THE EFFECT OF USING COMPUTERS FOR THE TEACHING AND LEARNING OF MATHEMATICS TO GRADE 10 LEARNERS AT SECONDARY SCHOOL

by

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DECLARATION

Student number: 44496362

I declare that: **THE EFFECT OF USING COMPUTERS FOR THE TEACHING AND LEARNING OF MATHEMATICS TO GRADE 10 LEARNERS AT SECONDARY SCHOOL** has not been previously submitted by me for a degree at this or any other university, that is my own work in design and execution, and all the resources that I have used or quoted have been indicated and duly acknowledged by means of complete references

25 August 2015

Signature   Date

Ramaesela Jerminah Khobo

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ABSTRACT

Over the past several decades there has been an emphasis on educational research pertaining to learners' performance in Mathematics and on finding methods to improve learner performance in this subject. In South Africa, Grade 12 learners' results in Mathematics from 2010 to 2013 were unsatisfactory as shown in DBE, 2013a. The teachers are challenged to find new teaching methods that will make the subject more interesting and appealing to the learners (Oliver & Makar, 2010 in Goos, 2010).

The purpose of this study was to investigate the effect of using computers in the teaching and learning of Mathematics with special reference to the topic of linear functions in order to improve learner performance. The literature reviewed shows that the use of computers not only improves the learners' performance but also changes their attitude towards Mathematics (Bester & Brand, 2013).

The quantitative research approach was used to gather the data, namely the quasi-experimental, non-equivalent control group pre-test-post-test design. Two intact classes formed part of the research study, that is an experimental group (n=50) and control group (n=50). The experimental group learnt the concept of linear function using GeoGebra software. The control group learnt the same concept through the traditional pen and paper method.

The data were analysed using the SPSS on ANOVA. The results indicated that there was a significant difference between the mean scores of the experimental group (μ=70.5) and the control group (μ=47.5). From the results it was evident that the use of computers had a positive effect on learners understanding of linear functions as reflected in their performance and on their attitude towards Mathematics, as seen in the questionnaire responses.

KEY WORDS

Computers, School Mathematics, Linear functions and Learner attitude

LIST OF ACRONYMS

- ANA Annual National Assessment
- ANOVA Analysis of Variance
- CAPS Curriculum and Assessment Policy Statement
- CVI Content Validity Index
- DBE Department of Basic Education
- DoE Department of Education
- FET Further Education and Training
- GDE Gauteng Department of Education
- GET General Education and Training
- HSRC Human Science Research Council
- ICT Information and Communication Technology
- IT Information Technology
- NCS National Curriculum Statement
- NCTM National Council for Teachers of Mathematics
- OBE Outcomes Based Education
- SPSS Statistical Package for the Social Sciences
- TIMSS Trends in International Mathematics and Science Study

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CHAPTER 1

BACKGROUND AND OVERVIEW OF THE STUDY

1.1 Introduction and background to the study

At the beginning of the twenty first century technology emerged as an integral part of our daily lives as well as part of the education landscape. It has changed how things were done previously (Guerrero, 2010). As a result schools are being challenged to use technology in order to change learners' perception that Mathematics is only for a certain group of people. The approach used by teachers of being knowledge transmitters and textbook-bound led to the learners building a negative attitude towards Mathematics.

Demir (2011) highlights that it is important to integrate technology in the teaching of Mathematics and science. Some of the Mathematics teachers are discouraged by poor performance of their learners and they leave the profession. The teachers' lack of content knowledge is another factor that contributes to poor learner performance in Mathematics, as has emerged at the symposium on Mathematics and Physical Science Grade 12 results 2010, held at UNISA on 22 February 2011(Nel, 2015). The teachers tend to learn the content from the textbook and teach learners content without any comprehension of the work. The learners agree that it is exciting and enjoyable to use computers in Mathematics classroom, and their performance improves (De Souza, 2005). The country has a shortage of skilled Mathematics teacher. It is this challenge of poor performance of leaners in Mathematics that prompted this study.

This study investigates the effect of using computers in the teaching and learning of Mathematics with specific focus on the topic of linear functions. During the researcher‘s experience of teaching Mathematics she observed that the learners struggle with the simple computation and manipulation of formulae. When the learners learn linear function in algebra, it is a challenge for them to determine the value of the dependent variable, appropriate scale for drawing graphs and the drawing of the graph. They spend more time on trying to determine the value of the x-intercept, gradient and y-intercept, thereafter they take some time drawing the graph using the table method of substitution. According to Johnston-Wilder and Pimm (2005), the use of computers could assist learners in computation and thus reduce the time spent on one equation not only on functions but on geometry, trigonometry and data handling. The learners also learn from computer-feedback, observe pattern, see connection, work with images, explore data and explain to their teachers and their peers.

The results available in the “Trends in International Mathematics Science Study” (TIMSS) indicate that learners from homes that have extensive educational resources have higher achievement scores than those learners from disadvantaged backgrounds. In Reddy’s opinion (2006), learners in South Africa enjoy and value Mathematics, but their performance is still very poor. Township schools have a shortage of resources for effective teaching and learning, for example, computers for teaching Mathematics, computer software for Mathematics instruction, calculators and library material for Mathematics. Countries like Singapore have high availability of quality resources, and their learners’ performance in Mathematics is very high, as indicated in the TIMSS 2003 (Reddy, 2006).

According to the TIMSS, many studies have been conducted to identify the problems pertaining to the poor performance of learners in Mathematics (Ndlovu & Mji 2012; Reddy, van der Berg, Janse van Rensburg & Taylor, 2012) with the emphasis on the teaching and learning of Mathematics in South Africa. The findings indicate that there is a need to rescue the situation in South Africa, because the results show that in future fewer learners will graduate from the school system with results in Mathematics that are good enough to permit them to tertiary studies in the Science and Engineering fields, among others, as these fields of science and engineering are least to be chosen. Ogbonnaya (2010) points out that the use of computers improves learners’ attitude towards Mathematics, and consequently improves their performance in that subject.

Having introduced the study and discussed the background, the next section presents the problem statement.

1.2 Statement of the problem

South Africa was one of the lowest performing countries in Mathematics with an average scale score of 352 out of 550. It was below average when compared to the international Mathematics average scale score of 550(HSRC, 2011). Most countries participated at Grade 8-level but, South Africa participated at Grade 9-level. South Korea was the country that scored the highest with an average scale of 613 on TIMSS results of 2011 (Reddy, 2006). The problem of the low performance by learners of Mathematics in the country is evident in the Annual National Assessment (ANA), where Grade 9 learners obtained an average percentage of 13% in 2012, and an average of 14% in 2013. In addition, only 2% of the total number of learners who wrote the ANA achieved at least 50% and above in 2012 and in 2013 on Department of Basic Education, ANA results (DBE, 2013b). Moreover, the Grade 12 Mathematics results are also a major concern, since the pass rate at 40% is considered as poor performance (DBE, 2013a). Table 1.1 below indicates the overall achievement in the past four years of Grade 12 learners.

Table 1.1: *Overall achievements rates for Mathematics Grade 12 (DBE, 2013, p. 126)*

Year	**Number of learners**	**Number of learners who achieved below 30% (from 0% to 29%)**	**% achieved at 40% (from 30% to 39%)**	**Number of learners achieved at 40% and above (from 40% to 49%)**	**% achieved 40% (from 40% to 49%)**
2010	**263 034**	**127 785**	**48.6%**	**81 473**	**31%**
2011	**224 635**	**106 327**	**47.3%**	**61 592**	**27.4%**
2012	**225 874**	**121 970**	**53.9%**	**80 716**	**35.7%**
2013	**241 509**	**142 666**	**59.0%**	**97 790**	**40.4%**

According to Table 1.1, There has been an increase in learners 'performance from the year 2010 to 2013 from 0% to 49%, but most learners still performed below 50%. This is a major concern for the National Department of Basic Education. In the National Diagnostic report (DBE, 2013a) it was indicated that learners were unable to plot points accurately on the Cartesian plane. In addition, the learners could not determine the coordinates, read the coordinates from graphs and find the equation of a linear graph.

(http://www.education.gov.za/linkclick.aspx?fileticket=gvgGNIRG001%3d&tabid=358&mid=1325, Accessed 25 September 2014).

The representation of function is fundamental to Mathematics. A function is represented by a written statement, an algebraic equation, table of input and output or a graph. Research shows that the connections made between these concepts are weak or non-existent, since learners view each concept as independent. Furthermore, they fail to connect graphs with the real world (Maree, Scholtz, Botha & van Putten, 2005). Learners need to understand the characteristics of functions, since the focus is on discovering the properties of linear functions (Sasman, Lienbenberg, Oliver, Linchevski, Lukhele & Lambrechts, 1999).

The current study emphasizes the learning of linear function and the accuracy of drawing graphs. Therefore, effective learning in this digital age requires the integration of technological tools in teaching, because technology allows learners to be accurate and develop critical and analytical thinking (Starkey, 2012; Lewis, 2013). Every South African learner in the General and Further Education Training band should be able to use Information Communication Technology (ICT) with confidence and creativity. This will assist them in developing the potential and knowledge that they need in order to achieve their personal goals and to be full participants nationally and internationally (Hoyles & Langrange, 2008). From the above, it is evident that the effective use of computers in the classrooms is encouraged.

Consequently there is a need to change the methods employed in the teaching and learning of Mathematics. The poor performance of learners in Mathematics when learning linear functions prompted the current study. The researcher sought to explore the use of computers, in particular GeoGebra software, as an intervention in the teaching and learning of Mathematics to improve the learner performance in the learning of linear functions. The purpose of the study follows in the next section.

1.3 The purpose of the study

The primary purpose of this empirical study was to investigate the effect of using computers in the teaching and learning of Mathematics, in particular on the topic of linear functions to learner performance. Despite the DBE investing in and supporting the use of technology for curriculum purposes in the Gauteng Province, including the Gauteng on-line programme and the recent programme on e-learning whereby handheld tablets were provided to schools for teaching and learning, there appears to be reluctance on the part of the teachers to the use of these resources for teaching and learning.

1.4 The research questions

In order to collect data relevant to the purpose of this study, the following questions were posed:

- How can the use of computers in the teaching and learning of linear functions in Mathematics affect learner performance?

  In order to answer the above question statistically using quantitative approach, this sub question was asked.

  - Is there a significant difference between the performance of learners who use computers and those who do not use computers for learning linear functions in Mathematics?
- How can the use of computers in the teaching and learning of Mathematics on linear functions affect the attitudes of learners towards the subject?

1.5 The significance and motivation of the study

The study was primarily inspired by the need to find an alternative approach of teaching Mathematics to improve learners' performance. The availability of computers in the school where the researcher intends to do the study, also contributed to the need of conducting this study. According to Guerrero (2010) and Govender (2007), computers make content easy to learn. Previous researches showed that the effective use of computers results in good learner performance in Mathematics (Rowan & Bigum 2012; van Hoorn, Scales, Nourot & Alward, 2010). These researchers' findings motivated the study.

In South Africa most learners performed below 50% in Mathematics (2010- 2013) as shown in Table1.1. This performance shows that there is a need to change the way Mathematics is taught. The diagnostic analysis of the results in 2013 showed that, learners still struggle with the plotting of linear graphs and finding the equation (DBE, 2013a). Mavhungu (2013) investigated the use of computers in the teaching and learning of hyperbolic graphs and her results showed that the use of computers was beneficial to leaners when drawing graphs. In addition, IIhan (2013) stated that learners appreciated the change of graphs on linear function and visualization of the concepts when using GeoGebra software. Furthermore, the study by Eyyam and Yaratan (2014) on the impact of using technology in Mathematics lesson to learners' achievement and attitude showed that the use of technology does not have impact on learners' success only but also on their attitude towards the subject.

The purpose of this study was to investigate the effect of using computers in the teaching and learning of Mathematics, in particular on the topic of linear functions. The effect was investigated in regards to learners' performance and their attitude towards the subject.

The findings of this study were significant in adding to the body of knowledge. The study contributed in adding another dimension to the literature in Mathematics education on the effect of using computers for teaching Mathematics to learners' performance and their attitude, specifically on the topic of linear function. Moreover, the topic of linear function is the foundation of all graphing concepts. There are not many technology- related studies on Mathematics in particular on linear functions. Schoemaker (2013) also argue that there are little researches on the effect of technology to learners' performance.

People who will benefit from this study are the parents, learners and teachers. The parents will enjoy seeing the performance of their children in the topic of linear function improving when they use computers for learning. Learners will develop a positive attitude to the subject as they see their performance improving when using computers. Teachers' work will be simplified because, they will no longer have to draw many graphs to show the effect on the graph when the value of the gradient is negative or positive.

1.6 Definitions of the terms

1.6.1 Computers

The concept of a computer refers to a machine that process information according to a set of instructions (Newby, Stepich, Lehman, Russell & Ottenbreit- Leftwich, 2011). In the current study the computer is used as a tool for teaching and learning of Mathematics, in particular the GeoGebra software.

1.6.2 School Mathematics

The term Mathematics refers to the study of numbers, equations, functions, geometric shapes and their relationships (Tapson, 1999).

In this study Mathematics is a school subject that will be used for learning and teaching linear functions.

1.6.3 Linear function

A linear function is any function that graphs to a straight line; the function has either one or two variables without exponents. A function of f is linear if it can be expressed in the form$f(x) = mx + b$, where m and b are constant and $f(x)$ is the dependent variable (Tapson, 1999). In this study the concept of linear function is taught using GeoGebra software. This software will allow the learners to draw graphs and to find properties of graphs and functions.

1.6.4 Learner attitude

An attitude is someone‘s opinion or feeling about something (Rundell, 2002).

In this study attitude refers to an opinion or feeling that learners indicates on Likert-type opinion statement. Learners were asked to state their level of agreement on the questionnaire, after using computers for the learning of linear functions in Mathematics.

1.7 Research methodology

This study employed quantitative research approach, and the focus was on a quasi-experimental research design. The pre-test and the post-test are administered to measure the performance of the learners. A questionnaire was used to measure the attitude of the learners towards Mathematics. The results were analysed using the SPSS ANOVA and descriptive statistics. The study used intact classes, meaning all the learners in that class would be involved in the study. Two groups, that is the experimental group and the control group were used as participants. The experimental group used computers in the learning of Mathematics, whereas the control group used the traditional method of pen and paper.

1.8 Delimitations of the study

This study was confined to two classes of learners who study Mathematics as a subject in specific school in Ekurhuleni North District that has access to the use of computers in the teaching and learning of Mathematics.

1.9 Assumptions

This study assumed that:

The learners are computer-literate as they have a period allocated to computer studies on their time tables.

The learners who would be involved in the study would be willing and co-operative to participate in the study.

1.10 Brief chapter overview

Chapter 1 provided an introduction and background of the study. In addition, it gave the statement of the problem to be investigated, the purpose of the study and the research question that needs to be answered by this research.

Chapter 2 focused on a review of literature with regards to the role of technology in the teaching of Mathematics, and also the theoretical framework of the study.

Chapter 3 highlighted the research methodology, the instrument, the population and the sample of the study. Additionally, issues related to validity, reliability and ethical consideration were also discussed in this section of the study.

Chapter 4 dealt with detailed analysis and interpretation of the results.

In Chapter 5 the researcher discussed the results of the study in relation to the research question and the theoretical framework, and the conclusion that were reached. The limitations and recommendations for future research were highlighted in this section of the study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The purpose of this chapter is to present the literature on concepts or issues related to the effect of using computers as technological tool for teaching and learning of Mathematics, as well as literature pertaining to the learners' performance in this subject. Additionally, a literature review for this study focuses on aspects related to the academic concepts which are relevant to the teaching and learning of Mathematics using computers.

Educational researchers, both nationally and internationally, have debated on how Mathematics could best be taught to improve learners' performance, and to make the subject more appealing to learners (Barkartsas, Kasimatis & Gialamas 2009; Li & Ma 2010; Biyela, 2008). Generally, learners find that Mathematics is a subject that is difficult to learn (Centre for Development and Enterprise (CDE), 2004). According to CDE, this difficulty maybe due to the way Mathematics is taught.

South Africa's poor performance of learners in Mathematics maybe due to the outdate teaching practices and teachers' lack of basic content knowledge of the subject. Moreover learners who obtain good marks in Mathematics in Grade 12 do not choose teaching as a career (Mji & Makgato, 2006). The situation needs to be addressed by finding an alternative method of teaching that could attract learners to study Mathematics, and create a more positive attitude.

The dilemma of the poor performance of the learners encourages the researcher to investigate how Mathematics is being taught, as well as to search literature to establish what other researchers have found out about the issue of the poor performance in Mathematics by the learners, and how the performance could be improved. Theories and keynotes on the teaching and learning of Mathematics, the learners 'performance in Mathematics, the role of computers in the teaching and learning of Mathematics and learners' attitude towards the subject will be discussed in this chapter. The researcher is keen to learn what may really change the learners' performance.

2.2 Technology in the teaching and learning of Mathematics

The literature indicates that the use of technology for teaching and learning not only improves learners' performance but it also boosts their confidence, motivation and develops positive attitudes (Andrade-Arechiga, Lopez & Lopez-Morteo, 2012) The teachers are also continually growing as professionals, with adequate pedagogical content knowledge and highly engaging Mathematics activities (Bester & Brand, 2013). The curriculum is mathematically rich with assessment done on computers, offering learners the opportunity to learn important Mathematical concepts and procedures with understanding (Rowan & Bigum, 2012).

2.2.1 The role of technology in the teaching and learning of Mathematics

The current study focuses on the use of the computer as a technological tool for the teaching and learning of Mathematics. The role of computers in Mathematics enhances efficiency, problem solving, decision making, communication and research (Mkomange, Ilembo & Ajagbe, 2012). In addition, technology supports learners' understanding and appreciation of Mathematics. This is relevant as it is emphasized in the Curriculum on Assessment Policy Statement (CAPS in DBE, 2011a).

Chawla and Mittal (2013) argues that technology has become an important tool for learning Mathematics as it may be used to improve and promote the learning of Mathematics. This is also stressed in the National Council of Teachers of Mathematics (NCTM, 2000) in its standard, by indicating that technology can facilitate problem solving, communication and reasoning in Mathematics. Unlike (Mkomange et al, 2010) the emphasis by Chawla and Mittal (2013) is on the idea that learners can incorporate Mathematics that is taught in the classroom in the real world. Initially the use of technology when studying Mathematics was seen as a means to finding solutions. Now the role of technology is seen as an agent of change from time-consuming routines to in-depth understanding Chawla and Mittal (2013). They further indicate that if technology is used to improve the learning of Mathematics at all levels, the learners will be better prepared to use technology appropriately, confidently and effectively.

