested in learning. They also assumed that their learners were more attentive because of the iBox use as it captures their interest.

Participants also looked at the iBox as a means which improved their quality of teaching because teacher-learner social interaction improved which resulted to lesson goal attainment (Saxe, 1991; Monaghan, 2003). Learners started asking questions they would not normally ask. Learners moved to the chalkboard to write answers because of their improved interest to learn.

7.4 Effective clarification of concepts and misconceptions

The participant's confidence in teaching was boosted by the manner in which the iBox assisted them in presenting their lessons. Mathematical concepts were made clearer and easier to grasp with the use of the iBox prepared lessons. When lessons were taught, the participants showed no lack of content knowledge by way of body language, tone of voice or interaction with the learners. For all participants, their mathematics teaching experience is more than ten years (see Figure 5.1) Even though there is no correlation between years of teaching experience and possession of better content knowledge, being experienced in teaching was a bonus to the participants.

The iBox enabled participants to correct concepts that were not conceived in an appropriate manner resulting in attempting test questions badly. Participants even claimed that the iBox allowed them to make a thorough explanation and a different interpretation of a mathematical idea. This allowed them to make a deeper impression on learning.

7.5 Enhanced teacher competence and confidence

The iBox was used by Bruno as a DVD player to show a video lesson where learners listened to other voices (the video lesson that was used had two facilitators) other than that of their

teacher. The iBox was also used by Nancy and Pat to show the PowerPoint iBox prepared lesson. Both PowerPoint projected images started by highlighting the outcomes of the lessons thereby channelling learners' attention to what the lesson was about.

The participants did not allow the iBox to take control or take charge of the lesson but rather the use of the iBox aided in enhancing the teaching and learning of mathematics. All introductions of lessons were done by the participants without the use of the iBox. In all three lessons at the time of introduction the iBox was in class but not switched on. This strategy kept learners attentive. It was observed that as soon as the iBox was switched on the learners' attention improved. Throughout the lessons, the participants were interacting with the learners whilst the iBox was providing tuition. Participants agreed that the iBox helped them to achieve the objectives of their lessons but did not replace the teacher.

The participants showed that the iBox lessons they projected were used prior to teaching the lesson for preparation. They knew what the projected image was going to be. The participants paused the iBox to highlight certain points, explain further, ask a question or allow learners to perform an assessment activity.

The iBox was used by the participant to provide the assessment activities during and at the end of the lesson. One of the participants gave learners a task and used the iBox's projected image as a model answer. The iBox was therefore used either as a primary or a secondary resource. Based on observation, when the lessons were taught the iBox lessons were also used to take notes. At some stage one participant asked the learners to stop writing because they were being distracted by taking notes from the projected images.

7.6 Embracing traditional teaching methods

Traditional tools such as the chalkboard, textbooks and learners exercise books were also used during the lessons when the iBox was used. The participants kept on writing some additional work on the chalkboard. Other participants even added during interviews that they cannot dispense with the chalkboard. However, one participant disagreed saying with more technological knowledge one can teach effectively using technology only. The iBox was used to bridge the gap between traditional and modern ways of teaching (Davis & Rose, 2011).

Even though group and class discussions were employed during lessons, they were overpowered by the traditional question and answer, teacher tell and chalk and talk methods.

7.7 Lack of technical and pedagogical support

The iBox, as with most technology, presents technical challenges. One such challenge (see Table 5.3) is sound which is low for big classes. Another technical challenge experienced was cooling off of the tool. Technical challenges could be solved by technical support offered either at a district or provincial level.

Accessibility of the iBox to the teachers is another challenge. Some iBoxes in some schools are stored in places not easily accessible to teachers so that the iBox is kept safe. Also competition for the iBox poses a challenge because all schools sampled had one iBox which, in some schools, is the only technological tool. Teachers were not able to use the iBox in one school because of the poor electrical power supply in the area where the school is situated. The participant said poor power supply was caused by cable theft.

Competency in using technology and competency in the subject matter are other challenges impacting on putting technology into good use. Participants did not show any incompetence in content knowledge delivery.

Vandalism within the school is another challenge with the iBox. In one school electrical sockets were vandalised. Apart from vandalism; infrastructure in some schools poses challenges. There are no special rooms suitable for technology use as a result teachers were faced with problems when using the iBox.

Some teachers were not using the iBox or some parts of the iBox because the implementation strategies, including training on the use of the tool, were not adhered to. Further, some teachers lack technological knowledge or see themselves as not suitable for technology use. Training and re-training seems to be inevitable. This study had its limitations. These limitations need to be acknowledged.

7.8 Limitations

After having concluded on the themes of the study it is order to re-look at its confinements. The first limitation is sampling. The number of schools that were sampled was only those that had received the iBox from the KZN DBE project of ICT integration in schools. It was possible that there were other schools that own the tool as their own venture or NGO intervention.

Another limitation, still on sampling, is the sample size. The number of participants was very restricted. The number of the sample of participants was small on its own taking into consideration the targeted schools. From the sample the research had to concentrate on the respondents that use the iBox only. A further restriction took place because it was not feasible to get the participants who were willing and available to continue with the study at the time that was set for the research.

A further limitation was that even though a teacher from the sample of participants was a mathematics teacher, the iBox was used to teach another specialisation subject. The objective of the study was to explore the experiences of teachers in mathematics teaching. Finally the researcher had to be mindful of not advocating the use of the tool by the teachers in schools as a Departmental official. The teachers were treated and respected as participants of a research all the time. As a result of all the limitations, the findings cannot be generalised.

