

**INTEGRATING INFORMATION COMMUNICATION AND TECHNOLOGY
IN MATHEMATICS EDUCATION AT SECONDARY LEVEL, A CASE OF
NAIROBI COUNTY, KENYA**

BY

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DECLARATION

I confirm that this thesis is my original work and has not been presented in any other university/institution for certification. The thesis has been complemented by referenced works duly acknowledged. Where text, data, graphics, pictures or tables have been borrowed from other works- including the internet, the sources are specifically accredited through referencing in accordance with anti-plagiarism regulations.

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DEDICATION

I dedicate this thesis in honour of my mother, JOYCE ANGAI AMUKO. In the memory, of my father, JETHRON AMUKO OBULUSTA.

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I would like to thank the Almighty God for providing resources and giving me strength to complete my Masters programme in spite of the various challenges, I have encountered. To God be the glory.

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ACRONYMS

CEMASTE	Centre for Mathematics, Science and Technology Education in Africa
CFSK	Computer for Schools Kenya
ICT	Information Communication and Technology
KCSE	Kenya Certificate and Secondary Education
KESI	Kenya Education Staff Institute
KISE	Kenya Institute of Special Education
KICD	Kenya Institute of Curriculum Development
MoE	Ministry of Education
MTQ	Mathematics Teacher Questionnaire
NEPAD	New Partnership for Africa's Development
NI₃C	National ICT Innovation and Integration Centre
SMASE	Strengthening Mathematics and Science in Secondary Education
SRL	Self-regulated Learning
SQ	Students Questionnaire
TPACK	Technological Pedagogical Content Knowledge
T.S.C	Teachers Service Commission
UNESCO	United Nation Educational Scientific and Cultural Organization

ABSTRACT

The purpose of this study was to explore the various challenges and opportunities influencing integration of ICT in teaching and learning Mathematics in secondary schools in Nairobi County. The study sought to: Determine the levels of ICT integration in teaching and learning Mathematics; identify the challenges and opportunities of ICT use in teaching and learning Mathematics; and identify best pedagogical practices used in teaching Mathematics using ICT. The study adopted Rogers's diffusion theory, whereby the user or adopter is critical in the whole process. The study, adopted a descriptive survey research design hence data were largely descriptive in nature. Three instruments were used to determine the results in the study: teachers and student questionnaires', a structured interview schedule for the deputy heads of department and an observation checklist. The study was carried out in twelve public secondary schools in Nairobi County. The schools included three National schools and nine County schools. The study adopted purposive sampling to select teachers, while simple random sampling to select schools, deputy principals and Form Three students. The sample comprised two hundred and ninety nine (299) respondents. The sample of the study included twelve secondary schools, twelve Mathematics teachers, two hundred and seventy five (275) form three students and twelve heads of Mathematics department. Data analysis was done using Statistical Package for Social Sciences (SPSS) version 20, which involved the use of percentages and frequency tables. The findings indicated that there were low levels of ICT integration; Mathematics teachers are not well prepared to integrate ICT in teaching Mathematics. The study concluded that, despite, the major challenges faced by teachers, they are expected to develop their technological skills and knowledge as well as use ICTs in their teaching. This study recommends that students be allowed to use smartphones for learning purpose only and teachers to be trained on how to integrate ICT in teaching and learning Mathematics during their pre-service course and in-service practice.

CHAPTER ONE

INTRODUCTION

1.1 Preamble

This chapter entails the background to the study, statement of the problem, the purpose of the study, the objectives of the study, the research question, the assumption of the study and the theoretical framework based on the Rogers diffusion theory. The chapter also contains the conceptual framework illustrating the relationship between the dependent variable, independent variables and the intervening variables and lastly, the operational definition of key terms in the study.

1.2 Background to the Study

The history of Mathematics instruction is full of examples that confirm the critical role of certain tools in the conceptual development of Mathematics as a scientific discipline. The most prominent, recent and modern tool for teaching is Information Communication and Technology (ICT) (Laborde and Sträßer, (2010)). ICT refers to forms of technology that are used to transmit, process, store, create, display, share or exchange information by electronic means (UNESCO, (2007)). According to Miles and Singal (2010), ICT stands for many different types of electronic systems which include LCD projectors, ipods, smart boards, fax machines, cyber schools, printers, scanners, digital/video cameras, radio, television, DVDs, landline cellular phones, calculators and networks and various computer software, video conferencing, instant-messaging, blogs and e-mail.

There are several benefits of using ICT in teaching and learning Mathematics. ICT has the potential to transform the nature of education; improving teacher's design work, enhancing the roles of students and teachers in the learning process and helping to create a collaborative learning environment (Amuko, Miheso and Ndeithu, (2015)). As a result, the integrating of ICT in teaching and learning is high on the educational reform agenda of developed and developing countries. For developing countries, ICT can be seen as a way to merge and even leapfrog into a globalizing, technological world. In spite of this, the use of ICT for teaching is limited at best (Peeraer and Van Petegem, (2011)).

The Gachathi report (1976), noted that the 7-4-2-3 system of education lacked the capacity and flexibility to respond to the changing aspiration of individual Kenyans and the labour market needs in term, of new skills, new technologies and the attitude to work (Wanjohi 2011)). Integration of ICT in teaching and learning Mathematics in the Kenyan secondary schools, prepares learners, to be able to meet Kenya's labour market demand. ICT has the potential to improve the educational system to a great extent. However, developing countries are far from reaping these benefits because of certain challenges such as administration support, teacher's confidence and competence (Khan ,Hossain, Hasan and Clement (2012)).