The emphasis on the use of technology in the Mathematics curricula has mostly favoured experimentation with innovative software tools, purposefully designed and implemented to assist Mathematical learning and to advance mathematical thinking (Chronaki & Matos, 2013). In addition, although such influential research was conducted, the integration of technology in the Mathematics classrooms remains a huge challenge. Computers take learners from innovation to activity and from boredom to creativity. (Chronaki & Matos, 2013)

When using computers the learners become researchers, motivated, interested, engaged, active and collaborative in the subject of Mathematics. The use of computers encourages constructivist theory of learning. The teachers are no longer the transmitters of knowledge, but facilitators of knowledge. Technology becomes the teacher's partner in teaching and planning of each lesson. Its appeal to the learners is that it has the potential to change the Mathematical classroom culture into a talkative and positive place of learning. Computers have the capacity to win back learners in Mathematics, while teachers celebrate its visual, interactive and attractive capacity (Yerushalmy & Swidan, 2011). This study seeks to find a way to change how Mathematics can be taught using technology. The discussion of the literature in this chapter shows that computers can influence the learning of Mathematics in a positive way.

The advantage of using technology is that learners become interested in the learning of Mathematics. Moreover, it reduces learning time and provides the learners with the opportunity to learn using modern methods. Sometimes learners' knowledge of technology supersedes that of the teacher. Some teachers feel inferior and become discouraged to continue using technology since teachers want to be in control of the classroom and believe that they have all the knowledge. Technology, if integrated well in the teaching and learning process, yields positive learning results and transforms the learning process (Rice, Cullen &Davis, 2010).

The current study has its purpose to discover the effect of using computers in the learning of Mathematics, in particular the topic of linear functions.

What follows is the discussion on the topic of linear function.

2.2.2 Linear functions in the teaching of Mathematics

The focus of this section is on the topic of linear function in the subject of Mathematics. In addition, the topic was chosen because it is the foundation of all graphing in Mathematics. A study by Adu-Gyamfi and Bosse (2011) on the learner's interpretation and their specific ways of working with tables, graph and algebraic notations on linear functions revealed that they have a limited understanding of linear functions. This shows that learners need to get clear understanding of the topic. Adu-Gyamfi and Bosse (2011) further indicated that a representation of Mathematics concepts on graphs and tables enable learners to build a pictorial synergy of Mathematics relationships.

Nistal, van Dooren and Verschaffel (2012) evaluated learners' representational choices while they solve linear function problems. Learners had a choice to solve problems using either tables, formula or having no choice at all, where the teacher had to choose for them. The results indicated that there was a strong correlation where learners had to choose a method to solve problems. The current study's emphasis was on the use of computer with special reference to the GeoGebra software. The next discussion is on the use of the software for teaching and learning of linear functions.

2.2.3 The teaching of linear functions using Geogebra software

GeoGebra is a Dynamic Mathematics Software (DMS) for teaching and learning of Mathematics from middle school through college level to University. It provides basic features of Computer Algebra System (CAS) to bridge the gaps between geometry, algebra and calculus (Hohenwarter & Preiner, 2007). In addition the software was created to help learners gain a better understanding of Mathematics and foster mathematical experiments and discoveries both in classroom and at home (Hohenwarter & Preiner, 2007). GeoGebra in this study was used as software for teaching and learning of linear function. The software was chosen because it can be freely downloaded, and it can be used in classroom and at home.

Havelkova (2013) study focused on the potential of using GeoGebra software in linear algebra. He highlighted that the use of the software was successful in that it deepened the learner's knowledge and enhances their understanding of the concept in further complexities. Moreover, there was a change in the learner's expectation of using the software to learn linear algebra in the classroom. Granberg and Olsson (2015) also agree that the use of GeoGebra in learning linear functions helped the learners to understand the concept of linear functions. Their results indicated that GeoGebra supports collaborative and creative reasoning by providing learners with immediate feedback. Furthermore, their activities involved sharing their reasoning with one another and with the teacher; they were involved in trial and error and also in argumentations. The current study also involved sharing of ideas and creative reasoning when solving linear function using GeoGebra software.

Ilhan (2013) supports the use of GeoGebra for teaching linear functions. He emphasises that GeoGebra creates a visual learning environment, makes the teaching of linear functions more organised and presentable, and learners can relate the topic to their daily life. Furthermore, GeoGebra software fosters the teaching of poor performers in the subject of Mathematics. Hohenwarter, Hohenwarter and Lavicza (2008) subsequently indicated that their participants were pleased with the usefulness and versatility of GeoGebra. They said that it is user friendly, easy and potentially helpful for the teaching of Mathematics.

Some researchers (see section 2.2.3) believe that GeoGebra is helpful for the teaching of Mathematics, in particular linear functions. The study by Doktoroglu (2013) revealed that linear relations with the software had no effect on the learners' achievement compared to regular instructions. The study further indicated that the software only had significant effects on the teaching of graphs.

2.3 The learners' attitude towards the teaching and learning of Mathematics

Good performance in Mathematics is an essential requirement for the learners to gain admission to scientific and technological professions. However, their performance in the subject is still poor as reflected in the Annual National Assessment results of 2014, where the learners obtained an average of 11% in Mathematics country wide (Report on the Annual National Assessment of 2014 in DBE 2014). Bora and Ahmed's (2013) study on the effect of learner attitude towards Mathematics revealed that the learners have a negative attitude towards Mathematics as shown by the mean score of 40.25 (Bora & Ahmed, 2013). According to CAPS there is a need for every child to learn Mathematics and develop the love for it and to appreciate its beauty, as emphasised in the curriculum on aims and skills (DBE, 2011a).

Negative attitudes are the results of frequent and repeated failures when dealing with mathematical tasks (Mata, Monterio & Peixoto, 2012). Children in lower grades have a positive attitude towards Mathematics. However, as they progress to higher grades their attitude become less positive. This may be due to the pressure to perform well and demanding tasks of the higher grades. The current study focused on an alternative method that could help to change learners' attitude towards Mathematics, in particular linear functions.

Researchers show that learners with positive attitudes perform better in the subject (Mata et al., 2012; Ramanujam & Subramaniam, 2012; Manoah, Indoshi & Othuon, 2011).Even though Japanese learners outperformed learners from other countries in Trends for International Mathematics and Science Study, yet they displayed a relatively negative attitude towards the subject (Manoah et al., 2011). The learners' attitude may be improved by using teaching and learning methods that are interactive and practical.

Researchers in Mathematics have focused on and assisted with the importance of learners making sense of what they are learning in schools (Reed, Drijvers & Kirschner, 2010). The understanding of the subject matter is what motivates supports and engages the learners in the construction of Mathematical knowledge. Mathematics in terms of learning is challenging, when learning support is insufficient. Learners learning interest may easily decrease and cause increase in negative attitude (Tseng, Chang, Lou & Chen, 2011). Mathematics is a primary requirement for the application of engineering and also a language of science. Therefore it is vital for learners to develop positive attitude in the subject (Tseng et.al., 2011)

Reed et al. (2010) argue that what learners learn when using computers appears to be moderated by their attitude towards both Mathematics and computers. In addition, learners with a more positive attitude have higher test scores than those with a less positive attitude to the use of computers in Mathematics. Learners with less positive attitudes to the use of computers indicate lack of success in the improvement of their Mathematics test scores (Reed et al., 2010).

Choi, Jung and Baek (2012) investigated the interrelationship between student attitude, engagement and achievement in Mathematics with technology. Their results show that high achievement in Mathematics was associated with a positive attitude towards learning the subject using technology. They also observed that learners' positive attitude decreased as they progress through grades. However, this could have been due to learner's personal interests and their career paths. Learners in the higher grades begin to realize what they want to study in the future and choose their subject accordingly. Where some learners need to further studies in Mathematics, they are unable to do so because of their fear in this subject.

Learners think of Mathematics as an irrelevant subject, distant from the lives of the majority, often boring and uninteresting, with out-dated teaching strategies (Ramanujam & Subramanian, 2012). There is a need for a paradigm shift in the method used for the teaching of Mathematics; the shift should be from the content and procedural knowledge to the process and learning environment. This shift will promote participation and offer every learner a sense of success (van Hoorn, Nourot, Scales & Alward, 2011)

The use of technology significantly improves attitude towards the learning of Mathematics. The learners who are exposed to the use of computers develop a positive attitude towards the subject and want to continue using computers. This use of computers results in creativity among learners and the desire to take control of their learning process. Furthermore, computers create an excitement among the learners and an improved motivation towards Mathematics as a subject (Barkarstas et al., 2009).

Despite other results that show positive impact on the use of technology for teaching Mathematics and the increase in positive attitude towards the subject, there are a number of studies that disagree. The study by Njagi, Havice, Isbell and Smith (2011) indicates that there is no change of learners' attitude towards computers leading to no change in learners' performance. In their study learners' perceptions of using the internet for learning were that it was time-consuming. The learners first have to learn how to use a computer before they can learn Mathematics. When the learners are unable to use a computer, they will not be able to see its impact on their studies.

A major challenge for teachers is to plan, prepare and teach Mathematics in contexts. They should develop a classroom environment that is conducive to learning which is encouraged in Integrated Quality Management System (IQMS) on learning performance for creation of a positive learning environment (Dhlamini, 2009).

Knowledge is empowering and attitude is persisting (Marshman & Grootenboer, 2012). Although Mathematics brings knowledge to the learners, their attitudes often destroy that knowledge. Mathematics is a very useful subject; however, learners continue to reject Mathematics when they have a choice, particularly in Grade 10 when they are given the opportunity to choose their subjects for the next phase of their studies. This trend continues even at tertiary level where learners who obtain distinctions in Mathematics in Grade 12 do not study Mathematics at tertiary level as their major subject. As a result, the country will continue to have a shortage of skilled people in Mathematics.

According to Marshman and Grootenboer (2012), the introduction of technology in learning promotes greater engagement and more concrete learner identity and deep learning. Their study reveals that there is a positive change in learner attitude and confidence when using computers. In this country Mathematics graduates are in short supply and mathematically-based professionals are in great demand and are highly paid. In addition, the country needs Mathematics graduates if it is to remain globally competitive. Consequently; this situation requires learners' attitudes to change.

The learners need to participate in technology-related studies and be able to use internet effectively for academic purposes. The positive attitude that learners display when using technology may consequently lead to a change in the attitude towards Mathematics, which could result in an improved performance in Mathematics. However, results show a neutral attitude towards Mathematics when technology is used (Manoah et al., 2011). Based on Manoah et al.'s (2011) results, it may be assumed that the learners' attitude may be influenced by various aspects, such as the culture and beliefs of their specific society.

While technology can possibly deliver greater effectiveness in teaching, it has the potential to undermine established practices and cause disruption in the learning environment (Gillespie & Walker, 2012). It follows then that others see new technology as less transforming and more interruptive to complex routine, they are generally people who are resistant to change. Despite the negative attitudes of some, the learners' achievement in Mathematics when using computers requires attention.

2.3.1 The learners' attitude and quantitative research approach

The literature reviewed shows that learner attitude can be measured using quantitative research approach. Yusoff and Janor (2014) on their study of the generation of an interval metric scale to measure attitude shows that Likert type scale can be used to measure quantitative data on attitude. They refer to the words attitude, opinion and feeling as intangible because they can only be experienced and felt, not touched. Moreover, they argue that this variables can be expressed in terms of numbers using quantitative approach and the most common rating scale to measure attitude, opinion or feeling is called Likert-scale on scale ranging from (strongly agree to strongly disagree) by Rinsis Likert in 1932 (Yusoff & Janor, 2014).

The study by Karadeniz, Sears and Colak (2013) on the effect of Google sketch up to teachers' attitude towards technology in Mathematics, they used the quantitative research approach to measure attitude on Likert type scale ranging from "strongly agree" to "strongly disagree". In addition, they used SPSS statistical software to analyse quantitative data. Manoh, Indoshi and Othoun (2011) developed a five point Likert-scale on strongly disagree to strongly agree for a positive stated items to establish learners attitude towards Mathematics curriculum. The current study also used the quantitative research approach to measure learners' attitude towards Mathematics (linear functions). Learners gave their opinion on a questionnaire items using Likert type scale on "strongly agree"to "strongly disagree". Furthermore, SPSS statistical software was employed to analyse the quantitative data.

2.4 The achievements of learners in Mathematics when using computers

Current issues in education are about how and what is taught to the learners who will be leaders of the coming generations. Researchers have agreed that there is a need to educate learners with skills, abilities and knowledge for the 21stcentury, as these are the key elements that learners need to acquire to succeed in life and at work

(Choi, Jung & Baek, 2012). Learning and innovation skills are creativity, critical thinking, logical reasoning, problem solving, communication and collaboration as highlighted in the National Curriculum Statement R-12 (NCS R-12, 2011 in DBE, 2012). This study focused on the learners' performance when technology is integrated into the curriculum for Mathematics.

The literature consulted for this study shows that if technology is correctly used, it can enhance the quality of teaching and learning in Mathematics. When technology is integrated in the learning environment it may help to produce learners that are able to reason logically when solving problems (Stolts, 2012). In addition, when technology is used for high-order learning it results in improved mathematical achievement in learner performance. Technology-supported collaborative learning has a positive effect on learners' performance in problem-based tasks (Stolts, 2012).

Despite the Gauteng Department of Education (GDE) providing some schools with technological resources, there is only limited evidence of the positive effects on learners improved performance (The project of Gauteng on-line and GDE providing other schools with IPad tablet computers). According to Rowan and Bigum (2012) the lifelong and widespread consequences of educational failure means that the education system needs to change if there is to be hope that children in the schools around the world could share the benefits of quality education. The teachers need to discover ways to understand how technology could contribute to a broader transformation in education.

In respect of the integration of computers to improve learner's performance, (Wolfram, 2010) focuses on a subject called computer- based Mathematics, where learners learn Mathematics using computers. He found that using computers makes Mathematics more practical and more conceptual. Moreover, it improves understanding, thus improving learners' performance. He points out that learner could be engaged for many hours on one problem when calculating by hand, but with the computer, many calculations with different degrees of complexity may be completed within an hour. This study‘s reviewed literature shows that using computers could help learners to engage in many problem solving activities within a limited time. It is evident that while it is still difficult or challenging to integrate technology in the classroom, it is important, and will improve learners' conceptual understanding.

There are a number of teachers who still believe that the learners need to learn the basics of Mathematics using the traditional method before they are introduced to the use of computers. These teachers also believe that when learners use computers, they are not being intellectually stimulated (training their minds), because in their opinion everything turns into the mindless pushing of the button (Wolfram, 2010). Computers liberate learners from using calculations that are time-consuming and enable them to engage in greater conceptual understanding at a higher cognitive level. Education in the future will be less about doing things for or to the learners, but doing things with and by the learners themselves.

The effect of technology on attention and achievement within a classroom context in subjects of Mathematics, English and Geography shows that in all these subjects the application of technology-instruction resulted in a significantly higher difference between the average achievements of the learners who received technology instructions during the lesson (Bester & Brand, 2013). The investigation advances an important message that the use of technology supports teaching and learning and should be promoted in all learning areas across the curriculum. This emphasises that learners would gain more information with the help of sufficiently-stimulating technological content in their learning material.

In a technology-rich learning environment, learners can explore new information, construct new knowledge, and link theories into practice, thus maximising their achievement in any subject (Bester & Brand, 2013). In addition, to ensure that quality instructions are given, the possible usage of technology should be a priority when planning and presenting a lesson at school.

Although technology will never replace the human aspects of teaching, it has become a necessity in the classroom. Additionally, technology can contribute to better classroom management because the teacher can capture the attention of all the learners during a lesson using computers. This could contribute towards achieving good academic results and will most probably initiate less discipline problems because, the learners will be engaged in building their own knowledge.

However, Edward (2012) argues that when computers are integrated into teaching and learning in the classroom, the bond between the teacher and the learner is compromised when computers mediate this relationship. Artificial intelligence will be replacing inactive mental involvement. In addition education will be more informal as learners can also learn anywhere not only between the walls of the classroom (Edward, 2012). This indicates that there are people who still fear that technology will break the bond they have with their learners. However, technology should be seen as a partner not an enemy as other studies have indicated.

A study on the effect of teaching Mathematics in cooperative groups with computer-supported concept maps on probability (Gurbuz, Erdem & Firat, 2012), shows that teaching carried out in cooperative groups with computers was significantly more effective than that of using traditional methods in terms of conceptual learning. Using computers in experimental groups improves learner achievement. Learners who used computers enjoyed the process and interacted with their peers. They also got the opportunity to construct their knowledge visually. According to their study a computer has the ability to make abstract content in Mathematics concrete, and will also assist learners when they are given problems that deal with problem solving Gurbuz et al., 2012).

The study by Abu Bakar, Tarmizi & Mohd (2010) on the effects of integrating Geometer's sketchpad (GSP) and the traditional teaching strategy to learners' performance, points out that there was no significant difference between the GSP group and the traditional group. According to Abu Bakar et al (2010), these results could be due to the fact that learners were not familiar with the use of computers, the GSP, the concept of geometry and time constraints. It is a fact that learners need to be familiar with the use of the computer before they can use computers for curriculum purpose and the teacher needs to plan well in advance to enable learners to focus and concentrate on the content that needs to be learnt. This will yield authentic results on learner achievement and the use of technology for the teaching and learning of Mathematics.

Computers promote improved learner engagement and understanding by allowing real time tracking of learner's progress. Moreover computers will give learners instant feedback about their performance. (Guerrero, 2010) unlike the teacher who takes time to mark the work and only then give feedback and sometimes the feedback is no longer relevant to learners. Computers give instant feedback as Guerrero (2010) points out. Teachers need to view computers as instructional tools.

Learners and teachers should know how to use a computer in the school and be able to access the information that they need (Action plan 2014 in DBE, 2011c). The use of computers was highlighted by Department of Basic Education on its action plan of 2014, towards the realisation of schooling 2025. The emphasis was that learning and teaching materials should be in abundance and of a high quality. Furthermore, the action plan focuses on improving the results of learners in all the grades who pass Mathematics by 2014. This can be possible if the Department of Education can make more funds available for learning and teaching support materials, for example, computers and computer software for curriculum and training of teachers on how to use computers effectively in the classroom.

2.5 The theoretical framework

This study focuses on theories in education, Mathematics and technology and the theory that underpins all the theories in the related aspects, is the theory of constructivism. There are different types of constructivism theories. In this study the theories of cognitive constructivism, social constructivism and radical constructivism will be discussed. Fosnot (2005) defines the theory of constructivism as the theory about knowledge and learning that describes knowledge, not as truth to be transmitted but as constructed explanation by an individual. Furthermore, it involves making meaning in cultural and social communities, while learning is viewed as a self-regulatory process.