7.9 Conclusion

The main findings are a result of the case analysis which helped to gather the differences and shared standpoints of the participants regarding the use of the iBox. This study concludes that the iBox has the capability to enhance the teaching and learning of mathematics in schools. Infrastructure, vandalism, technical support, technology implementation strategies, accessibility of the technological tools within the school and teacher development especially on TPCK need to be addressed. When these are taken care of Information and Communication Technology (ICT) can be fully accommodated for integration in schools as well as achieving the objectives of the lessons that are taught. The iBox also demonstrated integration with improved human conditions because it assists with better attention which may improve behaviour problems.

The iBox demonstrated a value to be ideal in both disadvantaged and advantaged schools because it is portable, durable and interactive. In some schools where there is limited ICT infrastructure, traditional technologies such as printed material may remain more effective and accessible but room for modern technologies should be opened. This conclusion suggests that disadvantaged schools should be assisted to develop since the use of technology attempts to improve and support equal access to learning in rural and deprived areas.

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Appendix A - Ethical Clearance Certificate.

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

26 November 2015

Mrs Sibongile Tsepiso Mthembu (207526440)
School of Education
Edgewood Campus

Dear Mrs Mthembu,

Protocol reference number: HSS/0715/013M
New project title: Exploring the use of the iBox when teaching Mathematics in selected KwaZulu-Natal Secondary School

Approval Notification – Amendment Application

This letter serves to notify you that your application and request for an amendment received on 20 November 2015 has now been approved as follows:

- Change in Title
- Change in Supervisor

Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form; Title of the Project, Location of the Study must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

Best wishes for the successful completion of your research protocol.

Yours faithfully

.....
Dr Shenuka Singh (Chair)

/ms

cc Supervisor: Dr Jayaluxmi Naidoo
cc Academic leader Research: Professor P Morojele
cc School administrator: Ms Tyzer Khumalo

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
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Website: www.ukzn.ac.za

Appendix B – Informed Consent Letter

B 94 Kwa Dabeka Extension
Clermont
3602

The Participant
X School
X Location

Dear Participant

RE: REQUEST TO CONDUCT RESEARCH

I am a Masters student in Mathematics Education, at UKZN Edgewood campus, conducting a research. The research focuses on the iBox which is a technological device offered to the school last year. It is of interest to explore its usage by Grade 10 Mathematics teachers and get their experiences on using it. It is also of interest to explore its impact on teaching and learning in the school.

I kindly request you to participate in the research. Contact time will not be compromised. Please be assured that:

- the information gathered will be used for the research only
- your identity and the identity of the school will not be divulged under any circumstances
- fictitious names will be used to represent the participant or school name
- all information will be treated with confidentiality and privacy
- participation is voluntary; therefore participants are free to withdraw at any time without negative or undesirable consequences
- participants will not be coerced to disclose what they do not want to reveal
- participants have the right to withdraw at any stage of the research process if they wish to
- there will be no benefits received by participants as part of their involvement
- there are no correct or wrong answers, responses reflect a personal opinion

- audio recording is done to minimise distortion
- data will be stored safely in the University for a maximum period of five years and thereafter destroyed.

This study is supervised by Dr S. Bansilal, Cell Number: 083 279 5916, Email address: bansilals@ukzn.ac.za.

My contact details are: 084 584 6655(Cell)/ 031 7110987(H)/ 031 360 6198(W) and bongimthembu1@gmail.com (email address).

Yours faithfully

S.T. Mthembu (Mrs)
(Sibongile Tsepiso Mthembu)

REPLY SLIP

I, ---------- (full names) have read and understood the contents of this letter. I agree to participate in the research.

---------- ----------

Signature of participant Date

Appendix C - Letter of Consent to Conduct Research in Schools

B 94 KwaDabeka Extension
Clermont
3602

The Principal
X School
X Location

Dear Principal

RE: RERQUEST TO CONDUCT RESEARCH

I am a Masters student in Mathematics Education at UKZN Edgewood campus, conducting research. The research focuses on the iBox which is a technological device offered to the school last year. It is of interest to me to explore its use by the Grade 10 Mathematics teachers and get their experiences in using it. It is also of interest to explore its impact on teaching and learning in the school.

I kindly seek permission to conduct research in your school premises because I need to observe teaching and get the school's profile. Contact time will not be compromised.
Please be assured that:

- the information gathered will be used for the research only
- your identity and the identity of the school will not be divulged under any circumstances
- fictitious names will be used to represent the participant or school name
- all information will be treated with confidentiality and privacy
- participation is voluntary; therefore participants are free to withdraw at any time without negative or undesirable consequences
- participants will not be coerced to disclose what they do not want to reveal
- participants have the right to withdraw at any stage of the research process if they wish to

- there will be no benefits received by participants as part of their involvement
- there are no correct and wrong answers, responses reflect a personal opinion
- audio recordings will be done to minimize distortion
- data will be stored safely in the University for a maximum period of of five years and thereafter destroyed.

This study is supervised by Dr S. Bansilal, Cell Number 083 279 5919, Email address: bansilals@ukzn.ac.za.

My contact details are: 084 584 6655 (Cell) 031 711 0987 (H)/031 360 6198 (W) and bongimthembu1@gmail.com (email address).

Yours faithfully

S.T. Mthembu (Mrs)

(Sibongile Tsepiso Mthembu)

……...

REPLY SLIP

I ……..(full names) have read and understood the contents of this letter. I agree to allow you to conduct research in my school.

…… ……

Signature of principal Date

Appendix D - Questionnaire

A Questionnaire to be completed by the teachers (open-ended and closed-ended)

Fill in by ticking the appropriate box where applicable.