In Kenya, policy makers continue to introduce strategies for ICT, with the intention of increasing its use in schools. Such strategies are likely to have effect on the school level factors, such as time and technical support (Kipsoi, Chang'ach and Sang, (2012)). Time is an important element in the integration of ICT into teaching and learning. Strategic planning is crucial especially when it comes to offering

teachers quality professional training for technical support. However, the success of ICT integration in schools depends on school managers, who will make ICT access possible and ensure effective removal of obstacles that hinder successful of integration of technology in teaching and learning environments (Kipsoi, Chang'ach and Sang, (2012))

Positive attitudes towards computer use by school teachers are important for effective integration of the technology in the school curriculum and also for pedagogical practices (Amuko, Miheso and Ndethiu, (2015)). A teacher's belief can be a major barrier to ICT integration. Some teachers have a negative belief about the use of ICT in teaching Mathematics because of their own negative experiences such as anxiety and stress. The process of integrating ICT into Mathematics' teaching is directly affected by teachers' belief and attitude towards using computers as a tool for teaching and learning Mathematics (Güven, Çakiroğlu and Akkan, (2009)). Teachers who have a positive attitude towards ICT easily adopt and integrate ICT into their teaching.

Research efforts in Malaysia and USA have been devoted in exploring teachers' Technological Pedagogical Content Knowledge (TPACK). The TPACK framework, addresses the issues related to ICT integration from a knowledge perspective. It implies that if teachers develop associated TPACK, many issues can be resolved (Tsai and Chai, (2012)). In Kenya, Gikonyo, (2012) noted that ICT integration in education appears to indicate limited knowledge on the quantity and quality of research in the area of pedagogical integration of ICT.

Kenya Institute of Curriculum Development (KICD), the national curriculum centre, plays an important role in implementing the national goals of education in Kenya and Sudan. It has initiated a policy on the integration of ICT in teaching various subjects in secondary school curriculum. The Kenyan Government's 'Vision 2030' demands technology integration in teaching and learning and recognises ICT as a foundation for an economy that is knowledgeable. In Kenya, the National ICT Innovation and Integration Centre (NI₃C) was established in October 2010 under the Ministry of Education as a development capacity hub for effective use of ICT in education and training of teachers, on how to integrate ICT in different subjects. The main objective of the national innovation centre was to develop a centre of excellence which will identify and drive ICT innovations and their integration in all aspects of education and training. This facility was to work closely with the sectoral specialized institutions including, TSC, KESI, CEMASTEIA, KICD, KISE, CFSK, UNESCO and NEPAD Kenya project.

NEPAD- Kenya project is a stakeholder that has played a major role in the integration of ICT in education in Kenya and the rest of Africa. The NEPAD e-Africa commission task team is responsible for developing the NEPAD ICT programme and its projects. In Kenya six schools namely: Mumbi Girls Secondary School, Menegai Mixed Secondary School, Isiolo Girls Secondary School, Wajir Secondary School, Maranda High School and Chavakali High School, have benefited from NEPAD. The schools have access to ICT infrastructure.

Kenya has placed considerable emphasis on the importance of ICT in its Educational sector, as evidenced by the 10th August 2011 promulgation of the National ICT

Strategy for Education and Training. The Ministry of Education has taken steps to support the implementation of the strategy either by direct action or through various institutions and agencies with which it works. In addition, there are many other organisations, such as banks and private companies which are not directly involved with the Ministry of Education, who plays a major role and supports projects involving ICT in education to improve, levels of education in Kenya.

Performance in Mathematics in Nairobi County has been poor. Evidence from the Kenya National Examination Council report 2009-2013. Student's performance in Mathematics has been poor Nationally. Table 1.1 gives the details

Table 1.1: Overall KCSE Performances in Mathematics

Year	Average mark out of 200	% score
2009	42.59	21.30
2010	41.34	20.67
2011	37.15	18.56
2012	38.15	19.06
2013	36.09	18.05

Source: Kenya National Examination Council Annual report 2009-2013.

This trend of performance in Mathematics puts high prospect of having the Nation of Kenya not to achieve industrialization by the year 2030. Factors influencing integration of technology in teaching and learning Mathematics in secondary level have attributed the poor performance to school challenges ranging from infrastructure, support, training and time management.

1.3 Statement of the Problem

Integration of Information Communication and Technology is very important in the teaching and learning of Mathematics. Integration of ICT in the Kenyan secondary curriculum provides opportunities to change the way teaching and learning occurs. ICT in schools plays an important role in the pedagogical, cultural, social and administrative sectors. ICT boosts collaborative project-based and self-paced learning in subjects such as Music, Art and Mathematics. Integration of ICT can play a significant role in equalizing opportunities for marginalized groups and communities. For teachers, it enables them to become effective in their teaching. The Kenya government, through the Ministry of Education and KICD, has collaborated with non-governmental organization such as NEPAD –Kenya project and CFSK in providing ICT training and infrastructure to teachers in secondary schools.

ICT plays an integral part in any country's development plan. Through its Vision 2030 plan, Kenya has heavily factored in the use and integration of ICT in the education system. Despite the fact that the government of Kenya has put up measures to improve the quality of education being offered in secondary schools, ICT is not adequately utilized by teachers in their Mathematics lessons because of the various factors which hinder them. Buabeng-Andoh (2012) and Kipsoi et al (2012), recently conducted studies in developing countries. Their research established that some of these challenges experienced can be eliminated. It is in this light that schools in the recent past have been keen to invest in ICT infrastructure to facilitate ICT use and integration. In Kenya, limited research has been carried out to

determine factors that contribute to access and use of ICT, especially in Mathematics. There is need for secondary schools in Kenya to invest in the effective use of ICT in teaching and learning of Mathematics.