In the theory of constructivism learners are considered to be active participants in their learning and seeking of meaning (Piaget, 1953). The current study encourages learners to be actively involved in their learning, while the teacher assists them in their understanding of what they are learning. According to Hardle, Baviskar and Smith (2012), prior knowledge is important and it refers to the existing knowledge that learners bring to the classroom. The teacher could use this knowledge to fine-tune the lesson. Piaget also emphasise the importance of prior knowledge.

Whilst the teaching of Mathematics is traditionally seen as the transmission of knowledge from the teacher to the learner, constructivism is a theory that views knowledge as being constructed by individual (Fosnot, 2005). Knowledge was factual, objective and textbook oriented. Learners were assessed on the ability to reproduce what the teacher had taught them. There is a need for a paradigm shift from teacher-centred perspective to learner centred approach. The learners should be engaged in the development of knowledge while learning is taking place. The teacher has to create a positive classroom environment by employing practical examples and using different teaching and learning tools (Fosnot, 2005). Since cognitive constructivism is an important theory for this study it is discussed next.

2.5.1 Cognitive constructivism

Piaget (1953), states that children construct their own knowledge. His theory focuses mainly on the individual and how he or she constructs knowledge. He emphasizes the fact that individuals construct new knowledge using prior knowledge, and further states that children's schema are constructed through the process of assimilation and accommodation. Assimilation is when children bring new knowledge to their own schemas, and accommodation is when children have to change their schemas to accommodate new information (Powell & Kalina, 2010). In education learning occurs when an individual processes new information to match what is already in the memory. Piaget‘s theory still holds truth for learning today and is used in many learning areas and in the implementations of the curriculum. The emphasis is on learner-centred teaching approach. Another theory that has relevance for this study is social constructivism, because it complements Piaget‘s theory.

2.5.2 Social constructivism

The theory of social constructivism also focuses on the construction of knowledge. Vygotsky (1978) in Powell and Kalina (2010) argues that learning and development is a collaborative activity, and that children are cognitively developed on the context of socialization and education. This theory includes cognitive development, the zone of proximal development (ZPD), social interaction, culture and inner speech. According to Vygotsky (1978), ZPD is the distance between the actual development levels as determined by independent problem-solving and the level of potential ability as determined through problem-solving under adult supervision or in combination with more knowledgeable peers. This is a level where an individual could be assisted to create meaning and understanding. Scaffolding is an assisted learning process that supports ZPD for learning to occur a child must make contact with the social environment on an interpersonal level and then internalize this experience (Powell & Kalina, 2010). Children grow into the intellectual life of those around them (Garrison, 1995). As a result learning has to be practical, relevant and relate to a real-life situation.

The theories of cognitive and social constructivism claim that guided forms of teaching and learning are necessary as learners construct their own knowledge. The role of the learner is that of an active participant in the construction of knowledge. In addition, the teaching and learning process has to be learner centred (Powell & Kalina, 2010). Social constructivism assumes an active learner constructing knowledge in cultural practice (Hung & Nichan, 2000). Effective teaching methods include creating an environment where learners feel free to create understanding and memorise concepts. The focus of constructivism is on knowledge, experience and understanding.

Piaget (1953) and Vygotsky (1978) theories have differences. Cognitive constructivism points out those ideas that are constructed by an individual through a personal process, where thinking precedes language. The focus is on the reasoning ability of an individual and how the individual interprets knowledge. However, social constructivism states that ideas are constructed through interaction between the teacher, the learner and the learning tools, and suggests that language precedes thinking. The emphasis is on how culture and language affect the individual's acquisition of knowledge.

An additional branch to constructivism is known as radical constructivism.

2.5.3 Radical constructivism

Another view on constructivism is that of von Glaserfeld (1989) on radical constructivism. Von Glaserfeld (1989) in Joldersma (2011) believes that in learning each individual construct reality through conceptual activities that requires action. According to von Glaserfeld (1989) knowledge is not passively received but actively builds up on the information received. Teaching occurs when the teacher moves away from content-driven instructions to creating opportunities for the learners to make sense of and understand what is to be learned. Nevertheless, all these theories focus on knowledge-construction. However, radical constructivism differs from others in the sense that it focuses on individual thinking and interpretation of information received.

The current study focuses on the theory of social constructivism by Vygotsky. In social constructivism learners build knowledge by interact with their surroundings. Similarly, in this study learners interact with the teacher by asking questions, peers by explaining their solutions and technological tools by solving problems.

Having discussed the various constructivism theories it is imperative to relate these theories to the teaching and learning of Mathematics.

2.6 Constructivism and Mathematics teaching and learning

Constructivism has been a leading theory in the learning of Mathematics and the main idea of constructivism is that the learner is constantly reconstructing understanding. In constructivism learning for understanding is based on learners' existing knowledge and experience. The principle of teaching Mathematics should be that learners will learn best by trying to make sense of ideas on their own with the teacher as a guide to help them along the way (Yahong, Weihong & Li, 2011).

Constructed knowledge promotes critical thinking that helps learners to integrate mathematical concepts within different aspects. Lopez (2012) argues that new knowledge cannot be transmitted directly, but must be constructed by the learner from prior knowledge and through social interaction. Social interaction refers to discussion of information with other learners. It encourages an active learning environment where learners are motivated. When learners are motivated they can develop the problem solving skills and become creative and critical thinkers.

According to Ernest (2001) social constructivism is a philosophy of Mathematics amongst other subjects. He points out that the social constructivist view of Mathematics is that it is a social construction, a cultural product and fallible like any other branch of knowledge. The views of Ernest about Mathematics point to the relevancy of the subject to everyday life. He further highlights that Mathematics can be relevant to the learner when they make their own interpretation of information received from others. Subsequently the concepts of Mathematics are derived by abstraction from direct experience within the physical world and from other people.

Mathematics is one of the important subjects, considering the opportunities that are associated with studying it. The teaching and learning of Mathematics is vital for the good of the society. Mathematics provides useful, self-enhancing and marketable skills. Furthermore, it provides fulfilment in employment and also offer learners enriching way of seeing and understanding the world with an essential component for working as critical citizens in modern society (Ernest, 2009)

Constructivists look at the insight of individual learner when constructing knowledge (Abdulwahed, Jaworski & Crawford, 2012). Their view is useful when scrutinising the way in which the individual understand particular Mathematical concepts. Their focus is on learner‘s understanding and development of knowledge, specifically in Mathematics. The current study view technology as important hence, it is essential that technology is combined with constructivism in the teaching and learning of Mathematics.

2.7 Constructivism and Technology in the teaching and learning of Mathematics.

Technology promotes learner's self-directedness since the use of computers entails active learning. The change from traditional method to technological methods is encouraged and will eventually help to develop constructivist view of teaching (Mann, 1994).The use of technology in education has caused the theory of learning, namely constructivism to receive attention (Mann, 1994). Learners become more empowered by gaining access to real information and work on authentic problems when using computers. Constructivism emphasizes learning as developed by learning tools and computers may be used as instructional, support and cognitive tools that provide a richer and more exciting learning environment.

The theories of learning that form the foundation of instructional design have also changed as educators attempt to develop new approaches to improve learner performance(Rice, Cullen & Davis, 2010). These authors further states that, technology provides new opportunities to address issues of learning styles while providing a learner centred approach and promoting higher levels of thinking. Additionally, technological tools should be placed within a learning environment to support teaching. The curriculum where technology is integrated requires an appropriate learning theory as a framework in which the learner could be more creative and productive. The learner centred environment of constructivism empowers the teaching and learning process in order to improve the level of learning from basics to higher-order skills (Rice et al, 2010). Researchers suggest that constructivist teachers are more likely to use technology in their classrooms (Judson, 2006 in Rice et al, 2010). Stewart, Schifter and Selverian, (2010) observed that there is a positive relationship amongst teachers who use learner centred approach when they are teaching as well as how often they use technology as a way of enhancing learners' understanding and learning.

The constructivist theory and the use of technology for teaching works well together as they both encourage the learner to work independently while developing their own understanding (Chronaki & Matos, 2013). They emphasise that in order for technology to be effectively used in classroom, the teacher should master the theory of constructivism and use it effectively in conjunction with technology.

The literature consulted for this study shows that technology and constructivism yield a positive learning environment. It shows that teachers could easily involve their learners in the teaching and learning process using technology. Technology provides a positive learning environment that is emphasised in Mathematics curriculum and learners are practically engaged in their construction of knowledge.

The current study builds on the theory of social constructivism. The focus is on the importance of all aspects of the social context and interpersonal relations, especially teacher-learner and learner-learner interaction in learning environment including negotiation, collaboration and discussion (Ernest, 2001).

2.8 Summary

The literature was reviewed on the role of technology in the teaching and learning of Mathematics, in particular the topic of linear functions using GeoGebra software, learners' attitude towards Mathematics when using technology and the performance of learners in Mathematics. Various studies such as Stolts (2012) have reported that the use of technology in the teaching and learning of Mathematics enhances the learners with skills on problem solving, critical and creative thinking, logical reasoning, decision making and calculations. In other studies such as Reed et al. (2010) indicates that the use of technology is not only important for teaching and learning but it can change learners' attitude towards the subject and improve their performance. There was not much evidence on the effect using computers for teaching Grade 10 linear functions using GeoGebra software in South Africa. Therefore, the current study will contribute to the body of knowledge on the effect of using computers for teaching of Mathematics in particular linear functions to Grade 10 learners.

The next chapter discuss the issues related to research methodology in the current study.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the research design and the research method that was employed in this study. Aspects discussed in this chapter include methods of research, the population, the sample, methods of collecting data, instrumentation, and the analysis of data, validity, reliability and ethical considerations. A discussion of the research design follows.

3.2 Research design

The research design is described as the procedure for conducting the research. It indicates the general plan of how the research is set up (McMillan & Schumacher, 2010). The purpose of a research design is to specify the plan to generate the empirical investigation that is used to answer the research question, with a goal of providing the results that are credible. Credibility means the results show reality are accurate, trustworthy and reasonable. Good research designs are characterised by availability of resources, freedom from bias, and the control of irrelevant variables (Wiersma & Jurs, 2009)

This study adopted a quantitative research approach which was originally developed in the natural science to study science phenomena (McMillan & Schumacher, 2010). However, examples of quantitative research are now well-accepted in the social sciences and education. This approach makes use of numerical analysis. The objective of this approach is to develop mathematical models and theories.

The quasi-experimental research design which involves the use of intact groups of participants where there was no random assignment of participants was adopted in the current study (Wiersma & Jurs, 2009). The research was done in a school setting and intact classes were used. The research specifically focused on the non-equivalent control group pre-test- post-test design, It involves two groups that are pretested, administer an intervention and post tested (Gay, Mills & Airasian, 2011).

The researcher used this design because participants comprised of intact classes and random assignment was not possible. As a consequence, all the learners had an equal opportunity to either be in the control or experimental group. The design overcame threats to internal validity by using a large sample size and a short duration of the study. Furthermore, the participants were of the same average age, namely 15 to 17 years of age.

The non- equivalent control group pre-test- post-test design was used to measure the effect of using computers for the teaching and learning on the concept of linear functions in Mathematics to the performance and attitude of the learners in Grade 10. The study by Njagi, Havice, Isabell and Smith (2011), when assessing learners' attitude towards computer technology, used pre-test-post-test, non-equivalent control group design with all the participants (n=126) because it is appropriate for naturally-assembled classrooms. In the current study the researcher used the same design with (n=100).

Bester and Brand (2013) used a quasi- experimental design, when investigating the effect of technology on learner attention and achievement in the classroom. The design was used because at the beginning of each school year learners are randomly selected to the classes, ensuring that they are not streamed or grouped according to any criteria. In the current study, learners were not allocated to classes using any criteria; they had equal opportunity to be in any class.

Stolts (2012) used a quasi-experimental non-equivalent comparison group design in this study. The reason for the use of this design was that practically it was not possible to assign students randomly because of their timetables. Similarly Tienken and Maher (2007) (in Mertler and Charles 2011) when investigating the influence of Computer- Assisted Instruction on eighth grade Mathematics learners' achievement also used quasi-experimental pre-test-post-test design with the experimental group (n=121) and the control group (n=163) because students where in intact classes and randomization was not possible. This current study also used the same design because it was not possible to randomly select participants with control group (n=50) and experimental group (n=50).

3.2.1 The rationale for selecting the quantitative research method

The rationale for choosing the quantitative research method was based on the fact that it relies upon measurements and various scales to generate numbers that can be analysed, using descriptive and inferential statistics. Moreover, the researcher is a Mathematics teacher and is acquainted with the language that is used in quantitative research. According to McMillan and Schumacher (2010), this method is objective, value free and unbiased. It also uses a deductive process on generalization leading to prediction, explanation and understanding. In addition, quantitative approach gives results that are accurate through reliability and validity. The researcher adopted quantitative approach to develop deeper understanding of descriptive statistics. The mean and variation of learners' scores where compared in this study.

A quantitative research approach was employed in the study so as to objectively evaluate the use of computers as an intervention strategy in the teaching and learning of Mathematics. In addition, this study was conducted to determine if participation in the intervention had improved the learners' performance in Mathematics. This was measured using an achievement test. A measure of attitude was considered non cognitive, because the focus was on emotions and feelings. This involved what an individual liked, preferred and considered important. The quantitative approach could also be used to measure attitude using a closed end questionnaire.

Sample (2010) in his study on the effectiveness of a Mathematics tutoring program at an urban high school used a quantitative research data on Likert type scale. He used the scale to measure the attitude of learners towards Mathematics on positively worded questionnaire. The learners were to answer to statement using Likert scale options on strongly agree to strongly disagree. He also used the SPSS to analyse the quantitative data (Sample 2010). The current study also used a questionnaire on Likert type scale to measure learners' attitude towards Mathematics and SPSS was used to analyse the quantitative data.

Inferential statistics was used to assess the statistical significance of the results about the null hypothesis. Statistical significant is concerned with the correctness of the judgement about the null hypothesis (Newby, 2011). Obtaining the probability value (p-value) is the key in hypothesis testing. If the p-value is lesser than the significant value the researcher is allowed to reject the null hypothesis and tentatively accept the alternative hypothesis. The researcher can conclude that the observed relationship is statistically significant (Johnson & Christensen, 2012). The current study assumed the p-value of 0.001 as the threshold of the level of significance because, the smaller the level of significance the more confidence the researcher can be in rejecting the null hypothesis. In addition the significant level of 0.001 was used as a benchmark due to the reason that the research participants are human being, therefore the difference may not reach convectional statistical level but they are societally important.

The benchmark was also employed to avoid type 1 error of rejecting a true null hypothesis. The significant level of 0.001 means that the null hypothesis has 1 in 1000 (0.1%) chance of being true or 99.9% chance of not being true (McMillan & Schumacher, 2010). The calculated p-value depend on the sample size, the larger the sample size (n=100) the more confident the researcher can be that the results did not happen by chance but the intervention constituted the breakthrough (Newby, 2011).

A description of the research site where the study was conducted follows.

3.2.2 Description of the site

The research was conducted at a secondary school in Ekurhuleni North district. The school was chosen due to convenience, ease of access and financial viability. There was no need for additional administration or travelling costs because the school was a walking distance from where most of the participants stay. The principal and school Governing Body gave their permission for the researcher to conduct the study at the school as well as to use the school's resources because they understood the benefits that the research would bring to the school.

The school has a fully equipped computer laboratory. The laboratory that was used was sponsored by a reputable International information technology company. They donated desktop computers, i-Pad computers, video cameras and a whiteboard. The laboratory has an effective functioning internet connection. They also installed a software program called CAMI. The software deals with activities in Mathematics and

English from Grade1 to Grade12. The teachers at the school did not use the computers effectively for curriculum purposes

The teachers at the school were trained to use the software, but teachers still experience major challenges to integrating the use of computers in the classroom. The teachers argue that they have a syllabus to complete, so they don't have time to use the software. Since the purpose of this research is to investigate the effect of using computers on learners' performance, the researcher intention was to explore whether the effective use of computers would have any effect on the learners' performance.

The research was conducted in the natural setting of learners, as this enabled a comfortable and relaxed atmosphere. While a good relationship between participants encouraged a natural, non- intimidating situation. The only unfamiliar experience was that of the researcher teaching using GeoGebra software. Learners participating in the study were computer literate because they have had the opportunity to attend computer classes once a week. The learners' progress was not monitored because the lessons did not contribute towards marks for promotion to the next grade. A description of the population and sample for this study are addressed below.

3.3 The population and the sample for this study

According to McMillan and Schumacher (2010), a population is a large group of elements, that conform to specific criteria, and to which the researcher intended to generalize the results of the research. The target population in this study were all Grade10 learners who study Mathematics as a subject in a secondary school situated in the Ekurhuleni North district. Delimitating variables for this population is grade, class and gender.

Non-probability sampling with special reference to convenience sampling was used to select the sample for this study. According to Mertler and Charles (2011), convenience sampling takes groups of participants that simply happen to be available. Unless we know who we want to be able to make claims about, we cannot choose a sample that is representative of them (Arthur, Waring, Coe & Hedges, 2012). The empirical study employed convenience sampling because there are only two grade 10 classes in the school and those were the participants who were available.

The researcher chose this sampling technique because intact classes were used. The sample consisted of two grade 10 classes (n= 100), Class A and Class B in one school. Experimental group was class A (n=50) and control group was class B (n=50).

The reason for using Grade 10 in this study was that learners in Grade 9 were given the opportunity to choose subjects that they wanted to study in grade 10. Therefore, Grade 10 is the foundation for learners to pursue their studies in Mathematics. The researcher believes that it is in this Grade that the learners' performance needs to improve in order to build a positive attitude towards the subject.

3.4 Procedure for conducting the study

The purpose of this study was to establish the effect of using computers to improve the performance of learners in Mathematics. Consequently the participants in the study were grade 10 Mathematics learners. Since there are only two Grade 10 Mathematics classes in the school, that is class A and class B intact classes were chosen to participate in the study. The role of the learners, as explained in their assent form (Appendix F) is to learn linear functions, write a test and answer the questionnaire.

The researcher taught the experimental group (Class A) using computers as an intervention. Whereas the control group (Class B) was taught using the traditional method. Their teachers acted as assistants. According to Johnson and Christensen (2012) the key strategy to deal with researcher's bias, when involved in research is reflexivity. Reflexivity means that the researcher engages in self-reflection about potential biases and predispositions. In this study the researcher also engaged in self-reflection.