1. For how long have you been teaching mathematics?

   1 – 5 years □ 6 – 10 years □ more than 10 years □

2. For how long have you been teaching mathematics in your current position and school?

   1 – 5 years □ 6 – 10 years □ more than 10 years □

3. How would you rate your level of teaching of mathematics?

   Moderately experienced □ Experienced □ Very experienced □

4. What type of learners (on average) do you teach in mathematics?

   Less attentive □ Moderately attentive □ Very attentive □

5. When did you know about the iBox?

   Recently □ A while ago □ When it arrived □

6. How was it introduced to you?

   In a workshop □ Own initiative □ Through a colleague □

7. What access do you have on the iBox?

   None □ Very little □ Enormous □

8. How often do you use the iBox?

   Hardly □ Every week □ Once a month □

9. Do you use the iBox to prepare the lessons or in class teaching?

   Prepare lessons □ In class teaching □ Both A and B □

10. Which features of the iBox do you use the most and why?

    As a computer □ A and interactive board □ A, B, and webcam □

11. How are you currently using the iBox?

    _____
    _____
    _____

12. As far as you know, who else in the school uses the device?

    Nobody □ A few other teachers □ Lots of teachers □

13. What are your experiences in using the iBox?

    _____
    _____
    _____

14. What content knowledge have you covered using the device?

    _____
    _____
    _____

15. Are there are any challenges you face in using the iBox?

    Yes □ No □

16. If yes, what are these challenges?

_____
_____
_____

17. If yes in 15 above, how could these challenges be addressed?

_____
_____
_____

18. How do you overcome these challenges?

_____
_____
_____

19. What opportunities does the device have for you in teaching mathematics?

_____
_____
_____

20. Do you think the iBox usage has /may improve the quality of teaching and learning in mathematics in this school?

_____
_____

21. How has the iBox assisted you the most?

_____
_____

22. Would you recommend use the iBox to anyone?
No □ Yes □

23. Why would you do so?

_____
_____

THANK YOU

Appendix E – Observation schedule

	INTRODUCTION	DURING THE LESSON	END OF LESSON
TEACHER			
ATTITUDE			
BODY LANG			
TONE			
CONTENT KNOWLEDGE			
TIME MANAGEMENT			
USE OF TOOL/S	CHALKBOARD	iBox	iBox
OBJECTIVES ACHIEVED			
LEARNERS			
ATTITUDE			
ATTENTION			
INVOLVEMENT			
INTERACTION			
iBox			
RELIABILITY			
USAGE:SUPERFICIALLY INTERGRALLY HIGH-LEVEL USE			

Appendix F – First interview transcripts

Transcript of interview with Nancy

Researcher: Good morning Nancy

Nancy: *Good morning.*

Researcher: After having observed you teaching, I would like us to have a discussion based on the lesson as well as on some responses that you mentioned in the questionnaire. Do you plan to use the iBox at the beginning of the year, daily or do you plan to use only when you're about to conduct a lesson?

Nancy: *At the beginning of the year because it helps and make you to plan ahead. I plan to use it at the beginning of the year because that is when I do my planning.*

Researcher: **How do you choose to whether use the iBox or not for a specific lesson? For which content do you choose to use the iBox?**

Nancy: *I plan to use the iBox for all my work. The iBox allows me to complete my work in a short space of time.*

Researcher: **Do you use the iBox as your main tool or do you use it to supplement your other teaching tools?**

Nancy: *Although I often use the iBox, it does not replace other teaching tools like the chalkboard which will always be relevant. To avoid my learners being board I use different methods at different times. However, the learners seem to enjoy learning the iBox more than the other tools. So I often stick to it.*

Researcher: **Does the school have any other technological tool beside the iBox?**

Nancy: *Yes, we have also data projectors and overhead projectors.*

Researcher: **Is there enough content knowledge in the iBox?**

Nancy: *Yes, there is enough content, but it could have more features. For instant it could have more topic explanations without us having to keep pressing. There could*

Researcher: **Does this mean there is not enough content knowledge?**

Nancy*:* *No, it is not enough.*

Researcher: **Have you put any software to add on the basic content that is already on the iBox or do you use it as it is?**

Nancy: *I use CDs to cover other topics that are not in the iBox.*

Researcher: What other resources do you use to supplement your teaching beside the chalkboard and the projectors?

Nancy: *Yes, I use textbooks, study guides, handouts we receive from the workshops and from other colleagues that we share information and network with.*

Researcher: Do you share information?

Nancy: *We share information with colleagues within the school and with other neighbouring schools.*

Researcher: Do you do team teaching?

Nancy: *We do team teaching, especially towards the examinations.*

Researcher: Why do you team teach?

Nancy: *Team teaching is an advantage in a sense that you can make use of another teacher who is more of an expert or more comfortable in particular topic than you. It is for the benefit of the learners.*

Researcher: On which part of the lesson do you use the iBox the most?

Nancy: *I use and advise other teachers to use the iBox at the beginning of the lesson because it captures learners' interest.*

Researcher: What have you learnt since you have started to use the iBox?

Nancy: *It has enabled me to cover all the work that I need to cover?*

Researcher: Have you gained any knowledge?

Nancy: It has made me more interested in using technology. Learners too help to assemble the iBox. It helps teachers and learners to work together and teaching has become more pleasant.

Researcher: Besides the use of technology, have you grown in any other way?

Nancy: *I have grown because the way it has been designed, they are logical. The lesson just flows and it provides questions and answers at the end of each lesson*

Researcher: **If marks have improved can you attribute it to the use of the iBox?**

Nancy: *Learners marks have improved in mathematics.*

Probing: **Can you attribute the improvement to the use of the iBox?**

Nancy: *Yes, because even the learners that had less interest in the subject are now participating when using the iBox*

More probing: What does that participation impacts on?

Nancy: *The participation improves the knowledge of the learners.*

Researcher: **Does the iBox have any future in your teaching?**

Nancy: *If anything could happen to this iBox our lives could be very miserable.*

Researcher: Thank you for your time.

Nancy: *Thank you.*

Transcript of interview with Bruno

Researcher: Good afternoon Bruno.