1.4 Purpose of the Study

The purpose of the study was to investigate integration of ICT in Mathematics teaching and learning in secondary schools and provide information that can be used by policy makers, curriculum developers and implementers, school managers, and the society on the importance of using ICT effectively in teaching and learning Mathematics.

1.5 Objectives of the Study

- a. To determine the levels of ICT integration in teaching and learning Mathematics.
- b. To identify the challenges and opportunities to ICT use in teaching and learning Mathematics.
- c. To determine pedagogical practices in teaching Mathematics using ICT.

1.6 Research Questions

- a. What are the levels of ICT integration in teaching and learning Mathematics?
- b. What challenges and opportunities hinder the use of ICT in teaching and learning Mathematics?
- d. Which pedagogical practices are used in teaching Mathematics using ICT?

1.7 Significance of the Study

The study may be important to students, teachers, managers, educational planners, policy-makers and the society at large. The study may enable Mathematics teachers to become better instructors in the subjects, through the use of ICTs infrastructures that might be available to them. The study may also, benefit educational planners and policy makers to make appropriate decisions in integration of ICT in teaching and learning Mathematics; also it might increase efficiency in their training and selection of Mathematics teachers; and encourage teachers to have more interest towards, integration of ICT in Mathematics.

1.8 Assumptions of the Study

The researcher assumed that all sampled teachers had knowledge on how to integrate ICT in their Mathematics teaching. Most of the schools had enough ICT facilities to accommodate the entire class during a Mathematics lesson. All students in the schools had access to ICT facilities that are readily or easily available in the school.

1.9 Limitation and Scope of the Study

The study was focused in one subject area, Mathematics and it was conducted in only those schools that had computers laboratories and computers. It was conducted in secondary schools in Nairobi County, because the county has schools which have better ICT infrastructures.

1.10 Theoretical Framework

The study adopted Rogers diffusion theory, (Granovetter, (2005)).Which states that, integration of ICT in Mathematics education is a technological innovation. Rogers asserts that implementation of an innovation is just one phase of a five stage process of diffusion of communication channels over time among the members of a social system (i.e., Mathematics learning environment). His theory further argues that potential adopters of a technology progress over time through five stages in the diffusion process (Mathematics learning process). First, the Mathematics teachers and learners must learn about the innovation (knowledge); second, they must be persuaded of the value of the innovation (persuasion); third, they must decide to adopt it in teaching and learning Mathematics (decision); fourth, the innovation must be implemented by the Mathematics teachers (implementation); and finally, the decision of using ICT in teaching and learning Mathematics must be reaffirmed or rejected (confirmation) because Mathematics teachers and learners are critical in the whole process (teaching and learning Mathematics using ICT).

1.11 Conceptual Framework

The conceptual framework in Figure 1.1 shows various possible causes that hinder Mathematics teachers from integrating ICT in their Mathematics classroom successfully.