There were two variables in this study; the independent variable was the use of computers since it could be manipulated and the dependent variable which was the performance of learners because it could be measured. Variables are factors that vary, therefore the dependent variable depend on the independent variable (Gay, Mills & Airsian, 2011)

The participants in both groups were given a pre-test. Assumption was given to the idea that all participants would have the same mathematical knowledge and conceptual understanding at the beginning of the course. It was also assumed from the hypothesis that there was no significant difference between the groups at the initial stage of the study.

The researcher introduced the topic of linear functions to the learners and gave a brief overview of the topic. Each learner in the control group was given a book, pen and a set of Mathematical instruments while the learners in the experimental group were assigned to a computer. The teaching lasted for six weeks during which time learners were taught for 60 minutes every day of the week after school hours. In addition, learners were provided with worksheets on the topic of linear functions. After the intervention on the use of computers, both groups were given a post-test to compare whether there was any difference in their performance. The results are indicated in chapter 4 of this study.

Data collection is a very important aspect of any study and the data collection for this study is elaborated upon below.

3.5 The collection of data for this study

In this section the discussion is on the instruments that was used and how it was used in detail to ensure reliable and accurate results.

The instruments that were used are the achievement test and the questionnaire. Quantitative measurement uses instruments to obtain numerical data. The results from the instruments depend heavily upon the good quality of the measurements. If the measure is weak or biased, so are the results. Moreover, a strong measure increases confidence that the findings are accurate (McMillan & Schumacher, 2010). In the current study the content validity index was calculated to ensure accuracy of the instruments.

A description of the research instrument is presented next.

3.6 The research instruments

3.6.1 Tests

The achievement test consisted of ten items or questions that assessed learner's mathematical knowledge and skills in the concept of linear functions. The questions were closed - ended questions. The test questions were given to three educators who had more than ten years of teaching experience in Mathematics to moderate and evaluate the content of the test (Table 3.1). There was also a pilot study conducted at another school to detect any errors and ambiguities before the actual study. Table 3.6 (Appendix C) shows the results of the pilot study.

3.6.1.1 The pre-test

The similarity of the two groups was compared using a pre-test. This was administered prior to conducting the experiment (Wiersma & Jurs, 2009). The focus was on the drawing and interpretation of graphs. Pre-test (Appendix A) shows the content of this test.

3.6.1.2 The post-test

The post-test was administered at the end of the intervention to the learners on both groups. The experimental group used computers as the intervention, while the control group used the traditional pen and paper method. Their test scores were analysed. Post-test (Appendix B) shows the content of this test.

3.6.2 The Questionnaire

The questionnaire (Appendix C) for this study was compiled by the researcher. Cronbach's alpha was calculated for reliability (Table 3.1), detailed calculation is shown in Appendix B1. A ten-item questionnaire, with closed-end questions was used. The questionnaire was only administered to the experimental group after the experimental period. A Likert four type scale was used to measure the degree at which learners agree or disagree to an item on the questionnaire. This scale measure one item at a time and provides a range of answers to a question. The rating on the scale ranged from strongly agree to strongly disagree (Neuman, 2011)

The questionnaire was employed to measure the attitude of learners towards Mathematics after learning linear functions using computers. The questionnaire measured the general attitude of learners towards Mathematics, both positive and negative. Moreover, a pilot study was done for the questionnaire to check clarity of questions, the layout and the instructions.

In a study such as this study it is imperative to take cognisance of reliability, which is presented below.

3.6.3 Reliability

Reliability has to do with the consistency of the measurements obtained. Additionally, consistency is concerned with the similarity of the scores overtime (Arthur, Waring, Coe & Hedges, 2012). The reliability of the questionnaire can be monitored by asking similar questions in different parts of the questionnaire, to check the extent at which respondents are consistent in their answers. Reliability for this study was calculated on the results of the pilot study (n=10) and yielded the alpha value as α=0.911. This indicates a high reliability of the questionnaire (Table 3.3); therefore the questionnaire could be used in this empirical study. The detailed reliability for the questionnaire responses may be seen in Appendix B1.

Table 3.1 *Reliability Statistics of the questionnaire*

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.911	.918	10

This study ensured the internal reliability of the test items, whereby the Cronbach alpha was calculated using SPSS Version 22 (SPSS 2013). No item was removed; this means the test remained at 10 items (Table 3.2), detailed calculation is shown in Appendix B2. The alpha value for the test was 0,807 which indicated a high reliability. The reliability accepted alpha value is 0.7. Therefore the test was reliable and it was used in the study. Furthermore reliability was improved by asking experts to moderate the tests. A detailed reliability for the test may be found in Appendix B2.

Table 3.2 *Reliability Statistics of the test*

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items

.807	.807	10

Closely related to reliability is validity and the onus rests upon the researcher to ensure validity.

3.6.4 Validity

Validity means the extent to which scientific concepts match the reality and the degree to which explanations are accurate (McMillan & Schumacher, 2010). There are different types of validity, according to Tomal (2010). Content validity refers to the test to measure subject content and may be done by experts in the field who gave their expert opinions whether tests are valid. Internal validity focuses on the viability of causal links between independent and dependent variables. The link refers to the relationship between the intervention and test scores while external validity refers to the generalizability of the results.

The validity for these instruments was ensured, firstly, through the pre-test and post-test that was taken to experts for moderation. The panel of experts consisted of the Deputy Principal for curriculum; Departmental Head in Mathematics, and Grade10 to 12 post-level 1 teacher, all have more than ten years of teaching experience in Mathematics. The experts were asked to independently judge whether the test items reflected the content domain of the study. This is to determine whether the task represents the exact content related to the topic. They examined the content of the questions items for the test (Table 3.3) shows the results of validity of the test.

Table 3.3 *Validity of the test*

QUESTION	HOD	TEACHER 1	TEACHER 2
1	Y	Y	Y
2	Y	Y	Y
3	Y	Y	Y
4	Y	N	N
5	Y	Y	Y
6	Y	Y	Y
7	Y	Y	Y
7.1.1	Y	Y	Y
7.1.2	Y	N	Y
7.1.3	Y	Y	Y

YES-Y NO-N

The experts' opinions and suggestions were considered for the amendments that were made. Furthermore, the style of the testing used in these instruments was familiar to the learners. Secondly a pilot study was conducted, and this helped the researcher to be aware of the unforeseen problems that could emerge during investigation. Finally, all mistakes were corrected before the tests were used.

The researcher calculated the Content Validity Index (CVI) which was computed using the following formula:

The content validity index (CVI) was therefore computed as follows:

$$\frac{\textit{Total number of items in the test declared valid by all four raters}}{\textit{The total number of the items in the test}}$$

$$CVI = \frac{8}{10} = 0,80$$

For the learners' test, the CVI was found to be 0.80, which is greater than the acceptable value of 0.7.

The same panel of experts were also asked to assess the items in the questionnaire. Their results were used to calculate the validity of the questionnaire. Amendments were made were necessary. Table 3.4 shows the results from the experts.

Table 3.4 *Validity of the questionnaire*

ITEMS	HOD	TEACHER 1
A	Y	Y
B	Y	Y
C	Y	Y
D	Y	N
E	Y	Y
F	Y	Y
G	Y	Y
H	Y	N
I	Y	Y
J	Y	Y

The content validity index (CVI) was therefore computed using the following formula:

$$\textit{Content Validity Index (CVI)} = \frac{\textit{Total number of items in the questionnire declared valid by all the four raters}}{\textit{The total number of items in the questionnaire}}$$

$$CVI = \frac{8}{10} = 0,80$$

For the learners' questionnaire, the CVI was found to be 0.80, which is greater than the acceptable value of 0.7.

3.7 The pilot study

The pilot study is the trial run of the data-collection using a small group of learners from the population (Mertler & Charles, 2011). In this study the pilot study was conducted at another school to determine the time it would take to complete the instrument and also to detect any errors and ambiguities that may be found in the instrument. The results of the pilot study test can be seen in Table 3.6 (refer to Appendix C). It also made the researcher aware of any unforeseen problems that could emerge in the actual study. Participants (n=10) were given test questions to answer, and they were also asked to complete the questionnaire. Based on the results from the pilot study, amendments were made where necessary before the instruments (test) could be used in the empirical study. The results of the pilot study in Table 3.7 (refer to Appendix C) were used to determine the validity and reliability of the instruments. The results show that, the instruments displayed the desired level of content validity and were reliable.

3.8 Analysis of the data

There are different types of data analysis in quantitative studies. For the purpose of this research study, the focus was on statistical analysis with special reference to descriptive and inferential statistics. Descriptive statistics transform a set of observations into numbers that characterize the data and is used to summarize, organize and reduce large numbers of information (McMillan & Schumacher, 2010). On the other hand, inferential statistics assisted a researcher to draw inferences regarding the hypothesis about the population parameter (McMillan & Schumacher, 2010).

The data collected was analysed using descriptive and inferential statistics. Descriptive statistic was based on a graphical representation of data and calculations of mean, mode, gain score and median. For inferential statistics, two approaches were used; namely the F-test for comparing variances and one-way ANOVA for comparing means. The questionnaire analysis was done using graphs to determine the extent to which the computer usage had influenced the attitude of the learners in Mathematics. The graphical representation of data was selected because it is visual and reduces large amounts of information into smaller representations which are easy to interpret (McMillan & Schumacher, 2010). The details of the data analysis will be discussed in the next chapter.

In order to conduct any research study it is necessary to take cognisance of ethical considerations.

3.9 Ethical considerations

Research in education focuses mostly on human beings. Therefore it is the responsibility of the researcher to protect the rights and welfare of the participants in the research (McMillan & Schumacher, 2010). In order to conduct the research the applications for consent and permission was sent to different institutions.

Firstly, an application was sent to Gauteng Department of Education for permission and reference number. Secondly, the application for ethical clearance was sent to the University's Ethics Review Committee. Thirdly the application was sent to Ekurhuleni North district for their permission. Fourthly the application was sent to the school for permission. Lastly the informed consent form and assent forms were sent to all participants. The letters clearly explain the purpose of the study and also addressed issues of anonymity, confidentiality, voluntary participation, time and benefits. Since learners are still minors the parents' permission was also requested. The total number of letters sent to parents was 100 and all the parents responded positively and the same number of letters was sent to learners and they also responded positively.

3.10 Summary

This chapter presented the research methodology employed in this study. The methods and instruments that were used to collect the data were clearly specified. Issues of validity and reliability of the instruments were also discussed. The research focused on matters related to human beings, for this reason ethical clearance was considered. The results of the investigation are presented and analysed in the next chapter.

CHAPTER 4

THE PRESENTATION, ANALYSIS AND INTERPRETATION OF THE FINDINGS

4.1 Introduction

This chapter presents the analysis of data that was collected from 100 learners from the sampled school as well as the results of the study. As mentioned in section 3.6, data was collected using performance measurement tests (pre/post) and researcher designed questionnaire. The learners' answers to the performance measurement tests were marked using a marking rubric Table 3.5 (refer to Appendix C), which provided a detailed explanation of how the learners were scored in the pre-test and post- test. The pre-test and the post-test were marked using the same marking rubric. One-way ANOVA was used as statistical measures to ascertain the comparability of the two groups (experimental and control) before treatment was carried out. This was done by analysing the results of the pre-test for both groups, in order to check if there was any statistically significant difference between the two groups. Furthermore, one-way ANOVA was used to test whether there was any statistically significant difference between the performance of the learners in the experiment group and control group after the treatment. In addition, F-test was used to ascertain whether the results from ANOVA are not occurring accidentally.

In addition, means and variances were used to lay the foundation for the analysis of the two achievement tests and the interpretation of charts, tables and graphs used in the descriptive statistics of the analysis. To complement the abovementioned methods, the gain scores were also analysed for each group. One-way ANOVA was further used to ascertain if there was a significant statistical difference between the means of the gain scores in the experiment group and the gain scores in the control group. Lastly, the analysis of the questionnaire that was administered only to the experimental group was done using descriptive statistics.

4.2 The research question and Hypothesis

4.2.1 The research question

Is there a statistically significant difference between the performance of learners who use computers and those who do not use computers for learning linear functions in Mathematics?

4.2.2 Hypothesis

A hypothesis is a tentative explanation that accounts for a logic of facts and can be tested by conducting an investigation (Muijs, 2012). Hypothesis for this study was formulated as follows:

Null hypothesis (H_o): There is no significant difference between the performance of learners who use computers and those who do not use computers for learning linear functions.

Alternative hypothesis (H_1): There is a significant difference between the performance of learners who use computers and those who do not use computers for learning linear functions.

4.3 The analysis of data and results: Learner performance

4.3.1 Pre-test

4.3.1.1 Baseline results

One-way Analysis of Variance (ANOVA) is a statistical test that seeks to establish that two or more data sets are significantly different from each other (Newby, 2010). ANOVA was used to determine whether there was a statistically significant difference in the means of the two groups (Experiment and control groups) in this study (Keselman & Lix, 2012; in Arthur, Waring, Coe, & Hedges, 2012). This was done to ascertain if the two groups were comparable, in terms of knowledge and understanding levels, before the treatment was carried out.

To achieve that, the following hypotheses were formulated:

H_0: $\mu_1=\mu_2$. Null hypothesis

H_1: $\mu_1 \neq \mu_2$. Alternative hypothesis

4.3.1.2 Result of ANOVA for the Pre-tests

One-way **ANOVA** was used to compare the means (μ) of the two independent groups. The P-value, computed using the results of the pre-test for both experiment and control group, was found to be greater than the significant value of 0, 001(0.1% = less than one in a thousand chance of being wrong). The P-value was found to be 0.074413 (Table 4.1), which indicates that there is no statistical difference between the means of the two tested group. Detailed pre-test scores of learners for experimental and control groups are found in Table 4.11 (refer to Appendix D).

Table 4.1:*Summary of ANOVA for pre-test*

Groups	*Count*	*Sum*	*Average*	*Variance*
Experimental	50	1076	21.52	72.29551
Control	50	919	18.38	79.30163

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	246.49	1	246.49	3.251908	0.074413	3.938111
Within Groups	7428.26	98	75.79857			
Total	7674.75	99				

The P-value (0.074413) is greater than the significant value of 0. 001, the null hypothesis was not rejected which implied that the alternative hypothesis should not be accepted. In simple terms, the results from ANOVA indicate that there was no statistically significant difference in the conceptual ability and the knowledge of the learners (in the control and experiment groups) before the treatment was carried out. As a result, any statistically significant difference in performance after treatment was viewed to have had resulted from different teaching methodologies.

4.3.2 Post test

4.3.2.1 Post-test results

The scores of learners in control group after being taught using the traditional method and those of the experimental group who were taught using computers simulations are shown in Table 4.12 (Appendix D). One-way Analysis of Variance (ANOVA) and F-test were used to analyse the scores. One-way ANOVA was used to compare the means (μ) of the two post-test; and F-test was used to test whether or not the variances of the two groups are equal. The following hypotheses were formulated in this regard:

ANOVA: Single Factor hypothesis – (see Section 4.2.2)

H_0: $\mu_1=\mu_2$. Null hypothesis

H_1: $\mu_1\neq\mu_2$. Alternative hypothesis

for ANOVA and F-test respectively.

4.3.2.1. Results of ANOVA for the post-tests

Anova: Single Factor
Hypothesis – (see Section 4.2.2)
H_0: $\mu_1=\mu_2$. Null hypothesis
H_1: μ_1<>μ_2. Alternative hypothesis

Table 4.2: *Summary of ANOVA for Post-test*

Groups	*Count*	*Sum*	*Average*	*Variance*
Experimental	50	3525	70.5	183.9286
Control	50	2377	47.54	418.7433

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	13179.04	1	13179.04	43.73538	1.99E-09	3.938111
Within Groups	29530.92	98	301.3359			
Total	42709.96	99				

Conclusion: Since the p value (0.00000000199) is less than 0.001, which is the significant value, it can be concluded that there was a statistically significant difference in the means of the two groups. So we reject the null hypothesis that states that there is no significant difference between the performance of learners who used computers and those who did not use computers and accept the alternative hypothesis that states, there is a significant difference between the performance of learners who used computers and those who did not use computers.

4.3.2.2 Result of the F-Test for the Post-tests

F-test was used to ascertain whether the above results occurred by accident or were expected. The following table (Table 4.3) shows the results of the F-test:

Table 4.3: *F-Test Two-Sample for Variances*

	Control	*Experimental*
Mean	47.54	70.5
Variance	418.7433	183.9286
Observations	50	50
df	49	49
F	2.276662	
P(F<=f) one-tail	0.002356	
F Critical one-tail	1.607289	

From the table, the F value (2.27) is greater than the F-Critical one-tail value (1.60). As a result, the null hypothesis was rejected, while the alternative hypothesis was accepted. As a result, there was a statistically significant difference in the variances of the two tests, which implies that ANOVA results are not accidental.

The differences that were shown by both ANOVA and F-test are evident that the two groups had different means and variances and that did not occur by chance. So, the use of computers for the teaching and learning of Mathematics on linear functions affects the learners' performance. To support the findings made from analysis through inferential statistics, descriptive statistics were used.

4.4 Descriptive statistics of the learners' scores

Descriptive analysis focused on comparison (McMillan & Schumacher, 2010). Group scores were compared using tables and graphs. A comparison of some important descriptive statistics of learners' scores in the post-test of control and experimental groups is provided in Table 4.4. It can be seen that in general the experimental group performed better than the control group in the post-tests.

Table 4.4: *Descriptive statistics of experimental and control groups for post-test.*

Experimental group		*Control group*	
Mean	70.5	Mean	47.54
Standard Error	1.91796	Standard Error	2.893936
Median	70	Median	45
Mode	70	Mode	45
Standard Deviation	13.56203	Standard Deviation	20.46322
Sample Variance	183.9286	Sample Variance	418.7433
Range	52	Range	85
Total	3525	Total	2377
Count	50	Count	50
Confidence Level (95.0%)	3.854285	Confidence Level (95.0%)	5.815582

The above table provides a comparison of some important descriptive statistics pertaining to the scores learners' in the control and experimental groups attained in the post-test. It is evident that in general the experimental group performed better than the control group in the post-tests. The two performances can be linked to the different methods of instruction used in each of the two groups. Consequently, it can be inferred that the computer based instruction produced a better result than the traditional method of instruction.

In what follows, the measurement of learners' scores in the achievement tests is considered. The pre-tests and post-tests of both the control group and the experimental group are compared, with a view to obtaining details of learners' performances.