Bruno: *Good afternoon Maam.*

Researcher: Thank you for allowing me to have this interview. I observed that at the beginning of the lesson you did not use the iBox but you used the chalkboard. Was this deliberate?

Bruno: *Yes, I planned to start the lesson like that. I wanted to explain the aim and the outcome of the lesson. That is why I used the chalkboard.*

Researcher: Do you plan ahead to use the chalkboard or you decide when you are in the class?

Bruno: *I plan ahead when I am preparing for the lesson. I then decide which area I want the learners to focus on which then allows me to choose what is best suited to use for the lesson.*

Researcher: How do you choose which part of the lesson would be best suited for the iBox?

Bruno: *I consider the nature of the lesson. Some parts are easy to for learners to grasp; others require more clarification which is when I use the iBox. Sometimes the easier parts come with some misconceptions so I use the iBox to clear those misconceptions.*

Researcher: In terms of time management. How does the iBox help you?

Bruno: *Using the iBox is an added advantage because it offers more information for learners in a short space of time. You find that it would have taken you longer to give that information to learners.*

Researcher: Does the iBox have enough content knowledge?

Bruno: *It has limited information. Hence you have to supplement it with other tools/ resources.*

Researcher: Have you ever used any software to add to the basic content?

Bruno: *We have never added any software. At the training we were advised not to use other software but the one that came with the iBox. We have been cautious not to use anything else that might not be in line with what the DBE prescribed.*

Researcher: What other resources do you use to supplement your teaching?

Bruno: *I use the DVDs because the iBox can be used as a DVD player. I also use the PowerPoint presentations stored in my USB.*

Researcher: Do you share information with other teachers?

Bruno: *I share information with other teachers. I also make sure that other teachers are exposed to the iBox. Even when I have presentations in meetings I project information through the usage of the iBox.*

Researcher: Do you do team teaching? If so, how does it help?

Bruno: *Yes we do and it is helpful. Team teaching helps you learn more from your peers, and find out how they motivate their learners. It also helps to know the strengths and weaknesses of other teachers.*

Researcher: I realized that you moved around a lot at the beginning of your lesson, and as soon as you started using the iBox you stopped moving around and stood near the iBox. Why was that?

Bruno: *At the beginning I was explaining the outcome of the lesson. I did not move around when using the iBox because I wanted learners to concentrate on the DVD presentation and my movement would distract the learners' focus. I stood near the iBox so that I could pause it whenever needed to explain a concept.*

Researcher: What have you learnt since you started using the iBox?

Bruno: *Firstly it has enhanced my Mathematics knowledge, and helped enhance the content delivery to learners, and also improved my technology skills.*

Researcher: Has information/ knowledge been stagnant or growing?

Bruno: *It has grown.*

Researcher: Has information/ knowledge gained affected you teaching strategies?

Bruno: *I have learnt other teaching methods and have learnt different approaches to teaching from the DVD lessons facilitators on how to explaining concepts.*

Researcher: If the test marks of the learners have improved, can you attribute any of that improvement to the use of the iBox?

Bruno: *I have seen some improvement. Using the iBox has helped them to learn better by both hearing and seeing the visuals, which helps them to better grasp the concepts.*

Researcher: Does the iBox have any future in your teaching and learning?

Bruno: *Yes it does. I think we will need more than one iBox because some of my colleagues also use.*

Researcher: Will you still use the chalkboard for your teaching?

Bruno: Yes the chalkboard is necessary to be able to explain or give more clarity to learners by writing on the chalkboard.

Researcher: Thank you for your time.

Bruno: *Thank you Maam.*

Transcript of interview with Pat

Researcher: Good afternoon Pat

Pat: *Good afternoon Maam.*

Researcher: Thank you for having me in the lesson on Analytical Geometry Grade 10 where you looked at finding the difference between two points and you used the.iBox You revised Pythagoras by looking at the right-angled-triangle. You also revised the Cartesian plane, coodinates and plotting the points. I had an opportunity to come and I saw you using two books in the final preparation of your lesson. When do you plan to use the iBox? Do you plan to use the iBox at the beginning of the year or when you do your daily planning?

Pat: *It is not always easy to plan to use the iBox because in many instances we do not have electricity in our area. Also, there's only one iBox, sometimes you find that someone else is using it when you need it. So I always have to check if the iBox is available or not.*

Researcher: If the iBox is available, how do you choose which part of the lesson would be best suited for the iBox?

Pat: *It depends. Sometimes I use it just to generate interest from learners, sometimes I use it to deliver the content using the prepared lessons and other times I use it for revision and summary, pointing out the main points of a lesson especially in Grade 12.*

Researcher: Do you supplement the iBox?

Pat: *It depends on the topic. Sometimes I do not supplement it if the content knowledge is adequate. Other times if a topic needs different ways of explanation then I supplement the iBox with the chalkboard and hand-outs.*

Researcher: In terms of time management. How does the iBox help you?

Pat: *It has helped me cover a lot of content in a short space of time.*

Researcher: Does the iBox have enough content knowledge?

Pat *It depends on a particular topic. Other topics are well covered by the iBox, but others need more clarification and practice. That's when I supplement it. It has a lot of information. However, like any other technology, it has its limitations. And that's where you supplement it.*

Researcher: Have you ever used any software to add to the basic content?

Pat: *Yes we have installed geogebra.*

Researcher: What other resources do you use to supplement your teaching?

Pat: *The chalkboard and textbooks.*

Researcher: Do you share information with other teachers?

Pat: *I share information with both Mathematics and Non-Mathematics teachers to learn different teaching methods.*

Researcher: Do you do team teaching? If so, how does it help?

Pat: *Yes, when teaching Financial Maths, I work with Accounting and Economics colleagues. I do team teaching to get more practical examples.*

Researcher: How has the iBox helped you in this particular lesson?