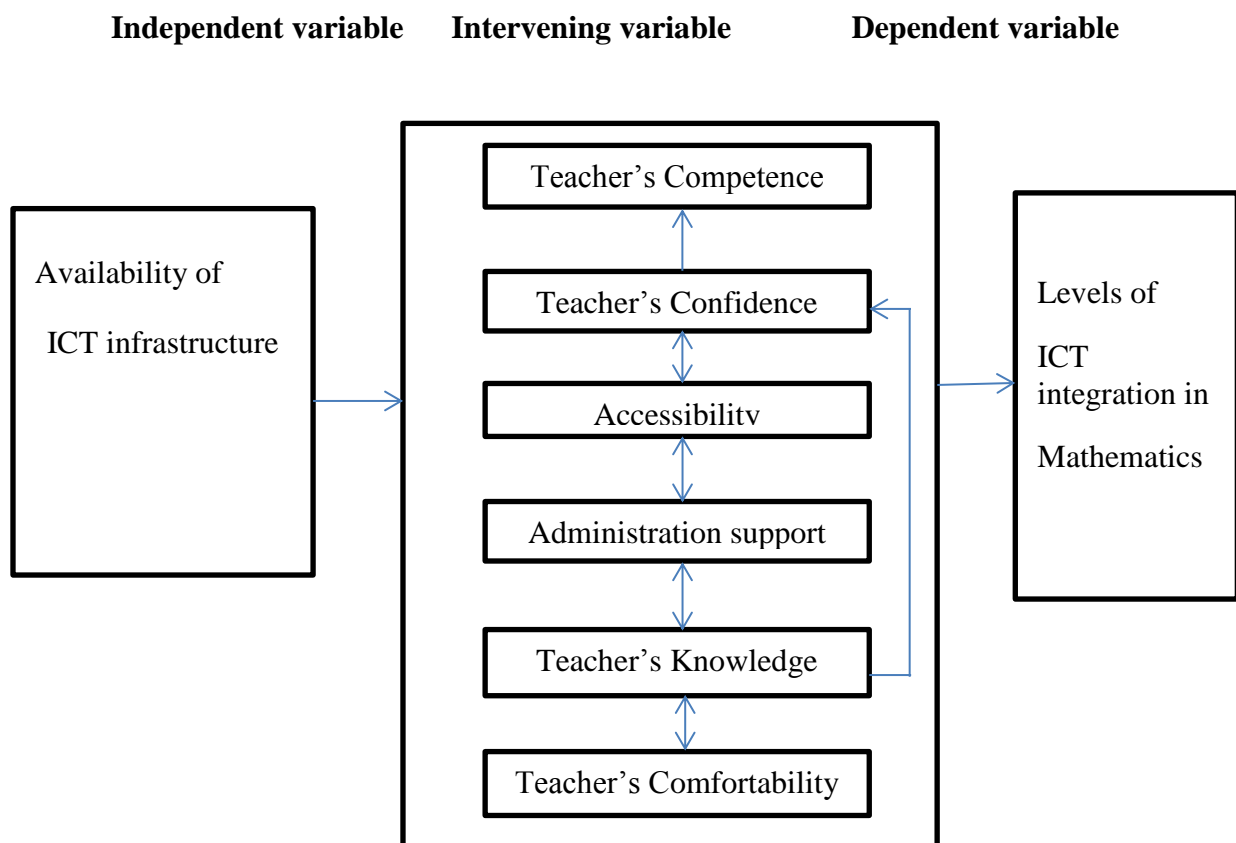


Figure 1. 1: 1.1 A Conceptual Framework of Integration of ICT in Teaching and Learning Mathematics and School and Teacher Related Factors.

Teachers' comfortability is defined by their attitude and belief. A teacher's attitude may have negative or positive impact on the levels of ICT integration in teaching and learning Mathematics. Teacher's comfortability is influenced by her/him knowledge. Teacher knowledge is defined by pedagogical knowledge and skills on the use of ICT Infrastructure that are available for use. Administration support has effect on both teacher knowledge and accessibility of ICT infrastructure. If the

teacher knowledge is limited, the teacher will avoid accessing the ICT infrastructure. Teachers with low confidence may have a higher expectation of technical faults occurring if they were to use ICT and as a result, they may avoid using it. A teacher who lacks confidence will not effectively teach Mathematics using ICT infrastructure. The outcome depends on the intervening variables of accessibility, competence, confidence, administration, teacher's knowledge and teacher's comfortability.

1.12 Operational Definition of Key Terms

District: An area of a country or city, especially one regarded as a distinct unit because of a particular characteristic.

Innovations: The development of new values through solutions that meet new requirements and inarticulate needs.

ICT: Information Communication and Technology, a range of technological tools and resources used to communicate, and to create, to disseminate, to store and manage information. Technologies do not refer to only the computers, but also broadly to Internet, broadcasting technologies (such as radio and television), telephones (including mobile phones), CDs and DVDs.

Integration: Act of combining into an integral whole, for example in this context it is the application of technology into teaching and learning to assist, enhance and extend student knowledge.

Levels of ICT integration: Human knowledge (teacher knowledge and learners' knowledge) in teaching and learning.

Secondary school level: A school that is intermediate in level between elementary school and college and that usually offers general, technical, vocational, or college-preparatory curricula.

Pedagogy: The activities of educating or instructing or teaching; activities that impart knowledge and skills.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The focus of this chapter will be to review literature on the integration of ICT in education, levels of integration of ICT in teaching and learning Mathematics, integration and factors of ICT in teaching and learning of Mathematics, and the pedagogical practices in teaching and learning Mathematics. The literature will be sourced from on-line journals, on-line books and the internet respectively. The literature review will consist of the following four sections respectively:

2.2 Integration of ICT in Education

ICT has been described as a potentially powerful enabling tool for educational change and reform and many of the productivity gains in the developed world economies over the past decade to a great extent can be attributed to the impact of ICT (Swan, (2010)). Information Communication and Technology, is generally referred to as “a range of technological tools and resources used to communicate, create, disseminate, store and manage information”. Technologies do not refer to only the computers, but also broadly to internet, broadcasting technologies (such as radio and television), telephones (including mobile phones), Compact Discs (CDs) and Digital Video Discs (DVDs). ICT is integrated when it is used to support and enhance the attainment of curriculum objectives and to engage students in meaningful learning (MOE Report, (2010)).

According to MOE Report, (2010) ICT integration in education does not mean that ICT is added as an additional subject in the curricula and that we limit ourselves to the learning and teaching of some software packages. Sadik (2008) defines integration of technology into learning as curricula utilizing authentic tasks that intentionally and actively help learners to construct their own meanings from thinking about experiences and allows for more interdisciplinary project-based instruction. Integration is defined not by the amount or type of technology used, but by how and why it is used (Sadik, (2008)). Meaningful integration of technology in Mathematics Education is achieved when students are able to select technology tools to help them obtain information in a timely manner, analyse and synthesize the information and present it professionally (Sadik, (2008)). Teachers integrate technology into teaching and learning of Mathematics for a variety of reasons such as: promoting student engagement, teaching 21st century skills, best teaching practice, to stay current, for hands-on interactive learning, to vary instructional methods, to perform labs and demonstrations, and for research and communication (Hechter, Phylfe and Vermette, (2012)) .

Yet, administrative, technological, organizational, and philosophical factors exist that seriously hinder the effective implementation of technology into classroom teaching and learning (Hechter, Phylfe and Vermette, (2012;136-152)) .

There is a need to identify organizational and philosophical factors that hinder the effective implementation of technology in the classroom.