4.4.1 Post-test pass rate for control and experimental groups

In this study, a pass mark means a score that is 50% or more; and a failure is any score below 50%. The pass rate, which is the percentage of all the learners who obtained 50 % or more, of the control group in the post-test was considered first. The table below shows the first five learners' scores. Detailed scores of learners' scores are presented in Table 4.5 (Appendix D)

Table 4.5: *Pass percentages in the control group for the post test*

Learners	Post-test %
1	53
2	63
3	70
4	80
5	63

From the table 4.5 (refer to Appendix D for detailed scores), it may be observed that 19 learners out of the 50 learners who wrote the test scored between 50% and 100%. This implies that 38% of the learners in the control group passed the test. The lowest mark was 15% while the highest mark was 100%. Only 10 learners out of the 50 scored 70% and above; which implies that 20% of the leaners who passed the post-test, in the control group, scored 70% and above.

Learners in the experimental group used computers as an intervention; their scores are shown in Table 4.6 (Appendix D). Only first five learner's scores are shown below.

Table 4.6: *Pass percentages in the experimental group for the post-test*

Learners	Passes (%)
1	53
2	70
3	70
4	80
5	50

Of the 45 learners Table 4.6 (refer to Appendix D for complete scores), that constitutes 90% of learners in the experimental group passed the post-test. The lowest mark was 5% while the highest mark was 95%. It is interesting to note that 28 out of 50 learners who passed scored 70% and above; which constitutes 56% of the passes, as against 20 % of passes in the control group.

Even though the highest mark in the control group was 100% the learner who came second scored 88%, whereas in the experimental group, the learner that took second position scored 93%. The third position in the control group was 80%, whereas in the experimental group it was 90%. In the control group, one has observed large gaps of 12 and 8 between the first and the second and the second and the third learners respectively, whereas the gaps between the first and the second, and the second and the third in the experimental group are 2 and 3 respectively. This shows a higher competitiveness in the experimental group than in the control group.

It was also important to compare the pass rate for the experimental and control groups for the post test visually. Figure 4.1 below shows the comparison.

4.4.1.1 Pass rate comparison of post-test for control and experimental groups

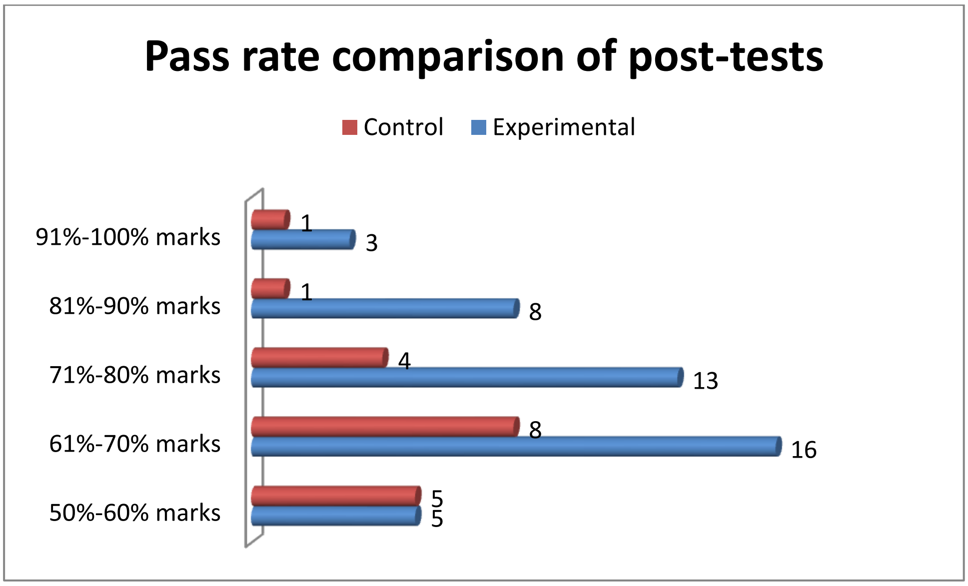

Figure 4.1: *Pass mark comparison of post-tests*

The above figure shows the number of learners who passed the post-test and also their score range. It may be seen that the experimental group performed better than the control group in all the class ranges, except for the lowest level of 50% to 60% where both groups have the same number of learners. In the second range (61% to 70% marks) the experimental group was double the number of the control group. The decline of the control group began in the 71%-80% mark range, where the number of the experimental group was triple the number of the control group. This achievement of the experimental group where they out-performed the control group may also be noticed in the 91%-100% mark range. Of great interest are the range 81% to 90% marks, where only one learner was recorded from the control group, as opposed to 8 learners in the experimental group. As much as a pass is considered important failure is considered much more important, because learners who fail need to be identified and given added attention. The five learners who attained the highest scores are listed in the Table 4.6. A detailed table of failure percentages in the post-test for the control group are shown in Table 4.7 (Appendix D)

4.4.1.2 Failure rate comparison of post-test for control and experimental groups

4.4.1.2.1 The Control group

The following table contains scores of learners in the control group who scored below 50% in the post-test. The table below only captures the first five learners' scores of the complete Table 4.7 in Appendix D.

Table 4.7: *Failure percentage in the control group for post-test*

Learner	Post-test %
1	25
2	18
3	33
4	23
5	23

The Table 4.7 (refer to Appendix D for detailed scores) indicates that the majority of the learners, that is 31 out of 50 learners, scored below 50% and they constitute 62% of the whole class. The lowest mark attained in this group was 15% while the strongest among the weak learners scored 45%.

4.4.1.3 The Experimental group

The table below indicates the scores of the learners in the experimental group who scored below 50%. The table below captures only the first five learners' scores of the completeTable 4.8 in Appendix D.

Table 4.8: *Failure in the experimental group for the post-test*

Learners	Failure (%)
1	45
2	43

3	48
4	43
5	48

The table shows that a minimal number of 5 learners, which constitutes 10% of the entire class from the experimental group, failed the post-test. The weakest among the weak learners in this category scored a 43%, while the strongest scored a 48%.

When compared with their counterparts in the control group, it is evident that the margins between the weakest and strongest among the weak learners are closer in experimental group and wider in the control group. In addition, the lowest in the experimental group ranked among the strongest in the control group. The figure below shows the comparison.

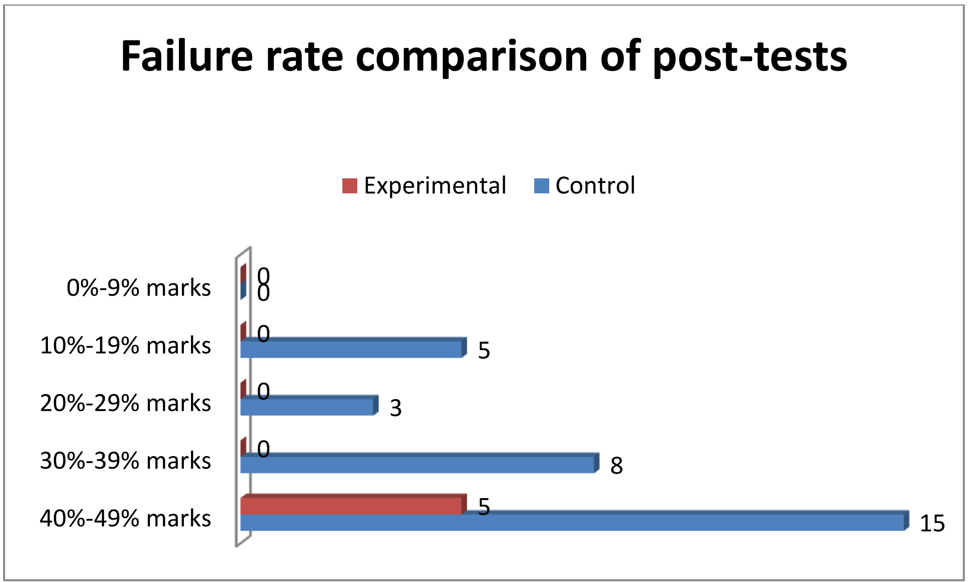

Figure4.2: *Failure rate comparison between control and experimental groups in post-test*

The above figure indicates failure rates in both groups. It may be observed that 15 learners in the control group who failed attained scores in the range of 40%-49% marks, which constitutes 48% of those in this category. It is of interest to note that, no one in the experimental group scored below 40%. Only five learners were recorded to have scored on the range of 40%-49% marks.

From this analysis, it is obvious that much more work needs to be done to help those who failed in the control group, especially with the 52% who scored below 40%.

The pre-tests and post-tests of the control and experimental groups are considered with a view to analysing these to establish the level of improvement within the same group and also between the two groups.

4.4.1.4 Learners score on the pre-test and post-test of the control and experimental groups

The next two figures show the line graphs of the control and experimental group learners' scores of both the pre-test and the post test for the purpose of visual comparison.

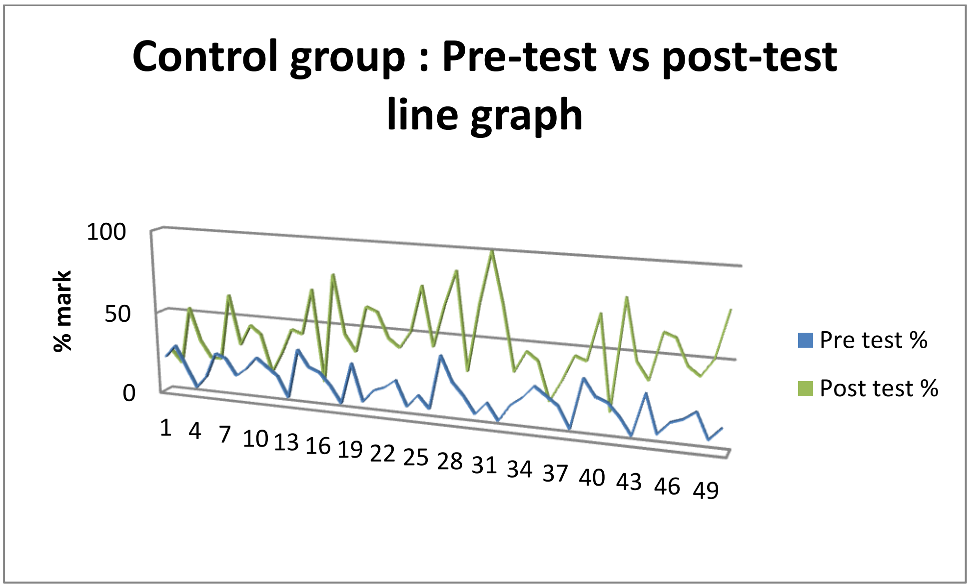

Figure4.3: *Line graph of pre-test and post-test scores of control group*

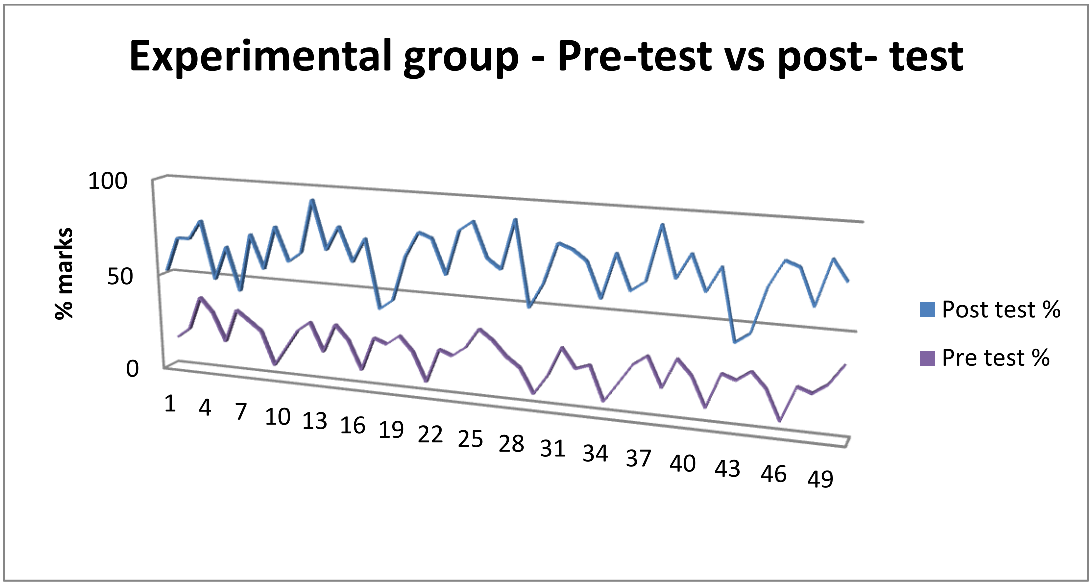

Figure 4.4: *Line graph of pre-test and post-test scores of experimental group*

From the figures above, it was clear that there was a general improvement in the scores of learners, when the pre-tests of the two groups are compared with the post-tests. However, a comparison of the two line graphs shows that the improvement in the experimental group is more pronounced than that of the control group. Most learners in the control group scored below 50% on pre-test whereas in the post-test there are few learners who scored more than 50%. In addition most learners in the experimental group ‘s pre-test also scored less than 50%, while in the post-test most of them scored more than 50%. It can be concluded that learners in experimental group on post test results, performed better than in the control group.

It also interest the researcher to identify the learners whose scores were improved in the post test, after being taught by the traditional method of instruction and computer assisted instruction in the control and experimental group respectively.

4.4.2 Gain scores for both control and experiment groups.

The gain score was used to measure the improvement of learners in the control and experimental groups. Thompson (2008) used gain score to assess the difference between two teaching instructions for reporting progress of learners. This study also use gain score to compare the improvements in control and experimental groups. The Table below shows the gain scores (post-test score minus pre-test score for individual learners) of learners in the experiment and control groups. The gain scores of the first five learners in the experiment group and their counterparts in the control group are presented on the table below (Table 4.9). Detailed scores of improvement rates are attached in Table 4.9 (Appendix D)

Table 4.9: *Control and experimental groups' improvement rate*

	Experiment group				Control Group		
	Pre-test	Post-test	Gain Score		Pre-test	Post-test	Gain Score
L1	15	53	38	L1	23	25	2
L2	20	70	50	L2	30	18	-12
L3	38	70	32	L3	18	53	35
L4	30	80	50	L4	5	33	28
L5	15	50	35	L5	13	23	10

From the table, it can be noticed that only 1 learner in the experiment group had a negative gain score, whereas there are five learners with negative gain scores in the control group. In addition, the mean gain score of experimental group is 48.18 % which is greater than the mean gain score of the control group of 29.71 %. To check if there was a significant statistical difference between the means of the experimental group and the control group, one-way ANOVA was computed using Microsoft Excel 2010. The following table shows the results of one-way ANOVA test:

Table 4.10 One-way ANOVA of gain scores

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Gain Scores (Experiment group)	49	2361	48,18367	298,2364
Gain Scores (Control group)	49	1456	29,71429	566,7917

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	8357,398	1	8357,398	19,32284	2,85E-05	3,940163
Within Groups	41521,35	96	432,514			
Total	49878,74	97				

From the table (Table 4.10), it can be noticed that the P-value (0, 0000285) is less than the significant value of 0.001. As a result, a conclusion, which states that there is a significant statistical difference between the means of the gain scores of the experiment group and that of the control group, was reached. The mean gain scores indicated that learners who were taught using computer simulations improved much better than the ones taught using traditional didactic methods.

4.4.3 Conclusion

It can be concluded that learners in the experimental group understood the concept and did well in post-test than those in the control group. In addition, one could attribute the success of the experimental group to the type of instruction they received which is computer based.

4.5 The analysis of data and results: Learner attitude

4.5.1 The questionnaires' research question

- How can the use of computers in the teaching of Mathematics on linear functions affect the attitude of learners towards the subject?

4.5.2 Analysis of the questionnaire

4.5.2.1 Descriptive statistics of responses and their interpretations

In order to capture the experiences of learners in the experimental group who used computer simulations in learning the concept of linear function. The researcher used a questionnaire for this purpose. Control group was not given the questionnaire because the focus was on the use of computers and attitude. Learners responded to the items in the questionnaire using the following Likert four type scale: Strongly disagree, disagree, agree and strongly agree. Gebrekal (2007) designed a questionnaire whereby respondents were required to indicate the extended to which they agree or disagree to each item on a Likert type scale. The questionnaire was used to assess the attitude of the respondents towards teaching and learning of

Mathematics (functions). In this study the same approach is used to measure the attitude of learners towards Mathematics in particular the topic of linear functions. Learners' attitude is defined as opinions (refer to section 1.6.4) on this study because learners gave their opinion on the use of computer in the teaching and learning of Mathematics (linear functions). Learners' responses were coded and presented with the following graphs and charts.

Learners in the experimental group's responses indicated that the use of computers increased an interest in the topic of linear functions. Overall 96% of learners supported the statement, out of which 20% strongly agreed while the majority which constitutes 76% merely agreed. It is interesting to note that the 4% of learners, who did not support the statement, were actually in strong disagreement as shown in figure 4.5, below.

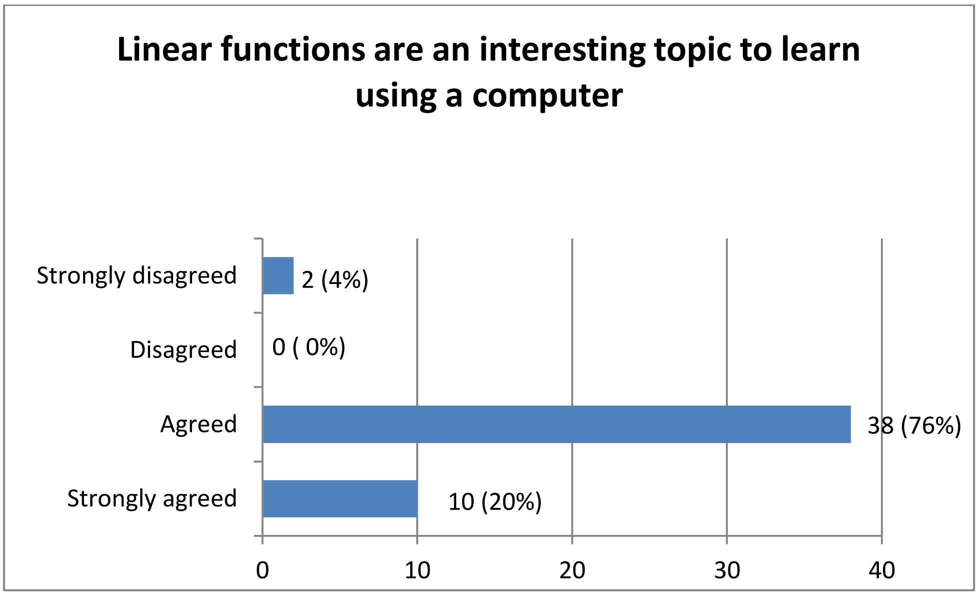

Figure 4.5: *Learners' interest to learn linear functions*

The responses represented by figure 4.6, about the convenience experienced when using computers to solve a linear function shows that all learners were in support of this statement. Those who strongly agreed with this statement are about a third while the remaining learners who agreed are more than two third of the class. The responses clearly showed that no one found the use of computer for learning inconvenient.