Pat: *It has helped me with some aspects of the lesson which would have taken more time to explain if I was using the chalkboard. Like any other innovation the iBox has limitations, for instance you saw that the coordinates did not show the correct signs; therefore one must supplement it to give the learners the correct information.*

Researcher: What have you learnt since you started using the iBox?

Pat: *I was fascinated by the animations and the use of games when giving examples.*

Researcher: Do you think we can do away with the chalkboard?

Pat: *It can be done away with. I used the chalkboard because I noticed that it takes time to switch the programmes. With Geogebra one does not need the board.*

Researcher: What are you general experiences when using the iBox?

Pat: *The negative part is that staff needs more training on how to use the iBox. I cannot use the iBox competently because there are still other icons that I cannot use. The positive part is that is that there are animations and simulations that are practically use in industries that I use in Technology that make teaching and learning very easy.*

Researcher: Why did you not use the interactive whiteboard that comes with the iBox?

Pat: *I am not comfortable with its usage.*

Researcher: What knowledge have you gained with the iBox usage?

Pat: *With Technology the animations make the lesson practical. With the prepared Mathematics lesson, I found that they use examples that I never thought of.*

Researcher: What new strategies/teaching methods have you learnt?

Pat: *There are no new strategies that I have learnt.*

Researcher: Thank you for your time.

Pat: *Thank you Maam.*

Appendix G – Second interview transcripts

Interview transcript with Nancy

Researcher: In the questionnaire you mentioned that the iBox has a challenge of not switching on if it had been used, how often has this affected you?
Nancy: *It happened once and I was given an advice that after switching it off you need it a reasonable time for cooling off.*

Researcher: Are there any challenges with the accessibility of the iBox in the school?
Nancy: *We need more than one iBox as more teachers want to make use of it especially in a school like ours with a high number of learner enrolment.*

Researcher: How many other teachers are using the iBox?
Nancy: *About 10 teachers.*

Researcher: In your opinion why are other teachers not using the iBox?
Nancy: *Lack of knowledge about the value of the iBox. Another reason is that a few of us who knew about it did not share the information with others.*

Researcher: How many iBoxes do you think will be sufficient in your school?
Nancy: *At least four, each department having its own that will be controlled and monitored by each HOD.*

Researcher: What do you think would have happened if you were the one that was workshopped by the iBox suppliers?
Nancy: *I would present the value and the importance of the iBox to the SMT and then share information with all the teaching staff.*

Researcher: Now that you know how to use the iBox, have you trained other teachers since, and why?
Nancy: *Yes, to make teaching easy and improve the quality of teaching.*

Researcher: How often do you use the iBox?
Nancy: *Once a week.*

Researcher: What other resources do you use to prepare to teach?
Nancy: *Discs in laptops; overheard projector and chalkboard.*

Researcher: You mentioned that you did not try the whiteboard feature of the iBox. Why? Is it too difficult to use?
Nancy: *The use of the iBox was new to us and the teacher from our school, who got the training, was not thoroughly trained on the whiteboard feature.*

Researcher: Do you know of any teachers who are using the whiteboard feature?
Nancy: *Not a single teacher in our school uses a whiteboard feature.*

Researcher: Which topics have you covered using the iBox?
Nancy: *In all the topics in my subject.*

Researcher: Which topics would you say were good in the iBox? Have you seen any iBox lessons that were not useful?
Nancy: *In Trigonometric graphs and Statistics.*

Researcher: You mentioned that the iBox helps you to save time, how so?
Nancy: *Every information and tool is in the iBox and it is easy to pause and make explanations and also allows learners to take salient points.*

Researcher: During the observed lesson I noticed that you kept on adding more than what was on the slides. Why did you do that?
Nancy: *I wanted to make lessons more practical by citing examples with which learners are familiar.*

Researcher: Did you plan beforehand to add on or it happened as the lesson progressed?
Nancy: *It happened as the lesson progressed and was aimed to give clarity.*

Researcher: The introduction was done on the chalkboard using own example and not something on the iBox lesson. Why?
Nancy: *To test prior knowledge and also to give a background to the new lesson something not covered in the iBox.*

Researcher: How did this introduction affect the lesson?
Nancy: *It made the lesson to be longer.*

Researcher: I observed that some of the activities you let learners do on their own and some were tackled as discussion during the lesson, why did you do that?
Nancy: *My belief is that Maths is practical subject in which learners must be engaged all the time.*

Researcher: What was/were the objective(s) of the lesson?
Nancy: *To teach learners important concepts in Statistics.*

Researcher: How did the iBox lesson help you to achieve the objective?
Nancy: *The iBox made it clearer and easier for learners to grasp the intended objectives of the lesson*.

Researcher: I observed that you let learners do some of the activities on their own and some as a class exercise. Why?
Nancy: *To check the level of understanding of the learners in the lesson taught. It also kept the learners actively involved in their own learning.*

Researcher: There was a time when you engaged learners into solving for x when this was not the objective of the lesson. Why did you let that happen?
Nancy: *To check on learners' prior knowledge.*

Researcher: At some stage you said a number was 16.5 when it was actually 106.15 and the learners corrected you. What did you make out of this?
Nancy: *This was an indication that learners were glued and following every step of the lesson.*

Researcher: If you have to teach the same lesson again, would you teach it the same way, and why?
Nancy: *No, because this was my first year experience using an iBox. There is always room for improvement.*

Researcher: In the previous interview you mentioned that you share information. What kind of information do you share? And who do you share it with?
Nancy: *The type of information for which we can use the iBox. I share this information with the colleague with whom we teach the subject.*

Researcher: Have you found any mistakes from the iBox/DVD lessons?
Nancy: *Yes, answers on the multiple choice not correct.*

Researcher: What suggestions would you give to improve the iBox lessons?
Nancy: *Information must be regularly updated.*

Researcher: What can you say about the benefit offered by the iBox in disadvantaged schools with crowded classes and poor resources?
Nancy: *Learners even in disadvantaged schools get much interested in technology rather than listening to the voice of the teacher. Furthermore, it makes the job of the teacher much easier.*

Researcher: Thank you again for having me.
Nancy: *Thank you.*

Interview transcript with Bruno

Researcher: In the questionnaire you mentioned that the iBox has a sound challenge, how often had this affected you?