2.3 Levels of Integration of ICT in Teaching and Learning Mathematics

The role of technology in teaching and learning is very versatile. Classification and analysis of the roles is necessary to integrate technology meaningfully. The importance in this field is the relationship between the use of technology and the teaching aims which will be achieved as well as the influence of technology on the teachers beliefs in their work (Barzel and Drijvers, (2009)). In Kenya ICT is increasingly being applied in teaching and learning in almost all the subjects being offered in secondary education (Gikonyo, (2012)). Mathematical knowledge, mathematical rules and mathematical practices are inextricably linked, and this connection can be strengthened by the use of technologies in teaching and learning Mathematics. (Olive, Makar, Hoyos, Kor, Koshelera and Strä/sser,(2010)). Learning with useful integration tools can lead to a functional understanding of mathematical concepts, as well as develop a broader understanding of the nature of Mathematics (Varughese, (2012)) . Technology enhances efficiency of mathematical thought and enables learners to make conjectures and immediately test them in a Mathematics learning environment. It also offers multiple mathematical representations that enhance generality of mathematical concepts and provide opportunity for counter example, unlike in a paper and pencil environment (Ogwel, (2008)).

Mathematics educators are primarily concerned with using technology to aid in instruction (for example, computers, calculators, software) and to facilitate student learning. Technology educators, on the other hand, are focused on how to use Mathematics to understand, use, and design different technologies (Merrill, Reece and Daugherty, (2010)). Mathematics educators appear to see technology as a tool

in service to solving Mathematical problems; technology educators appear to see Mathematics as a tool in service to solving technological problems (Merrill, Reece and Daugherty, (2010)).

The use of ICT in the Mathematics classroom has long been a topic for consideration by Mathematics educators. Some examples of ICT use in Mathematics include: portable graphic and scientific calculators and computerized graphing, specialised software, programmable toys or floor robots, spread sheets and databases (Mishra and Koehler, 2006). As discussed by UNESCO, (2007), for successful integration of ICT into the Mathematics curriculum, it is essential to have knowledge of the existing software that is used by Mathematics teachers. They highlighted that one of the major problems is that the educational software is often isolated and not integrated with the textbooks that many facilitators use. Moreover, many ICT applications are poorly attuned at the curriculum. Nobre, Amado and Carreira (2012), emphasized that the spread-sheet is a powerful tool in Mathematical problem solving and particularly in the development of algebraic thinking embedded in problem solving activities. They further stated that one of the gains of connecting algebraic thinking and the use of spread sheets is the creation of a significant environment to induce learners into algebraic language that facilitates the construction of algebraic concepts, especially concerning working with functional relations, sequences and recursive procedures (Nobre, Amado and Carreira (2012)).

As proposed by Varghese (2011), ICT could help teachers to visually present abstract concepts. The ability to think with external representations of processes by means of ICTs can scaffold the development of mathematical understanding. ICT

could change negative perceptions of learners about Mathematics. Teachers can use ICT to present information in multiple formats (For example, text, pictures, sound, animations, and video clips). Facilitators also could present activities in a layered order and with varying scaffolding levels.

ICT itself is not likely to improve ineffective teaching practices (Alayyar, Fisser and Voogt (2012;27))

On the contrary, Ifenthaler, Isaias, Kinshuk, Spector, Angeli and Valani, (2012) stated that ICT does not have an educational value in itself, but it becomes precious when teachers use it in the learning and teaching process. ICT can provide many possibilities for disabled learners to improve their mathematical abilities. There is need for Mathematics educators and curriculum developers to integrate educational software and textbooks (Bektaş et al., (2012)).

2.3.1 Computers in Assisted Learning in Mathematics

According to Lim and Pannen (2012), learning from computers sees the computer systems as a tutor. Computer-assisted instruction supports drill and practice. To function as a tool, the computer is used as a tool for teaching and/or learning. This includes, for example, the use of word processor, excel, spread sheet, databases and graphics applications in the teaching-learning process (Daugherty, Reese and Merrill, (2010)).

Educational computing activity, is “to use the computer as tutee is to tutor the computer; for that the student or teacher doing the tutoring must learn to programme, to talk to the computer in a language it understands”. The rationale behind this mode of computing activity was that the human tutor would learn what the teacher was trying to teach the computer and the learner would gain new insights into their thinking

through learning to program (Drijvers, Doorman, Boon, Reed and Gravemeijer, (2010;93)).

Computers can transform the logical-mathematical thought of a computer programmer to interesting interactive video games (Varghese, (2012)).

Despite the mandate that accompanies ICT education policy documents that computer technology be integrated into the range of courses in the secondary Mathematics key learning areas, there is evidence to suggest that computers are not widely integrated into Australian and USA secondary Mathematics classrooms (Hudson and Porter, (2010)). In the findings of Ottenbreit-Leftwich, Glazewski, Newby, and Ertmer, (2010) and Khambari, Moses, and Luan, (2009) it is highlighted that teachers use computers; to perform administration tasks rather than integration tasks. Examples of administration tasks are encoding lesson plans schemes of work, record of work covered, preparing examinations and surfing the Internet for visual aids. Despite teachers' increasing knowledge of, and familiarity with, technology and there being infrastructure to support it, many Mathematics facilitators are still not effectively integrating technology into their teaching (Hudson and Porter, (2010)).

2.3.2 Graphic Calculators in Teaching and Learning Mathematics

A calculator is a device for performing mathematical calculations; it is an electronic device that can be held in the hand (Bowker, Hennessy, Dawes and Deaney,(2009)). Lucas and Cady (2012) supported the notion that the calculator is an essential element in the teaching and learning of Mathematics; functional use means that it will be used only in activities such as computation, drill and practice and checking

paper and pencil work. They further asserted that teachers can use calculators to provide activities that help learners develop their mathematical understanding about concepts such as place value, the meaning of operations and estimation, and it is each classroom facilitator's responsibility to select appropriate activities and times for using calculators for instructions.