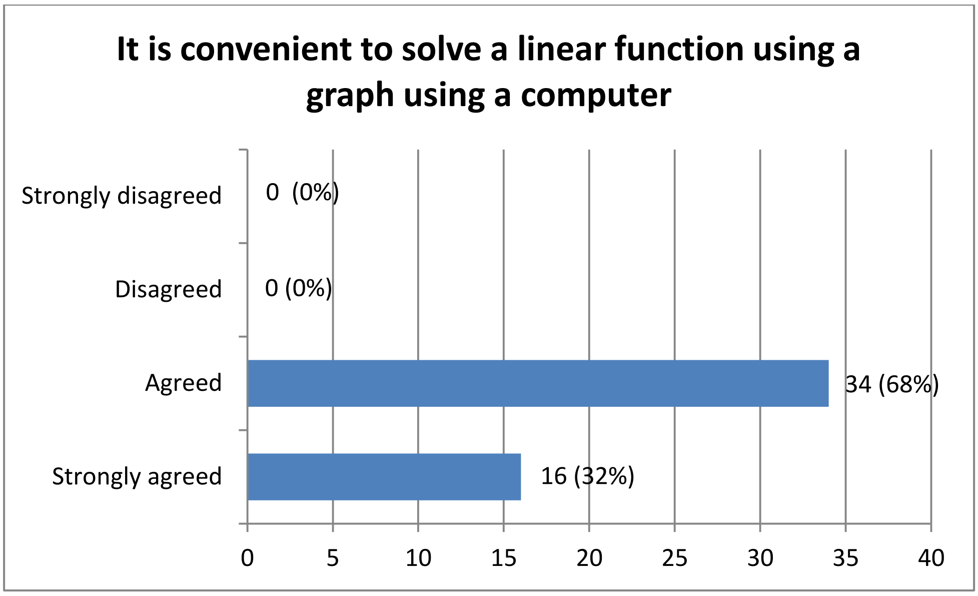

Figure 4.6: *Learners' convenience when using computer*

Creating a table of values for plotting a graph can be daunting and time consuming. Figure 4.7 shows the responses of learners on the creation of tables when using computers. Only 4% of learners strongly disagreed that the use of computers enables them to create tables of values of functions quickly. The remaining 96% support the statement. It was interesting to note that almost half of the class which constitutes 44% were at the other extreme and strongly in its support.

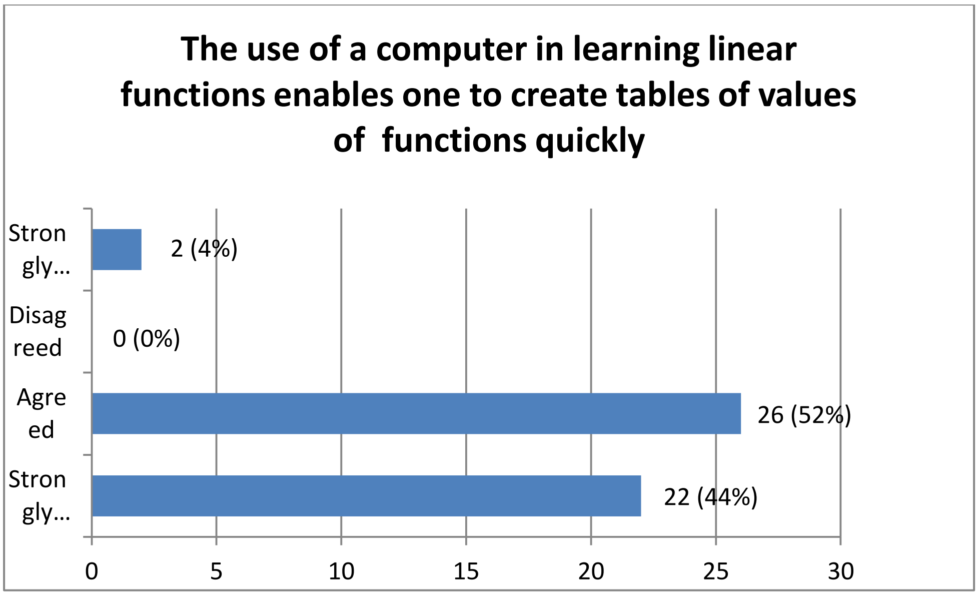

Figure4.7: *Creating tables of values when using computers*

Plotting graph manually can make plotting more difficult, when a learner has to scale the graph, locate origin of the graph and eventually identify coordinates. Whereas using computers for plotting linear graphs can be made easy, as indicated by the respondents in figure 4.8 below. This statement was supported by 92% of learners with only 8% who merely disagreed. None of them strongly disagreed.

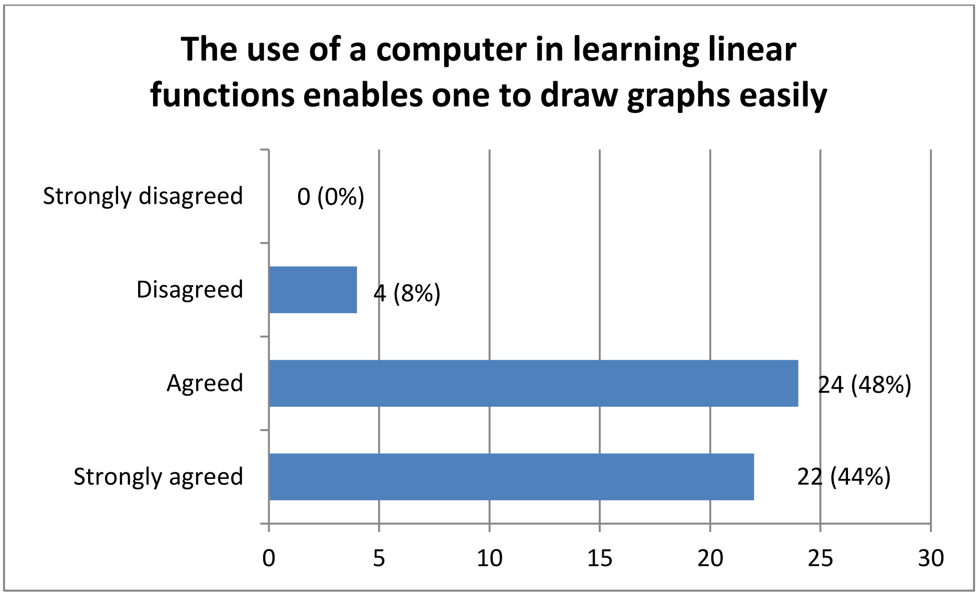

Figure4.8: *Plotting of graph when using computers*

The responses of learners on exploring the characteristics of linear graphs, that is: the effects of one variable on the other indicated that using computers enabled them to investigate the nature and properties of functions and the graphs. Strongly agreed 96% of learners were in support of this item. Those who disagreed were merely 4%.

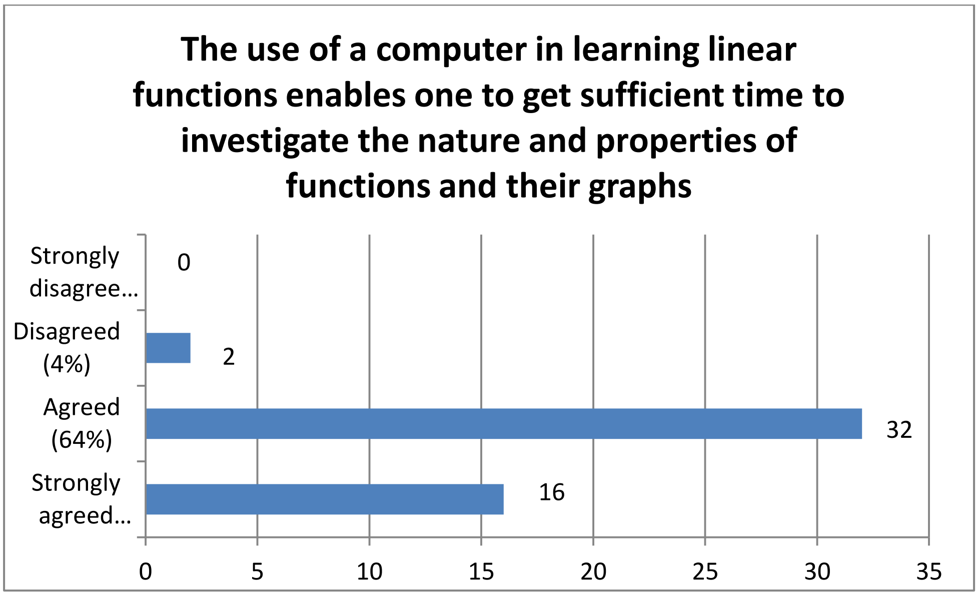

Figure4.9: *Nature and properties of functions and their graphs*

Working in a group is an opportunity provided by the use of computers in learning functions, which 96% of them supported. It was interesting to note that those who strongly agreed are in the majority; they were 8% more than those who merely agreed. The rest 4% also merely disagreed. These responses showed that using computers in learning linear functions provided opportunity for cooperation and group work.

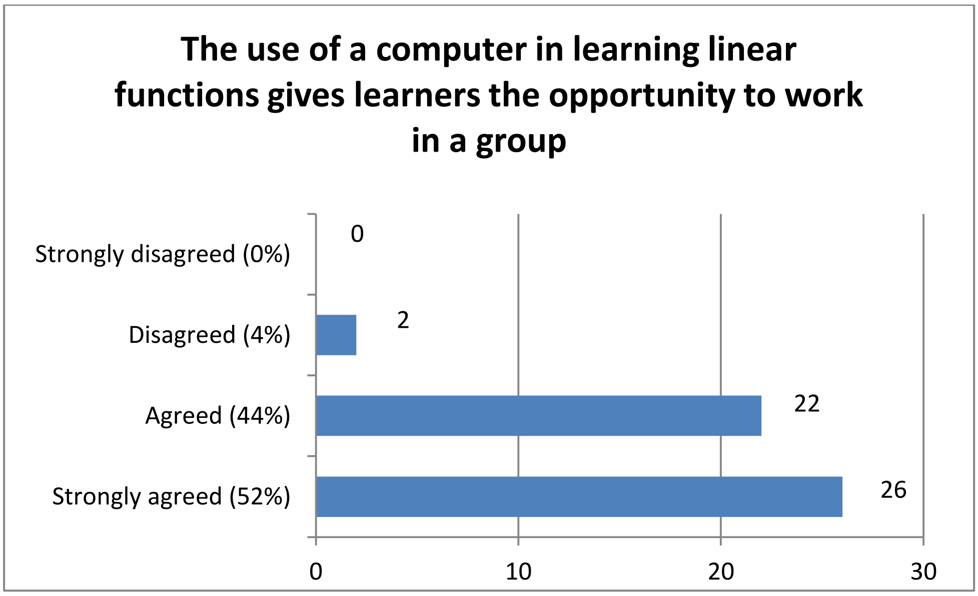

Figure 4.10: *Group work for cooperation*

Sharing views among learners is uncommon in a traditional Mathematics lesson. In this survey 92% of learners saw it as an opportunity to share their views because they were using computers to learn functions. Learners who strongly agreed about sharing their views were 36%, while 56% merely agreed. A minority that constitutes 4% disagreed with this view. One concluded that learning the concept of functions using computers gave opportunity for learners to share their views. It can also be observed that the use of computers encouraged sharing of ideas according to this data.

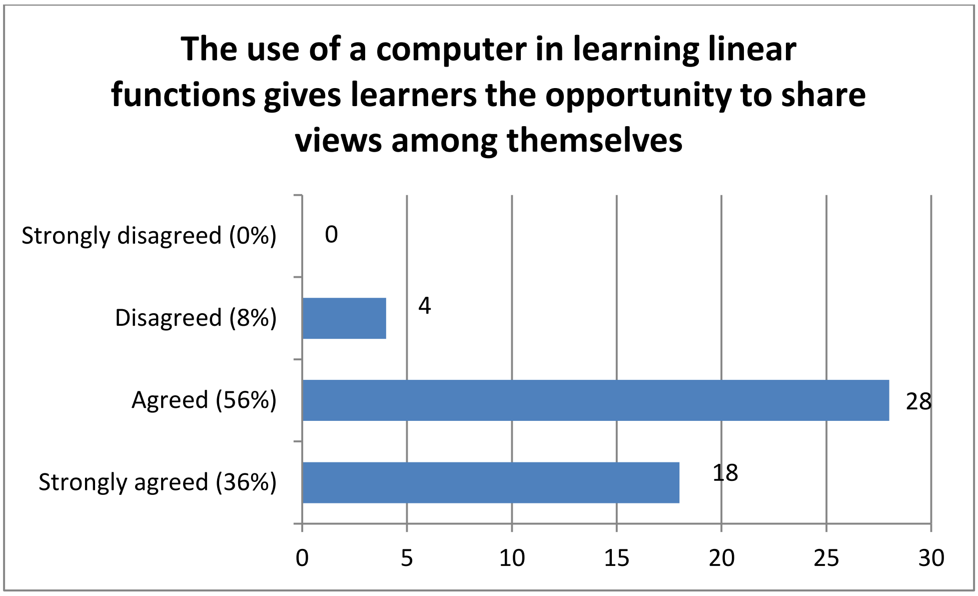

Figure4.11: *Learners get opportunity to share views amongst themselves*

The traditional teaching method is usually teacher centred and learners are passive recipients of information. However, learning with computers provided the opportunity for learners to engage with the teacher and share points of view together and learners are in support of computer learning. Those who strongly agreed are only 12% less than those who agreed. It may be observed that the use of computers encouraged the sharing of views as indicated by the respondents.

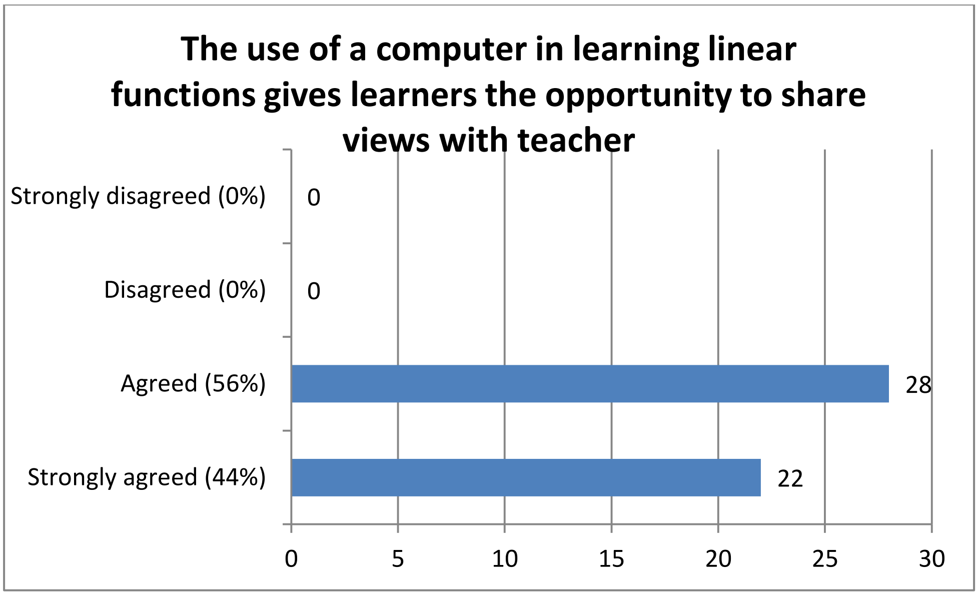

Figure4.12: *Learners get opportunity to share views with teacher*

Exploring of linear functions using computers spurs the interest of learners and motivated individual learners to solve problems on their own. This point was supported by 92% of learners with only 8% of them in disagreement. The emphasis was on learners' confidence and personality.

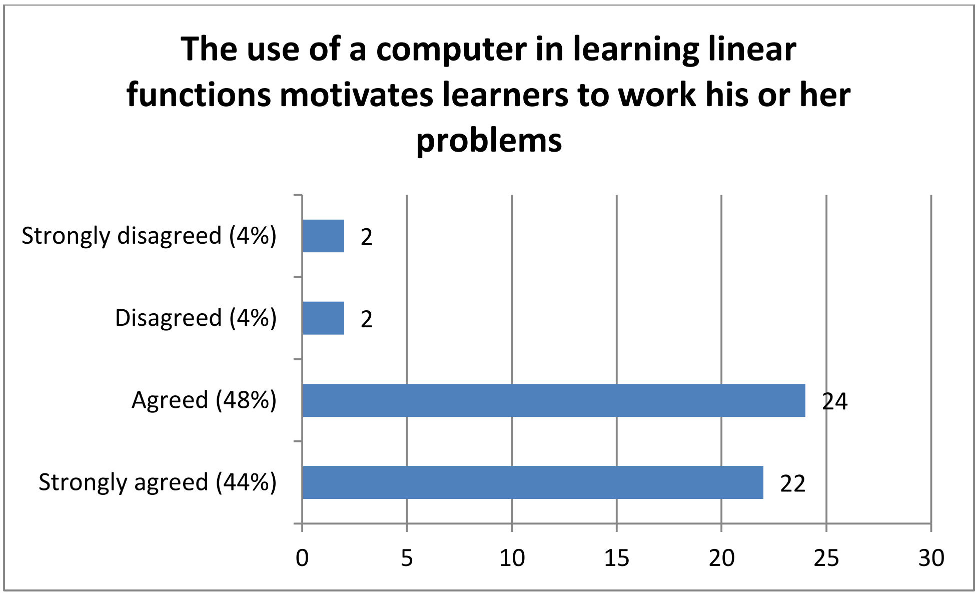

Figure 4.13: *The use of computers motivates learners to work their problems*

One of the problems in learning Mathematics is its abstractness, which is often experienced with the typical traditional teaching method of instruction. However, with the use of computers, all learners agreed that they had the opportunity to engage with real life mathematical problems on graphing. It was interesting to note that almost half of them, which constituted 48%, were in strong support of this statement.