Bruno: *Almost all the time when I use it in big classes.*

Researcher: Are there any challenges with the accessibility of the iBox in the school?
Bruno: *Yes, there is only one iBox so if I have planned to use it and another teacher also wants to use it, it becomes a problem.*

Researcher: How many other teachers are using the iBox?
Bruno: *Six other teaches.*

Researcher: In your opinion why are other teachers not using the iBox?
Bruno: *As the iBox is a computer, some teachers are computer illiterate.*

Researcher: How many iBoxes do you think will be sufficient in your school?
Bruno: *At least three will be enough.*

Researcher: What do you think would have happened if you were not the one that was not workshoped by the suppliers?
Bruno: *It would not have been used by teachers outside the mathematics and science department because these teachers claim most tools to be theirs.*

Researcher: Besides the first training that you offered to your colleagues after the initial workshop, have you trained other teachers since, and why?
Bruno: *Yes, I train newly appointed teachers.*

Researcher: How often do you use the iBox?
Bruno: *A plan is that I use it to introduce a new topic and after every chapter.*

Researcher: What other resources do you use to prepare to teach?
Bruno: *Charts, iBox prepared lessons and textbooks.*

Researcher: You mentioned that you did not try the whiteboard feature of the iBOx. Why? Is it too difficult to use? Do you know of any teachers who are using this feature?
Bruno: *At the moment I do not know how to use it but I just need to find time master it.*

Researcher: Which topics have you covered using the iBox?
Bruno: *Sequences, functions, trigonometry and probability.*

Researcher: Which topics would you say were good in the iBox?
Bruno: *Functions.*

Researcher: Have you seen any iBox lessons that were not useful?
Bruno: *Transformation geometry since it is no longer taught.*

Researcher: You mentioned that the iBox helps you to save time, how so?
Bruno: *When using a DVD or any iBox prepared lesson they have drawings and pictures therefore less time is taken to teach a lesson. Sometimes I let learners watch a lesson undisturbed, I then consolidate on the work that they have already visualised.*

Researcher: During the observed lesson I noticed that you paused the DVD lesson. Why did you do that?
Bruno: *I normally know the parts which become a challenge to learners and I then clarify those.*

Researcher: Did you plan beforehand to pause or it happened as the lesson progressed?
Bruno: *I planned beforehand.*

Researcher: Why did you do the activity before opening the DVD lesson? Was this not covered by the DVD lesson?
Bruno: *It was covered but I wanted to introduce the lesson myself before learners could watch a DVD.*

Researcher: How did this introduction affect the lesson?
Bruno: *It was easy for learners to follow and grasp the information because I had highlighted some concepts in my introduction.*

Researcher: I observed that you never asked the learners to do any activity during the lesson, why?
Bruno: *It was a revision lesson so I wanted learners to just watch then understand where they went wrong and we did the activities together.*

Researcher: What was/were the objective(s) of the lesson?
Bruno: *Revision and clarity of misconceptions on how to draw the line of best fit and to calculate the equation thereof.*

Researcher: How did the DVD lesson help you to achieve the objectives?
Bruno: *It helped to cover a lot of work in a short space of time. As the iBox is a technological tool, learners become more interested in the lesson and they pay more attention.*

Researcher: Why did you pause the DVD lesson after the facilitator gave the overview of the lesson?

Bruno: *I wanted to check if learners have grasped what was outlined.*

Researcher: Why did you highlight the outlier issue? From your experience, what have you noticed about learners' understanding of outliers?

Bruno: *There is a lot of misconception and confusion in terms of the outlier.*

Researcher: I observed that you interrupted the lesson when the facilitator mentioned that the lesson is going to find the equation of the line of best fit, why did you do this?

Bruno: *Some learners came to me saying they have a problem with finding the equation of the line of best fit and had their own understanding. I wanted to iron out that issue.*

Researcher: There was a time when a learner asked 'what happens when there is only one point on the line of best fit, if one has to find the equation for the line'. What did you make out of this?

Bruno: *In this case a learner was not clear about a concept. The learner had some information on finding the equation of a line of best fit but was confused because the he (it was a boy) was not clear on how to draw the line of best fit.*

Researcher: Why did you let the learners join in the conversation? How does it help your lesson when you allow the learners to lead the direction of the discussion?

Bruno: *If some learners have a better understanding of concepts, I make share with the class. It becomes easy for other learners to understand their peer because they question him/her according to their level.*

Researcher: If you have to teach the same lesson again, would you teach it the same way, and why?

Bruno: *Yes I would teach it the same way but improve in some aspects because 90% of the learners performed well in the next test.*

Researcher: In the previous interview you mentioned that you share information. What kind of information do you share? And who do you share it with?

Bruno: *The mathematics content knowledge is shared with teachers in the school, neighbouring schools and AMESA friends. I share the iBox information with all teachers in the school through relevant HOD's.*

Researcher: Have you found any mistakes from the iBox/DVD lessons?

Bruno: *Never.*

Researcher: What suggestions would you give to improve the iBox lessons?

Bruno: *1) Improve the volume of the speakers*
2) Content knowledge to be upgraded regularly
3) Interactive board training to be done.