In addition, Barzel and Drijvers (2009) stated that in most approaches to Mathematics learners acquire arithmetic skills and knowledge before learning algebra. The step from arithmetic to algebra is influenced by the use of graphic calculators. The use of calculators increases students' confidence in the accuracy of their graphs, and thus enables them to work with less dependence on the facilitator and fostering students independence (but without reference to peer exchange) and (Bowker, Hennessy, Dawes and Deaney, (2009), and Pierce and Ball, (2009)). Similarly, Ruthven, Deaney and Hennessy, (2009) indicated that Mathematics facilitators considered the calculator as a valuable tool for checking learners' sketches or manipulation, relating to the theme of supporting processes of checking. However, some teachers expressed concern about limitations of calculators graphing in respect of the frequent need to adjust the graphing window and to interpret approximate co-ordinate values, so qualifying the perceived contribution of this technology to an ideal of focusing on overarching issues and accentuating important features (Bowker, Hennessy, Dawes and Deaney, (2009))

Students in the United Kingdom use graphic calculators to solve equations in their exams. However, there is a limitation in that this technique leads to just one approximated solutions and additional reasoning or re-applying the procedure is

needed to find other solutions or to be sure that all solutions have been found, (Ruthven, Deaney and Hennessy, (2009)) . In North America graphic calculators are used primarily to generate patterns of graphic images; most commonly by learners themselves; through a guided-discovery approach which, some teachers have reported, has been made possible only through use of the technology,(Ruthven, Deaney and Hennessy, (2009)). The reasons why facilitators use graphing technology are related principally to saving lesson time and generating more examples, increasing instructional variety and enhancing learner motivation, (Ruthven, Deaney and Hennessy,(2009)). The graphing software is generally preferred over graphic calculators (Bowker, Hennessy, Dawes and Deaney, (2009)). Calculators need to be used effectively in order to enhance learners understanding; specifically, calculators should help facilitators develop deeper Mathematical understanding and not replace that understanding (Masalski, (2005)).

2.3.3 Mobile Phones in Teaching and Learning Mathematics

M-learning is the process of learning with assistance from a mobile, wireless device. L Calkins (2009) recognized that learning environments that integrate mobile technology, rather than limiting learners to a traditional linear flow of information from the educator, encourage learners to participate throughout the educational process. Calkins (2009) further said that wireless technology can be utilized as a tutor, supplying software applications to learners in an effort to generate higher quality studying habits on the go. Smartphones can also act as a tutee, as students learn to program their devices to better assist their efforts in education, simultaneously building technical skills necessary for the future. Mobile devices are

used as effective tools in educational settings as well, allowing for more efficient collection and analysis of information, leading to a more meaningful and enlightening educational experience (Calkins (2009)).

In the UNESCO (2011) report, the Nokia mobile company have presented mobile learning programmes and services, such as Nokia mobile Mathematics and Nokia education delivery. They are used in both formal and informal learning environments to bring better access and better quality content to classrooms and outside school learning. These services offer interactive learning experience for students and as a possibility to use learners' social network for peer-support by combining social media application and learning.

In France, mobile phones have banned in schools because of the potential cancer risk caused by radiation from using mobile phones (Miles and Singal, (2010)). Research shared from Canada describes the following challenges for mobile learning: small screen and keyboards; facilitators not knowing how to design and develop mobile instructional learning materials; negative facilitator perceptions of mobile learning; not enough mobile learning instructional materials; and no standard for mobile learning instructional materials. It could be argued that most of these factors do not only apply to Canada but are universally applicable (UNESCO, (2011)) report.

The use of mobile phones in education is less expensive compared to the use of computers and other technologies that are widely used in education. Research relating to this subject matter is necessary for the successful integration and adoption of mobile technology into the classroom environment of tomorrow, because very few studies have focused on mobile phone learning. This gap prompted the study.

2.4 Challenges and Opportunities Influencing Integration of ICT in Teaching and Learning Mathematics

Seffrin, Panzan and Ruth (2008) define a barrier as an event or condition that hinders the adoption decision. Hudson and Porter (2010) observe that Mathematics teachers are also faced with inhibiting challenges or barriers to computer use. For this reason, there have been several studies which have specifically focused on secondary Mathematics teaching. Bennison and Goos (2010) and Amuko, Miheso and Ndethiu, (2015), describe two types of barriers, currently hampering the integrated use of technology by teachers:- external (first order) barriers and internal (second order) barriers.

Amuko, Miheso and Ndethiu, (2015), observe that policy makers in Kenya continue to introduce strategies for ICT, with the intention of increasing its use in secondary schools. These strategies are likely to have an effect on the school level factors. The teacher level obstacles are more difficult for policy makers to tackle as it is the teachers themselves who need to bring about the required changes in their own attitude and approach to ICT. Amuko, Miheso and Ndethiu, (2015), in their research findings stated that, the main factor in front of Mathematics integration process is the gap between the curriculum's expectations and teachers' beliefs. However, they suggested that, the integration of ICT into the Mathematics classroom depends on individual teachers as well as the schools' contextual factors.

2.4.1 Teacher Related Challenges in Teaching and Learning Mathematics

Teacher related, challenges impact on fundamental change and are typically rooted in teachers' core beliefs and are therefore the most significant and resistant to change (Amuko, Miheso and Ndethiu (2015)). Teacher related factors refer to teacher comfortability, teacher confidence and teacher competence. Research indicates that lack of teacher confidence prevents teachers from using ICT in their teaching (Amuko, Miheso and Ndethiu, (2015)). They also indicated that limitation in teachers ICT knowledge makes them feel anxious about using ICT in the classroom and thus not confident to use it in their teaching (Amuko, Miheso and Ndethiu, (2015)).