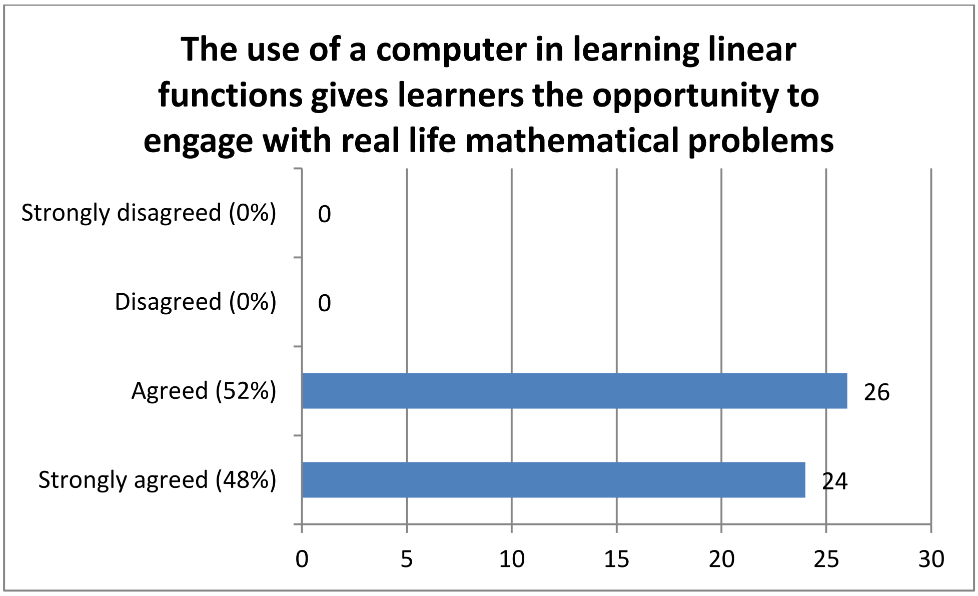

Figure4.14: *Learners are engaged with real life mathematical problems on graphing.*

4.6 Summary

In general, the analysis of the questionnaire's responses indicates that learning linear functions using computers had a positive effect on the learners attitude towards learning linear functions in Mathematics. Learners' performance also improved. Therefore, it can be concluded that learning linear functions using computers is important in Mathematics.

The next chapter discusses the summary of literature and findings of the study. It also focuses on the recommendations, limitations and conclusion of the study.

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter focuses on the summary of the literature review in relation to the results and the findings from the empirical study. It also presents the recommendation for future research, as well as the conclusion, and points out the limitations of the study. The purpose of this study was to investigate the effects on Grade 10 learners' performance when using computers for the teaching and learning of the Mathematical topic of linear functions, using the GeoGebra computer software package.

5.2 Summary of the chapters

The current study was motivated by poor performance of learners in the subject of Mathematics. Chapter 1 provided the background of the study and the evidence of poor performance of learners in Mathematics as evident in Table 1. The findings from this study showed that the learners' performance can improve when using computers effectively, particularly in learning linear functions as evident in figure 4.3 on pass rate comparison of post-test.

Chapter 2 discussed the literature reviewed and the theory in detail. In the school where this study was done, the researcher used computers where learners were actively involved in their learning. There was social interaction between the teacher and learners. This social interaction suggests that constructivist learning strategy was implemented. Learning was learner centred (Powell & Kalina, 2010), and learners in this study developed their own knowledge using computers and interacting amongst themselves and with their teacher, as is evident from questionnaire results on responses for item 6, 7 and 8. Shelly, Gunter & Gunter (2012) believe that technology integration shifts learning to a learner- centred approach, collaborative work and information exchange, as emphasised in constructivism.

The empirical study employed a quantitative research approach. The emphasis was on quasi-experimental design which involved the use of intact classes (Wiersma & Jurs 2009). In chapter 3 this approach was discussed as well as the population and the sample. The sample consisted of 100 participants, with 50 learners in control group and 50 in experimental group. Stolts (2012) used the same approach but with sample size of 284 participants because learners were in intact classes and randomisation was impossible. The Content Validity index was calculated (CVI=0.8) for test and questionnaire. Reliability was also calculated for test with Cronbach's ($\propto = 0.918$) and for questionnaire ($\propto = 0.807$), the alpha values showed that the instruments were reliable. The use of computers was found to be an appropriate method that made the subject more appealing to the learners in this technology driven society. Chapter 4 will be discussed on summary of finding.

What follows is the summary of literature reviewed integrated with findings

Many studies revealed that the use of technology improves learner performance (Stolts, 2012; Rowan & Bigum, 2012; Wolfram, 2010; Bester & Brand, 2013) as mirrored in this study, the achievement test results showed that learner performance had improved with the use of computers.

The study by Maree et al. (2005) on the experiential modification of a computer software package for graphing algebraic functions shows that technology has the potential to transform learning where learners make connections between formulae, graphs and tables. The focus of this study was on the topic of linear functions. It was evident in the diagnostic report of 2013 that learners in some schools were unable to determine and read the coordinates and find the equation of linear graphs (DBE, 2013a). Table 4.3 shows the variances of both groups, from this table it can be concluded that the use of computers had a positive effect on the experimental group.

The literature reviewed for this study highlighted that the use of technology does not only improves learners' performance in Mathematics but also boosts their confidence, motivation and helps develop a positive attitude towards Mathematics (Andrade-Arechiga, Lopez & Lopez Morteo 2012, Bester & Brand 2013 and Rowen & Bigum, 2012). Moreover, research indicates that learners with a negative attitude towards the use of computers results in a lack of success with the improvement of their Mathematics scores (Reed et al. 2010). The learners' questionnaire responses in this study indicated that the use of computers when learning linear functions in Mathematics had a positive effect on their attitude towards Mathematics (Figures 4.5 to 4.14).

Despite all this positive feedback about the use of technology on learners' attitudes and performance in Mathematics, there are other studies that indicated negative outcomes when using technology for the teaching and learning of Mathematics. The study by Njagi et al. (2011) showed that there was no change in learners' attitudes when using computers. In addition, Manoah, Indoshi and Othuon (2011) indicated that there was a neutral attitude towards Mathematics when technology was used. Gillespie and Walker (2012) argued that technology is less transforming and more disruptive to complex routine. These results on no change, neutral attitude and less transforming of using technology could be due to learners' resistance to change. The current study revealed that the use of computers (GeoGebra) on the teaching and learning of Mathematics in the topic of linear function effectively improved grade 10 learners' attitude and their performance as evident from the findings of this study.

5.3 Discussion of the research questions and the findings

There were two research questions posed for this study.

5.3.1. Research question 1

- *Is there a significant difference between the performance of learners who use computers and those who do not use computers for learning linear functions in Mathematics?*

At the beginning of the research, the participants in the experimental and control groups were given the same pre-test. The pre-test scores were analysed using SPSS on ANOVA and the results showed that the mean performance score of the experimental group was not significantly different from the mean score of the control group indicating that the two groups were comparable, at the initial stage of the study.

At the end of six weeks period of study, participants in both groups were given the same post-test. The experimental group were exposed to the use of computers for learning linear functions, while the control group used the traditional method. The results indicated that the mean performance score for the experimental group (μ=70.5) was significantly higher than that of the control group (μ=43.5). Based on these results the conclusion could therefore be made that the use of computers had positive effect on the learners' understanding of linear functions.

5.3.2 Research question 2

- *How can the use of computers in the teaching of Mathematics on linear functions affect the attitude of learners towards the subject?*

This question was also positively answered as is evident from the responses of participants. The results from the questionnaire indicated that most learners agree or strongly agree to the idea that, the use of computers in learning linear functions made the topic more interesting, enables the drawing of graphs more easily and quickly and assisted with discovery of the properties of graphs while sharing their views with the teacher and amongst themselves. The results showed that the use of computers had a positive effect on the learner's attitude towards Mathematics in learning linear functions. Nevertheless, the uses of computers had some challenges; the challenge observed by the teacher and learners was that the computer does not show point by point plotting. To overcome this challenge more advanced computer software could be used. However, despite the positive results, there were limitations to the study.

5.4 Concluding remarks concerning the study

Although technology has been used in many schools in South Africa for up to a decade, the integration into all subject areas in classroom practice has become a new way to transform pedagogy (Ramorola, 2010). The findings from this study indicated that the use of computers had positive effect on the learners' performance and understanding of linear functions. Moreover, the use of computers had a positive effect on the motivation, confidence and attitude of learners in Mathematics. The questionnaire responses showed that using computers assisted learners in drawing of graphs quickly and easily, discovering the properties of graphs and sharing their ideas. Learning in this digital age involves thinking critically in a detailed and analytic way (Starkey, 2012). The statement indicated that there was a need to change from teacher- centred instructions to learner-centred learning that is emphasised in constructivism. When technology is effectively integrated in learning and teaching, it improves learner performance. It is important to understand that technology will never serve as a substitute for the teacher (Lewis, 2013). Moreover, even the content on authentic websites will not constitute learning until the teacher develops an activity which suits the level of understanding on learners.

5.5 Limitations of the study

The study had limitations in respect of its scope and data collection processes. Data were collected at one school since not many schools have well-equipped computer laboratories with access to internet connections and mathematical software. Consequently, the findings of the study cannot be generalized to the entire population of Ekurhuleni North district. The other limitations was that, the computers software programmes are written in English and learners in the school where the study was done are English Second Language speakers, it was necessary to translate instructions.

Identifying the limitations could assist in the recommendation for future research. Despite the limitations the results obtained from this study are useful because the research questions were positively answered. The study has explored the effect of using computers for curriculum purpose, with the focus on improving learners' performance in the subject of Mathematics.

5.6 Recommendations

Based on the findings of this research, the following recommendations are proposed:

5.6.1 Further research is necessary to investigate what inhibits teachers from integrating technology in their classroom for teaching and learning.

5.6.2 Schools should develop a policy that could assist in monitoring the effective use of technology on learner performance.

5.6.3 Further research that monitors learner performance when using technology in learning Mathematics from Grade 1 up to Grade 12 should be conducted.

5.6.4 Technology in the classroom should be integrated with social constructivism approach were learning is learner centred.

5.6.5 Computers should be used effectively to teach other topics and those learners who learn using computers should be tested in examinations using computers not pen and paper.

5.7 Final reflections

The study investigated the use of computers for the teaching and learning of computers in Mathematics. The study ‘s contribution was in the subject of linear functions using GeoGebra software as there were few literature in South African research on this topic. It was proved with evidence that the use of computers improved learners’ performance. Learners were actively involved in deductive reasoning, creative, critical and analytic thinking when solving problems. They used equation and tables to draw graphs, seen the relationship between graphs and make a conclusion. The results also showed that learners’ attitude towards Mathematics improved, they were sharing ideas with the teacher and their peers that also boosted their confidence and motivation in this subject.

The researcher recommended that other topics be investigated using computers for teaching and the effects on learners’ performance. Researches are conducted on the use of computers from grade 1 to grade 12 using effective computer software and monitoring the effect on learners’ performance. Those learners who use computers for learning they should be assessed using computers as a way of ensuring that teachers get motivated to use computers for curriculum purpose.

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Appendix A Pre-test questions

PRE-TEST

Instructions

- **Answer all questions**
- **Show all the calculations**
- **Write neatly and clearly**
- **Answers will be treated confidentially**
- **Total marks, 40 marks**

1. Sketch the graphs of the following functions using a table method on the same set of axes**.** **[6]**

   $x \in R\{-2; -1; 0; 1; 2\}$

   a. $f(x) = x + 1$

   b. $g(x) = 2x + 1$

   c. $h(x) = 3x + 1$

2. Sketch the graphs of the following functions using dual intercept method on the same set of axes. **[6]**

   a. $j(x) = -x + 1$

   b. $v(x) = -2bx + 1$

   c. $q(x) = -3x + 1$

3. What can you conclude from observing the functions and the graphs in question1 and question2? Explain in detail **[2]**

4. Sketch the graphs of the following functions using the dual intercept method on the same set of axes **[6]**

   a. $u(x) = x + 1$

   b. $p(x) = x + 2$

   c. $r(x) = x + 3$

5. Sketch the graphs of the following functions using the table method on the same set of axes **[6]**

   $x \in R\{-2; -1; 0; 1; 2\}$

   a. $s(x) = -x + 1$

b. $b(x) = -x + 2$

c. $z(x) = -x + 3$

6. What can you conclude from observing the graphs and function in question4 and question5? Explain in detail **[2]**

7. Sketch the graph of this linear functions on the same set of axes, using dual intercept method **[8]**

a. $t(x) = 3 - x$

b. $k(x) = 1 - x$

c. $l(x) = -2 - x$

d. $m(x) = 3 - 2x$

7.1 The graphs of $t(x) = 3 - x$, $k(x) = 1 - x$ and $l(x) = -2 - x$,
7.1.1 Compare the three graphs and write your observation**.** **[1]**
7.1.2 What is their gradient? **[1]**
7.1.3 Which graphs cuts the y-axis at the same point? **[2]**

Appendix B Post-test questions

POST-TEST

Instructions

- **Answer all questions**
- **Show all the calculations**
- **Write neatly and clearly**
- **Answers will be treated confidentially**
- **Total marks, 40 marks**

1. Sketch the graphs of the following functions using a table method on the same set of axes**.** **[6]**

$x \in \mathbb{R} \{-2; -1; 0; 1; 2\}$

a $f(x) = x + 1$

b. $g(x) = 2x + 1$

c. $h(x) = 3x + 1$

2. Sketch the graphs of the following functions using dual intercept method on the same set of axes. **[6]**

a. $j(x) = -x + 1$

b. $v(x) = -2x + 1$

c. $q(x) = -3x + 1$

3. What can you conclude from observing the functions and the graphs in question1 and question2? Explain in detail **[2]**

4. Sketch the graphs of the following functions using the dual intercept method on the same set of axes **[6]**

a. $u(x) = x + 1$

a. $p(x) = x + 2$

b. $r(x) = x + 3$

5. Sketch the graphs of the following functions using the table method on the same set of axes **[6]**

$$x \in R\{-2; -1; 0; 1; 2\}$$

a. $s(x) = -x + 1$

b. $b(x) = -x + 2$

c. $z(x) = -x + 3$

6. What can you conclude from observing the graphs and function in question4 and question5? Explain in detail **[2]**

7. Sketch the graph of this linear functions on the same set of axes, using dual intercept method **[8]**

a. $t(x) = 3 - x$

a. $k(x) = 1 - x$

b. $l(x) = -2 - x$

c. $m(x) = 3 - 2x$

7.1 The graphs of $t(x) = 3 - x$, $k(x) = 1 - x$ and $l(x) = -2 - x$,
7.1.1 Compare the three graphs and write your observation**.** **[1]**
7.1.2 What is their gradient? **[1]**
7.1.3 Which graphs cuts the y-axis at the same point? **[2]**

Test questions were extracted from Classroom Mathematics learners book Grade 10 CAPS (Pike, Barnes, Jawurek, Kitto, Myburgh,Rhodes-Houghton, Scheiber, Sigabi & Wilson 2011). They were modified to measure the needs of the test in this study.

Appendix B1 Questionnaire reliability

Reliability for the questionnaire

Table 3.1 Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.911	.918	10

Table 3.1 Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Linear functions are an interesting topic to learn using a computer.	26.83	23.367	.980	.	.883
It is convenient to solve a linear function using a graph if you use a computer.	26.83	26.167	.563	.	.909
The use of a computer in learning linear functions enables one to create tables of values of the functions quickly.	27.00	26.800	.748	.	.901

The use of a computer in learning linear functions enables one to draw graphs easily.	26.83	23.367	.980	.	.883
The use of a computer in learning linear functions enables one to get sufficient time to investigate the nature and properties of the functions and their graphs	26.50	30.700	-.024	.	.941
The use of computers in learning linear functions gives students the opportunity to work in a group.	26.33	26.667	.443	.	.917
The use of computers in learning linear functions gives students the opportunity to share views among themselves.	26.67	25.067	.884	.	.892
The use of computers in learning linear functions gives students the opportunity to share views with the teacher.	26.67	25.067	.884	.	.892
The use of computers in learning linear functions motivates students to work his or her problems	26.67	23.467	.785	.	.895
The use of computers in learning linear functions gives students the opportunity to engage with real life mathematical problems.	26.67	23.467	.785	.	.895

Appendix B2 Test reliability

Table 3.2 Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.807	.807	10

Table 3.2 Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Question 1	16.88	48.982	-.065	.	.829
Question 2	16.88	38.982	.513	.	.786
Question 3	18.50	39.143	.703	.	.769
Question 4	16.88	40.982	.379	.	.803
Question 5	17.25	33.071	.546	.	.796
Question 6	18.50	39.429	.677	.	.771
Question 7	17.13	34.982	.784	.	.750
Question 8	18.13	42.696	.437	.	.795
Question 9	18.13	42.696	.437	.	.795
Question 10	18.38	43.125	.561	.	.789

Appendix C Questionnaire and Chapter 3 Tables

QUESTIONAIRE
Instructions

- **Answer all questions**
- **Circle your answer from the given alternatives**
- **Only circle the alphabet next to your answer**
- **Answers will be treated as private and confidential**
- **Answer as honest as you possibly can**
- **Mark allocation, is one mark per question**

A Linear functions are an interesting topic to learn using a computer.

1. Strongly disagree
2. Disagree
3. Agree
4. Strongly agree

B. It is convenient to solve a linear function using a graph if you use a computer.

1. Strongly disagree
2. Disagree
3. Agree
4. Strongly agree

c. The use of a computer in learning linear functions enables one to create tables of values of the functions quickly.

1. Strongly disagree
2. Disagree
3. Agree
4. Strongly agree

D. The use of a computer in learning linear functions enables one to draw graphs easily.

1. Strongly disagree
2. Disagree
3. Agree
4. Strongly agree

E. The use of a computer in learning linear functions enables one to get sufficient time to investigate the nature and properties of the functions and their graphs

1. Strongly disagree
2. Disagree
3. Agree
4. Strongly agree

F. The use of computers in learning linear functions gives students the opportunity to work in a group.

1. Strongly disagree
2. Disagree
3. Agree
4. Strongly agree

G. The use of computers in learning linear functions gives students the opportunity to share views among themselves.

1. Strongly disagree
2. Disagree
3. Agree
4. Strongly agree

H. The use of computers in learning linear functions gives students the opportunity to share views with the teacher.

1. Strongly disagree
2. Disagree
3. Agree
4. Strongly agree

I. The use of computers in learning linear functions motivates students to work his or her problems.

1. Strongly disagree
2. Disagree
3. Agree
4. Strongly agree

J. The use of computers in learning linear functions gives students the opportunity to engage with real life mathematical problems.