Researcher: What can you say about the benefit offered by the iBox in disadvantaged schools with crowded classes and poor resources?

Bruno: *1) Poor resourced schools could use it as a DVD player*
2) Have more activities/lessons to be projected if they have a shortage of books or facilities to make copies
3) If there is a shortage of teachers, learners could even view lessons on their own without any facilitation by a teacher.

Interview transcript with Pat

Researcher: You mentioned in the previous interview that sometimes you cannot use the iBox because other colleagues are using it or there is no electricity in the area. How often has this occurred?

Pat: *With electricity, it happens every week. Cable theft (I am told) is very common in the area. With other colleagues using, it is not often, it is just that there is no roster that is followed.*

Researcher: How many other teachers are using the iBox in the school?

Pat: *3 teachers.*

Researcher: How many iBoxes do you think will be sufficient in you school?

Pat: *3 or 4 ideally, one iBox per teacher as a classroom tool.*

Researcher: In your opinion, why are other teachers not using the iBox?

Pat: *There is a notion that the iBox is for the mathematics and science teachers, but some teachers are not comfortable with it especially in front of the learners.*

Researcher: If you were to have another opportunity to be trained to use the iBox, what would you like the facilitator to focus on?

Pat: *Focus on the use of the IWB. With the presentations that I normally make, I just stand. I would like to move around whilst using the iBox*.

Researcher: Do you think it would have been better if you were the one who was initially trained by the supplier to use the iBox and in what way?

Pat: *I was happy with the lady who workshopped us, but a quick follow-up would have been better.*

Researcher: How often do you use the iBox?

Pat: *I use it every week. I practise a day before going to class and prepare thoroughly to see what is in the iBox lesson and what is not in the iBox lesson.*

Researcher: Which topics have you taught using the iBox?

Pat: *For revision, I have used the iBox for all topics. For teaching and for lesson preparation, I have used it in interpolation, extrapolation, cyclic quadrilateral, and financial mathematics*

Researcher: In your opinion which topics would you say are best covered in the iBox or are good?

Pat: *There is good coverage in financial mathematics but there is not enough coverage in cyclic quadrilaterals.*

Researcher: I noticed on the day of lesson observation that when you had opened a slide you continued to use your own explanation, why did you do that?

Pat: *The iBox is a supplementary item; it is not the main tool that is delivering the lesson.*

Researcher: In the lesson that you taught, the lesson on the distance between two points, even before you opened the iBox you let the learners draw the right-angled triangle and then state the theorem of Pythagoras, why did you do that?

Pat: *I wanted to check and revise the theorem of Pythagoras i.e. check previous knowledge and remind learners of it.*

(Probing): Did the iBox lesson go over the Theorem?

Pat: *Yes it did but it just highlighted a few points.*

Researcher: Why did you spend a lot of time on discussing the naming of angles and sides of a triangle?

Pat: *I was giving totality; it was also a revision of previous work.*

Researcher: How did the iBox help you to achieve the objective of your lesson?

Pat: *I am glad I did that revision, however it prolonged the lesson as a result of that the lesson took longer than I anticipated.*

(Probing): Did that help you to achieve the objective/s of the lesson?

Pat: *I think it did, but should have done the revision lesson (all GET work) on its own.*

(Probing): Did the iBox help you to put everything in one lesson?

Pat: *The iBox helped with the motivation not so much the content.*

Researcher: You also spent a lot of time explaining the relationship between sides and angles. Why did you do this?

Pat: *I was just revisiting, giving a flashback of what I taught earlier, showing the learners a link with Trigonometry which is a different section in mathematics*

Researcher: Some of the activities that you used were from the iBox lesson and some were not, were this deliberate or planned?

Pat: *The iBox was used to augment what I normally do or to broaden the knowledge that they already have.*

Researcher: One activity that you used from the iBox lesson was the one where the points were plotted on the Cartesian plane and learners had to give the coordinates of those points and you did not use the exact question asked from the activity? Why did you do this?

Pat: *Drawing the Cartesian plane on the chalkboard takes a long time, the iBox activity had points already plotted therefore convenient to use.*

Researcher: The answers provided by the iBox lesson for a particular activity had mistakes, how common is this?

Pat: *It is not common but I have seen another mistake in a data handling lesson. Learners were asked to draw a histogram but, for me, the information provided would enable learners to draw a bar graph maybe that was just an autographic error.*

Researcher: Another iBox lesson activity you used had points plotted but you gave your learners graph paper sheets to plot the points after having drawn a Cartesian plane. Why did you do this?

Pat: *I wanted to consolidate the concept of the Cartesian plane. Remember, learners were confusing the x and a y value, therefore more practice was necessary even though this was a GET aspect. I had anticipated the confusion, from experience of course.*

(Probing): Do you think this misconception was corrected?

Pat: *Yes, to a large majority of the learners.*

(More probing): How do you limit or avoid misconceptions, as you say you had anticipated the confusion?

Pat: *More emphasis and follow-up is needed I do follow-up lessons*

Researcher: After plotting the points on the Cartesian plane, you asked the learners to count spaces between the points. (probing. Was this new knowledge?

Pat: *No it was not.*

Researcher: The number of spaces between -1 and +2 was three but some learners said four. Do you have an idea why the learners gave such an answer?

Pat: *A possible answer is that their plotting could be wrong, for some of the learners.*

More probing: You checked some of the answers and not all of them, why?

Pat: *I would spend a lot of time if I had to check all the answers.*

Researcher: In the questionnaire and in the previous interview you said the iBox helps you to save time. Do you have examples of lessons where this is evident?

Pat: *The iBox shortens the lesson because it goes straight to the point. Data handling ogive, histrograms, scatter plots.*

Researcher: There was a text book and a lesson plan in class. Why were they there?