Younger teachers had higher confidence levels and were more positive towards ICT in education than senior teachers. The less experienced and the veteran teachers were positive about ICT in education compared with the highly experienced teachers who were mainly more negative (Afshari, Bakar, Luan, Samah and Fooi, (2009)). In addition they further indicated that female student users, compared with male counterparts, are inclined to hold negative reactions to computers and such differences may have resulted in the different ways of using computers. As discussed by Davis, Klawe, Ng, Nyhus and Sullivan (2008) computer use and expertise have been associated with masculinity, and therefore, gender socialization serves to act negatively on female ICT interactions. They further indicated that boys aged 13-16 had already acquired a gender stereotyped view of computer users. Boys in general receive more support from teachers, stakeholders and parents, and are more likely to be the main ICT user at home than girls are.

Teachers' computer competence is a major predictor of integrating ICT in teaching. Evidence suggests that majority of teachers who reported negative or neutral attitude towards the integration of ICT into teaching and learning Mathematics processes lacked knowledge and skills that would allow them to make an "informed decision" (Amuko, Miheso and Ndethiu, (2015)). A study conducted by Agyei and Voogt (2012) in Ghana among student teachers and practicing teachers Mathematics teachers, reported low levels of technology integration levels as a result of low competencies and access levels of technology. Successful integration of ICT in teaching is related to teachers' competence and attitudes towards the use of modern technology in their teaching and learning Mathematics (Amuko, Miheso and Ndethiu, (2015)).

Positive attitudes towards ICTs use by school teachers are important to ensure the integration of the technology is effectively carried out in the school curriculum and also during teaching and learning. Teachers' attitudes are influenced by their perception of the usefulness of ICT, their behaviour intentions and pedagogical aspects. Teachers' attitudes towards using ICT in teaching and learning are also influenced by several factors (Amuko, Miheso and Ndethiu, (2015)). Factors that can influence the teacher attitude towards ICT include ICT related knowledge and skills, and motivation to use ICT. Teacher age and teaching experience cannot be influenced or changed (Afshari, et al., (2009)). In addition Jimoyiannis, Tsiotakis, Roussinos and Siorenta, (2013) found that across a number of subject specialties including mathematics, teachers' post-training beliefs about the role of ICT in education were influenced by their gender, age, and teaching experience. In general, male facilitators held a more positive attitude towards ICT in education while female

facilitators held a more neutral or negative attitude. Teachers' attitudes and beliefs influence successful integration of ICT into teaching Mathematics (Keengwe, Onchwari and Wachira, (2008)).

Amuko, Miheso and Ndethiu, (2015), stated that, in teaching and learning of Mathematics, teachers' belief about Mathematics learning with or without using technology is considered to be important because it could influence teaching and learning, and Mathematics curriculum reform. At the classroom level, teachers' beliefs can accelerate or slow down curriculum reforms as teachers' beliefs are resistant to change and play a role in teaching practices. Findings from a study done in Kenya by (Amuko, Miheso and Ndethiu, (2015)), has shown that teachers who begin using ICT in their teaching, initially believe that technologies creates more work for them. In addition, they also found that, Mathematics teachers have negative beliefs about using computers in Mathematics teaching because of negative experiences; however, they expressed that these beliefs can be changed with in-service and out-of-service courses focusing on long-term constructivist approach. They further stated that, when teachers have the environments providing social support and enough technological substructures, their beliefs can change in the course of time and they can design a more constructivist learning environment.

Teachers adopting constructivist educational beliefs are more willing to adopt student-centred approaches and other innovative instructional approaches, while teachers adopting traditional beliefs are more likely to adopt teacher-centred instructional practices. The way teachers integrate computers into their classroom instruction seems to be strongly mediated by their belief systems (Sang, Valcke, van

Braak, Tondeur and Zhu, (2011)). Moreover, the process of integrating computers into Mathematics teaching is directly affected by teachers' beliefs about using computers as a tool for teaching and learning Mathematics. Cultural perceptions such as school cultures and social cultural factors need to be considered as an important element in the implementation of ICT and culture may play an important role influencing how teachers relate their beliefs to ICT use (Sang et al., (2011)).

2.4.2 School Related Challenges in Teaching and Learning Mathematics

School related challenges refer to inadequate provision of resources such as infrastructure, support, trainings and time. In Kenya, teachers rated lack of time as one of the most problematic factor to technology utilization in schools. They further said that mastering technology requires time (Amuko, Miheso and Ndethui, (2015)). Breakdown of a computer causes interruptions and if there is lack of technical assistance, then it is likely that the regular repairs of the computer will not be carried out resulting in teachers not using computers in teaching. The effect is that facilitators will be discouraged from using computers because of fear of equipment failure since no one would give them technical support in case there is technical problem (Amuko, Miheso and Ndethui, (2015)).

Yilmaz (2011) assessed technology integration processes in the Turkish education system and reported that it is important to provide schools with hardware and internet connections. In addition, it is also crucial to provide schools with technical support with regard to repair and maintenance for the continued use of ICTs in the schools. Peeraer and Van Petegem,(2011) and Kukali (2013) claimed that issues surrounding computer hardware were the most serious factors affecting

implementation. Teachers reported that computers were not reliable enough. They further found that, lack of Mathematics educational software had a negative effect on their using ICT in their classrooms.