1. Strongly disagree
2. Disagree
3. Agree
4. Strongly agree

Table 3.5: Scoring of marks for each question in percentage

Scores in percentage	Explanation of scores (Answer)
0% - 30%	➢ No understanding ➢ Incorrect method and incorrect answer ➢ Insufficient working shown
31% -40%	➢ Little understanding ➢ Poor attempt ➢ Unsatisfactory strategy
41% - 50%	➢ Moderate understanding ➢ Wrong method but correct answer
51% - 60%	➢ Average understanding ➢ Good method but no answer ➢ Correct steps followed
61% - 70%	➢ Clear understanding ➢ Correct method and error on the answer
71% - 80%	➢ Appropriate understanding ➢ Very good method and error on the answer
81% -100%	➢ Excellent understanding ➢ Excellent method and correct answer ➢ All working clearly shown

Table 3.6: Test scores per question per learner (Pilot study) Reliability

LEARNER	TOTAL	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q7.1.1	Q7.1.2	Q7.1.3
TOTAL	OUT OF (40)	OUT OF(6)	OUT OF(6)	OUT OF(2)	OUT OF (6)	OUT OF (6)	OUT OF(2)	OUT OF(8)	OUT OF(1)	OUT OF (1)	OUT OF(2)
L1	18	6	0	0	6	6	0	0	0	0	0
L2	22	6	3	2	6	1	1	0	1	1	1
L3	32	6	6	2	3	3	2	6	1	1	2
L4	28	3	3	1	6	6	2	4	1	1	1
L5	20	6	6	2	3	3	0	0	0	0	0
L6	12	3	2	0	3	0	2	0	1	1	0
L7	30	3	3	2	6	6	2	4	1	1	2
L8	09	3	3	0	0	0	0	0	1	1	1

Table 3.7: Responses on questionnaire items (Pilot study) of the experimental group

RESPONSE	ITEM A	ITEM B	ITEM C	ITEM D	ITEM E	ITEM F	ITEM G	ITEM H	ITEM I	ITEM J
STRONGLY DISAGREE	1	0	1	0	0	0	0	0	1	0
DISAGREE	0	0	0	2	1	1	2	0	1	0
AGREE	19	16	14	12	16	10	14	12	11	13
STRONGLY AGREE	5	9	10	11	8	14	9	12	12	12

Appendix D Chapter 4 Tables

Table 4.11 Pre-test scores for experimental and control groups

EXPERIMENTAL GROUP		CONTROL GROUP	
Learner	Scores in percentage	Learner	Scores in percentage
L1	15	L1	23
L2	20	L2	30
L3	38	L3	18
L4	30	L4	5
L5	15	L5	13
L6	33	L6	28
L7	28	L7	25
L8	23	L8	15
L9	5	L9	20
L10	15	L10	28
L11	25	L11	23
L12	30	L12	18
L13	15	L13	5
L14	30	L14	35
L15	23	L15	25
L16	8	L16	23
L17	25	L17	15
L18	23	L18	5
L19	28	L19	30
L20	20	L20	8
L21	5	L21	15
L22	23	L22	18
L23	20	L23	23
L24	25	L24	8
L25	35	L25	15
L26	30	L26	8
L27	23	L27	40
L28	18	L28	25
L29	5	L29	18
L30	15	L30	8
L31	30	L31	15
L32	20	L32	5
L33	23	L33	15
L34	5	L34	20
L35	15	L35	28
L36	25	L36	23
L37	30	L37	18
L38	15	L38	5
L39	30	L39	35
L40	23	L40	25
L41	8	L41	23
L42	25	L42	15
L43	23	L43	5
L44	28	L44	30

L45	20	L45	8
L46	5	L46	15
L47	23	L47	18
L48	20	L48	23
L49	25	L49	8
L50	35	L50	15

Table4.12: Post-test scores for experimental and control groups

EXPERIMENTAL GROUP		CONTROL GROUP	
Learner	Scores in percentage	Learner	Scores in percentage
L1	53	L1	25
L2	70	L2	18
L3	70	L3	53
L4	80	L4	33
L5	50	L5	23
L6	68	L6	23
L7	45	L7	63
L8	75	L8	33
L9	58	L9	45
L10	80	L10	40
L11	63	L11	18
L12	68	L12	30
L13	95	L13	45
L14	70	L14	43
L15	83	L15	70
L16	5	L16	15
L17	78	L17	80
L18	43	L18	45
L19	48	L19	35
L20	70	L20	63
L21	83	L21	60
L22	80	L22	45
L23	63	L23	40
L24	85	L24	50
L25	90	L25	78
L26	73	L26	43
L27	68	L27	68
L28	93	L28	88
L29	50	L29	30
L30	63	L30	70
L31	83	L31	100
L32	80	L32	70
L33	75	L33	33
L34	58	L34	45
L35	80	L35	40
L36	63	L36	18
L37	68	L37	30
L38	95	L38	45

L39	70	L39	43
L40	83	L40	70
L41	65	L41	15
L42	78	L42	80
L43	43	L43	45
L44	48	L44	35
L45	70	L45	63
L46	83	L4	60
L47	80	L47	45
L48	63	L48	40
L49	85	L49	50
L50	75	L50	78

Table 4.5: Pass percentages in the control group of the post-test

Learners	Post-test %
1	53
2	63
3	70
4	80
5	63
6	60
7	50
8	78
9	68
10	88
11	70
12	100
13	70
14	70
15	80
16	63

17	60
18	50
19	78

Table 4.6: Pass percentages in the experimental group of the post-test

Learners	Passes (%)
1	53
2	70
3	70
4	80
5	50
6	68
7	75
8	58
9	80
10	63
11	68
12	95
13	70
14	83
15	65
16	78
17	70
18	83
19	80

20	63
21	85
22	90
23	73
24	68
25	93
26	50
27	63
28	83
29	80
30	75
31	58
32	80
33	63
34	68
35	95
36	70
37	83
38	65
39	78
40	70
41	83
42	80
43	63
44	85

45	75

Table 4.7: Failure percentages in the control group of the post-test

Learner	Post-test %
1	25
2	18
3	33
4	23
5	23
6	33
7	45
8	40
9	18
10	30
11	45
12	43
13	15
14	45
15	35
16	45
17	40
18	43
19	30
20	33
21	45

22	40
23	18
24	30
25	45
26	43
27	15
28	45
29	35
30	45
31	40

Table 4.9: Improvement rates of the control group

Learners	Control group Improvement %
1	2
2	-12
3	35
4	28
5	10
6	-5
7	38
8	18
9	25
10	12
11	-5

12	18
13	40
14	8
15	45
16	-8
17	65
18	40
19	-5
20	55
21	45
22	27
23	17
24	42
25	63
26	35
27	28
28	63
29	12
30	62
31	85
32	65
33	18
34	25
35	12
36	-5

37	12
38	40
39	8
40	45
41	-8
42	45
43	40
44	5
45	55
46	45
47	27
48	17
49	42
50	63

Table 4.9: Improvement rates of the experimental group

Learners	Improvement %
1	38
2	50
3	32
4	50
5	35
6	35
7	17
8	52

9	53
10	65
11	38
12	38
13	80
14	40
15	60
16	-3
17	53
18	20
19	20
20	50
21	78
22	57
23	40
24	60
25	55
26	43
27	45
28	75
29	45
30	48
31	53
32	60
33	52

34	53
35	65
36	38
37	30
38	80
39	40
40	60
41	57
42	53
43	20
44	42
45	50
46	78
47	57
48	43
49	60
50	40

Table 4.13: Learners' responses to each questionnaire item

ITEM	STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE
Linear functions are an interesting topic to learn using a computer	10	38	0	2
It is convenient to solve a linear unction using a graph on a computer	16	34	0	0
The use of computer in learning linear functions enables one to create tables of values of function quickly	22	26	0	2
The use of a computer in learning linear functions enable one to draw graphs easily	22	24	4	0
The use of a computer in learning linear function	16	32	2	0

enables one to get sufficient time to investigate the nature and properties of functions and their graphs				
The use of computer in learning linear functions gives learners the opportunity to work in groups	26	22	2	0
The use of a computer in learning linear functions gives learners the opportunity to share views amongst themselves	18	28	4	0
The use of a computer in learning linear functions gives learners the opportunity to share views with the teacher	22	28	0	0
The use of a computer in learning linear functions motivates learners to work his or her problems	22	24	2	2
The use of a computer in learning linear functions gives learners the opportunity to engage with real life mathematical problems	24	26	0	0

Table 4.15: illustrate the responses of learners to each item in the questionnaire.

Appendix E Permission letter to parents

16118 James Doughlas Street
Daveyton
1520
04 March 2014

Dear Parent/ Guardian

PERMISSION FOR CHILD TO PARTICIPATE IN RESEARCH PROJECT
This letter serves to request your permission for your child/ward to participate in a research project which I will be conducting.

My name is Ramaesela Jerminah Khobo and I am a student at the University of South Africa, studying towards a Master's Degree in Mathematics Education. The purpose of my research is to identify strategies to improve the teaching and learning of Mathematics as well as to improve learners' performance.
Consequently, I request your permission to allow your child/ward to participate in this research project. Learners will be required to write tests and answer questionnaires. All information provided will be confidential and the learner may withdraw at any time without penalty. Under no circumstance will your child's name be mentioned in the research.
The research will be conducted after school hours during the third term of the school year. Letters will be sent to participants to inform them on the findings of this study.

Any questions regarding the study may be directed to the researcher on this cell phone number 0724513811 and e-mail address k.glenda@vodamail.co.za. My supervisor: Dr M. M. Phoshoko may also be contacted on 0124296993.

I will appreciate your assistance in this regards.
Yours faithfully

Khobo R. J

I……………………………………………………………, the parent/guardian

of ……………………………………………………………………, grant a permission for

my child to participate in the research.

…………………………………………….. ……………………………

Signature of parent/guardian Contact numbers

Appendix F Permission letter to learners

16118 James Doughlas Street
Daveyton
1520
04 March 2014

Dear Learner

PERMISSION TO PARTICIPATE IN RESEARCH PROJECT

This letter serves to request your permission to participate in a research project which I will be conducting.

My name is Ramaesela Jerminah Khobo and I am a student at the University of South Africa, studying towards a Master's Degree in Mathematics Education. The purpose of my research is to identify strategies to improve the teaching and learning of Mathematics as well as to improve learners' performance.

Consequently, I request your permission to participate in this research project. You will be required to write tests for an hour and answer questionnaires for 30 minutes. All information provided will be confidential and the learner may withdraw at any time without penalty. Under no circumstance will your name be mentioned in the research. You will benefit by acquiring computer skills and you should also discuss your participation with your parents before signing the form. Your parents will receive the copy of your signed assent form.

The research will be conducted after school hours during the third term of the school year. Letters will be sent to participants to inform them on the findings of this study.

Any questions regarding the study may be directed to the researcher on this cell phone number 0724513811 and e-mail address k.glenda@vodamail.co.za. My supervisor: Dr M. M. Phoshoko may also be contacted on 0124296993.

I will appreciate your assistance in this regards.

Yours faithfully

Khobo R. J

I……………………………………………the learner hereby grant a permission to participate in the research.

……………………………………………….   ……………………………

Signature of learner   Contact numbers

Appendix G Permission letter to teachers

16118 James Doughlas Street
Daveyton
1520
04 March 2014

Dear Teacher

PERMISSION TO PARTICIPATE IN RESEARCH PROJECT

This letter serves to request your permission to participate in a research project which I will be conducting.

My name is Ramaesela Jerminah Khobo and I am a student at the University of South Africa, studying towards a Master's Degree in Mathematics Education. The purpose of my research is to identify strategies to improve the teaching and learning of Mathematics as well as to improve learners' performance.

Consequently, I request your permission to participate in this research project. You will be required to teach learners using chalkboard and also using computers for an hour. All information provided will be confidential and the teacher may withdraw at any time without penalty. Under no circumstance will your name be mentioned in the research. You will benefit by acquiring computer skills and gain in depth content knowledge. Learners will be selected using stratified random sampling. Two teachers will also participate in the study.

The research will be conducted after school hours during the third term of the school year. Letters will be sent to participants to inform them on the findings of this study.

Any questions regarding the study may be directed to the researcher on this cell phone number 0724513811 and e-mail address k.glenda@vodamail.co.za. My supervisor: Dr M. M. Phoshoko may also be contacted on 0124296993.

I will appreciate your assistance in this regards.

Yours faithfully

Khobo R. J

I, ……………………………………………………………, the teacher willingly grant a permission to participate in the research.

……………………………………………. ……………………………

Signature of teacher Contact numbers

Appendix H Permission letter to Principal

16118 James Doughlas street
Daveyton
1520
04 March 2014

The Principal
Unity secondary school
1182 Britz & Matthewson Street
Daveyton
1520

Dear Sir/ Madam

PERMISSION TO CONDUCT A RESEARCH PROJECT

This letter serves to request your permission to conduct a research project.
My name is Ramaesela Jerminah Khobo and I am a student at the University of South Africa, studying towards a Master's Degree in Mathematics Education. The purpose of my research is to identify strategies to improve the teaching and learning of Mathematics as well as to improve learners' performance.
Consequently, I request permission to conduct a research in your school. I understand that as a researcher I am bound by ethics of the research to respect confidentiality. All information provided will be treated as private and confidential. Under no circumstance will the name of the school be mentioned in the research. Learners will be selected using stratified random sampling. Two teachers and approximately 67 learners will participate in the study. The research will be conducted after school hours. Learners will be required to write a test for an hour and answer questionnaire for 30 minutes and teachers will be required to teach learners for an hour. The research will be conducted after school hours during the third term of the school year. Letters will be sent to the institution to inform them on the findings of this study.
Any questions regarding the study may be directed to the researcher on this cell phone number 0724513811 and e-mail address k.glenda@vodamail.co.za. My supervisor: Dr M. M. Phoshoko may also be contacted on 0124296993.

I will appreciate your cooperation in this regards.

Yours faithfullly

Khobo R. J

I,…………………………………………………………the principal of the above mentioned school grant a permission to Khobo R.J to conduct research in the school

…………………………………………. ……………………………

Signature of the Principal Contact numbers

Appendix I Permission letter to GDE

16118 James Doughlas Street
Daveyton
1520
04 March 2014

Office of the Director
Gauteng Department of Education
111 Commissioner Street
Johannesburg
2000

Dear Sir/ Madam

PERMISSION TO CONDUCT A RESEARCH PROJECT

This letter serves to request your permission to conduct a research project.

My name is Ramaesela Jerminah Khobo and I am a student at the University of South Africa, studying towards a Master's Degree in Mathematics Education. The purpose of my research is to identify strategies to improve the teaching and learning of Mathematics as well as to improve learners' performance.

Consequently, I request permission to conduct a research in one of your schools in your district. I understand that as a researcher I am bound by ethics of the research to respect confidentiality. All information provided will be treated as private and confidential. Learners will be selected using stratified random sampling. Two teachers and approximately 67 learners will participate in the study. Learners will be required to write a test for an hour and answer questionnaire for 30 minutes and teachers will be required to teach learners for an hour.

Under no circumstance will the school's name be mentioned in the research. The research will be conducted after school hours during the third term of the year.

Letters will be sent to the institution to inform them on the findings of this study.

Any questions regarding the study may be directed to the researcher on this cell phone number 0724513811 and e-mail address k.glenda@vodamail.co.za. My supervisor: Dr M. M. Phoshoko may also be contacted on 0124296993.

I will appreciate your cooperation in this regards.

Yours faithfully

Khobo R. J

Appendix J Permission letter to District Office

16118 James Doughlas street
Daveyton
1520
04 March 2014

Office of the district Director
Ekurhuleni North District
59 Munpen Building
Benoni
1500Dear Sir/ Madam

PERMISSION TO CONDUCT A RESEARCH PROJECT

This letter serves to request your permission to conduct a research project.

My name is Ramaesela Jerminah Khobo and I am a student at the University of South Africa, studying towards a Master's Degree in Mathematics Education. The purpose of my research is to identify strategies to improve the teaching and learning of Mathematics as well as to improve learners' performance.

Consequently, I request permission to conduct a research in one of your schools in your district. I understand that as a researcher I am bound by ethics of the research to respect confidentiality. All information provided will be treated as private and confidential. Learners will be selected using stratified random sampling. Two teachers and approximately 67 learners will participate in the study. Learners will be required to write a test for an hour and answer questionnaire for 30 minutes and teachers will be required to teach learners for an hour.

Under no circumstance will the school's name be mentioned in the research. The research will be conducted after school hours during the third term of the year. Letters will be sent to the institution to inform them on the findings of this study.

Any questions regarding the study may be directed to the researcher on this cell phone number 0724513811 and e-mail address k.glenda@vodamail.co.za. My supervisor: Dr M. M. Phoshoko may also be contacted on 0124296993

I will appreciate your cooperation in this regards.

Yours faithfully

Khobo R. J

Appendix K GDE research approval letter

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

For administrative use:
Reference no. D2014/215

GDE RESEARCH APPROVAL LETTER

Date:	23 August 2013
Validity of Research Approval:	23 August 2013 to 20 September 2013
Name of Researcher:	Khobo R.J.
Address of Researcher:	16118 James Doughlas Street
	Daveyton
	1520
Telephone Number:	072 451 3811
Fax Number:	011 965 1503
Email address:	k.glenda@vodamail.co.za
Research Topic:	The effects of using computers for teaching and learning of Mathematics
Number and type of schools:	ONE Secondary School
District/s/HO	Ekurhuleni North

Re: Approval in Respect of Request to Conduct Research

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

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

2013/08/26

1

Making education a societal priority

Office of the Director: Knowledge Management and Research
9th Floor, 111 Commissioner Street, Johannesburg, 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0506
Email: David.Makhado@gauteng.gov.za

1. *The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*
4. *A letter / document that outlines the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
8. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
11. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
12. *On completion of the study the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.*
13. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

[signature] ....

Dr David Makhado
Director: Education Research and Knowledge Management

DATE: 2013/08/26 ....

Office of the Director: Knowledge Management and Research
9th Floor, 111 Commissioner Street, Johannesburg, 2001
P.O. Box 7710, Johannesburg, 2000 Tel: (011) 355 0506
Email: David.Makhado@gauteng.gov.za

Appendix L UNISA Ethics Clearance Certificate

UNISA | college of education

Research Ethics Clearance Certificate

This is to certify that the application for ethical clearance submitted by

RJ Khobo [44496362]

for a M Ed study entitled

The effects of using computers for teaching and learning of mathematics at Secondary School

has met the ethical requirements as specified by the University of South Africa College of Education Research Ethics Committee. This certificate is valid for two years from the date of issue.

Prof KP Dzvimbo
Executive Dean : CEDU

Dr M Claassens
CEDU REC (Chairperson)
mcdtc@netactive.co.za

Reference number: 2014 MAY /44496362/MC

19 MAY 2014