Pat: *The text book that was there was the one that I was using for research or preparation.*

Researcher: Do learners in your class have textbooks?

Pat: *Learners share textbooks because they lose them and the numbers of learners in different years vary and in some years the school orders different kinds of books.*

Researcher: In the first interview you said you have Geogebra software installed in you iBox. Do you think it would make a big difference if you had used Geogebra?

Pat: *There was going to be a big difference because drawings would be drawn quicker but I have a limitation of not being able to use it. Fortunately I have been offered an opportunity to learn about Geogebra at MUT.*

Researcher: In the previous interview you said you share information. With whom and what type of information do you share?

Pat: *With the maths GET teacher. With other non-maths teachers I share information in team teaching and we collaborate a lot.*

Researcher: Earlier you said the chalkboard can be done away with. How is this possible?

Pat: *There are tools that we are unable to use. If we knew how to use them there would be no desire to use the chalkboard.*

Researcher: In your opinion, is there a way in which the iBox lessons could be improved?

Pat: *More editing is needed to make content more accurate and be in line with the new syllabus. Animations could be included e.g. in theorems*

Appendix H – Certificate of Editing

Angela Bryan & Associates

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Plantations

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Date: 15 October 2015

To whom it may concern

This is to certify that the Thesis: Exploring the use of the iBox when teaching mathematics in selected KwaZulu-Natal Secondary Schools written by S. T. Mthembu has been edited by me for language.

Currently an English teacher at a private Secondary school, Angela has a Bachelor's degree specialising in English and Psychology. Her clients include academics from a number of universities, some of which are UKZN, Medical School, Rhodes and NWU. She has edited numerous articles for oversea publications including several translations from foreign languages.

Please contact me should you require any further information.

Kind Regards

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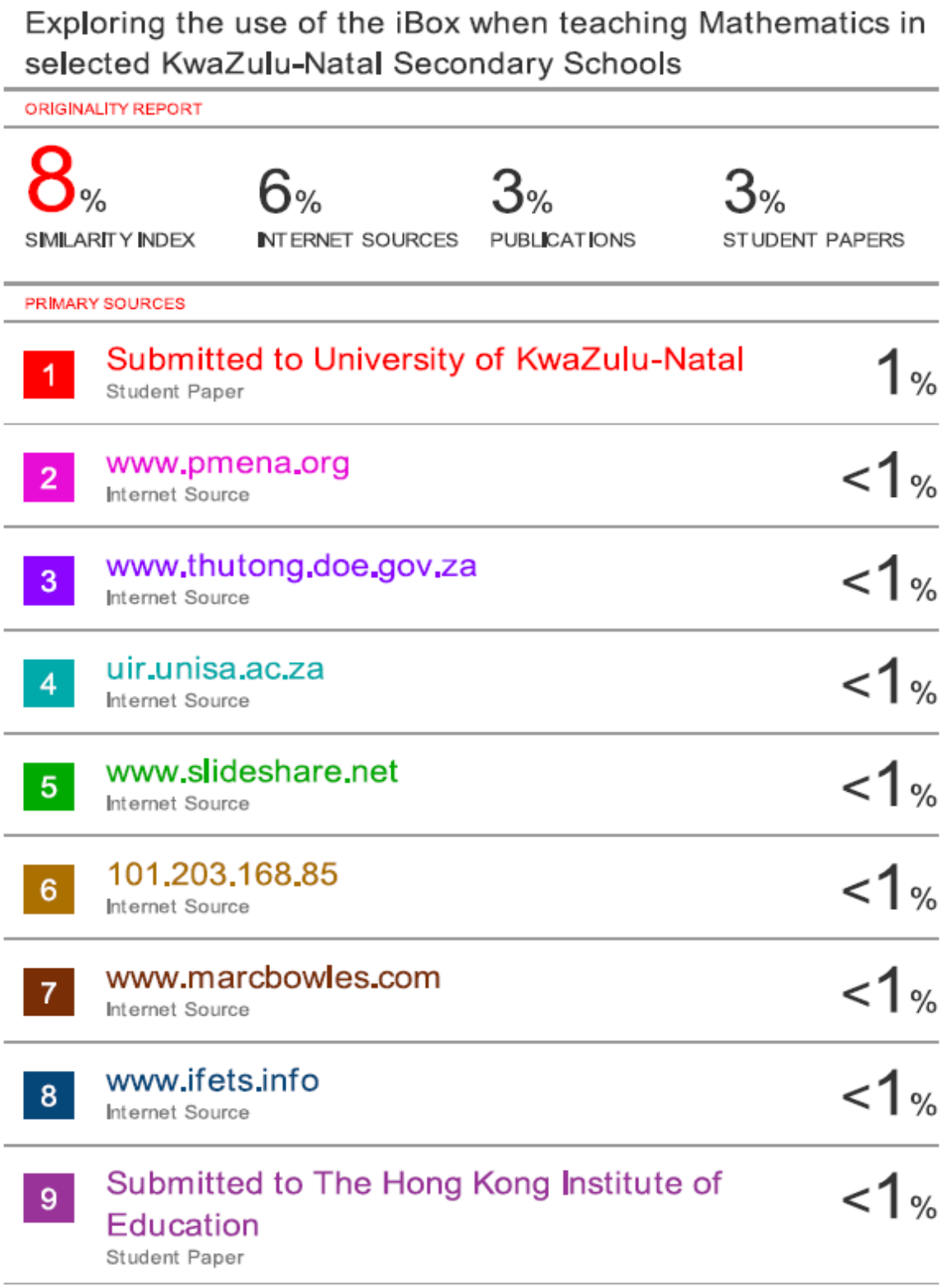
Appendix I - Turnitin Originality Report



Exploring the use of the iBox when teaching Mathematics in selected KwaZulu-Natal Secondary Schools

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