A study by researchers like Hamzah (2007) and Khambari, Moses and Luan (2009), Mathematics teachers in Sarawak, Malaysia, indicates that insufficient time, limited knowledge on how to use ICT in class and lack of technical support have prevented them from using it. For instance, Lim and Pannen, (2012) mentioned that lack of funding and staff support in case study from Indonesia; Lack of instructional software and funds, are major factors to ICT utilization in Jordanian school settings. Similarly, in a study conducted in Jordan by Al-Senaidi, Lin and Poirot (2009) , lack of institutional support and lack of time were the major hurdles to ICT utilization in secondary education. Dionys (2012) from Cambodia addresses the lack of digital resources and infrastructure (for example, the unstable electricity support) for technology integration in teacher training centres. Buabeng-Andoh (2012) asserts that while Jordanian schools were fully equipped with ICT infrastructure; there will be always some teachers who resist the change or disbelieve in ICT benefits.

Professional development is necessary for teachers to enable them to effectively use technology to improve student learning. Staff development should be collaboratively created, based on faculty input and school needs. It must prepare teachers to use ICT effectively. This training should not consist merely of short workshops or training, which is not enough to build proper knowledge and skills (Khan ,Hossain, Hasan and Clement (2012)). There are not enough training opportunities for teachers in the use of ICT in classroom environments. Current training programmes do not include

enough time for them to become comfortable with the software, nor does it include support to help them troubleshoot during the early implementation stages and the training experience is not tailored to their needs. Teacher training and continued, on-going relevant professional development is essential if benefits from investments in ICTs are to be maximized. Teachers remain central to the learning process (Bingimlas, (2009) and Kukali, (2013).

Lack of training and insufficient technology facilities are significant factors that influence effectiveness of technology. Having the latest technology, knowledge, enough training, proper time management and support from the community, are among factors that prevent teachers from using ICT in class (Ayub, Bakar and Ismail (2012)). A study, in New Zealand and Australia conducted by Hudson and Porter (2010) and Amuko, Miheso and Ndethiu, (2015), in Kenya found that, one of the barriers that Mathematics teachers identified in failing to adopt the use of computers in the classroom, is the lack of computer use is due to lack of experience, lack of adequate professional training and lack of professional support in the use of computers in Mathematics instruction. Successful use of technology for the benefit of children depends on the knowledge of teachers and their confidence and competence in using technology (Amuko, Miheso and Ndethiu, (2015)). The above scholar position is that teachers need to learn how to use technology; they also need to learn how to apply the technology to teaching and learning Mathematics.

2.5 Pedagogical Practices in Integration of ICT in Teaching and Learning Mathematics

Pedagogy is focused on teachers' instructional practices and knowledge of the curriculum and the development of applications within their disciplines that make effective use of ICTs to support and extend teaching and learning Mathematics (Girgin, Kurt and Odabasi, (2011)). Pedagogical content knowledge refers to planning and implementing instruction of authentic Mathematical tasks to foster students' learning process. Planning requires teachers' high order thinking skills and creation of new Self-Regulated Learning (SRL)-stimulating components in pedagogical contexts (Zohar and Schwartz, (2005)).

Syfers (2010) proposed three types of Mathematics curricular system models: content focused, pedagogically focused, and learner-centred. He further maintains that the Mathematics curriculum model comprises different pedagogical strategies, inter alia collaborative learning, problem-based learning and direct representation, in which ICT can act as a learning tool. In addition, Hoyles and Lagrange (2009) argued that a wide variety of ICTs can mediate interaction, but it is how these ICTs are used to support collaborative practices that make the difference in teaching and learning Mathematics. The use of ICTs to support collaborative learning practices requires new ways of learning and teaching and a new mind set about to do Mathematics.

Dionys (2012), in outlining his ideas about TPACK, concludes by highlighting the challenges of teachers' attitude change towards instructional approaches. Parkay, Stanford and Gougeon (2010) incorporate inquiry based learning in teacher

education courses, strengthening the pedagogical foundation for technology integration at secondary school level. Lim and Pannen (2012) linked ICT competence and pedagogical consideration when evaluating teacher education programs. However, deeply rooted beliefs can prove to be hard to detect and unless deep changes are effected, the programs may teach skills and knowledge but still fail to produce the necessary shift to pedagogy (Lim and Chai 2008) . Using ICTs effectively requires teachers to have a wide repertoire of teaching approaches to call upon. Teachers must be proficient in using ICT not only to support their professional productivity and development, but mainly, to effectively integrate ICT into instruction and learning. Effective teacher preparation is an important factor for successful integration and sustainability of ICT in Mathematics education (Jimoyiannis, Tsiotakis, Roussinos and Siorenta, (2013)).

Technology proficiency is not a strong predictor of technology integration and those successful educational applications of ICT depend upon proficiency in the instructional methods in Mathematics education (Girgin, Kurt and Odabasi, (2011)). Most ICT teacher professional development initiatives a tend to focus on technological aspects (i.e., how to use various tools) while pedagogical and instructional issues (i.e., why and how to use those tools to enhance learning) are often taken for granted. As a consequence, the application of ICT in school settings has been driven more by the accordance of technology rather than by the demands of pedagogy and didactics of the particular subject matter (Amuko, (2015)). Training and the typical content of technological instruction for facilitators are also reported as limited to computer literacy, focusing on fundamental computer operation and

standard applications rather than preparation on how to use technology as a pedagogical tool (Scheg, (2014)) .

Teachers in developing countries such as Kenya do not have much opportunity for professional development after initial teacher preparation (Otienoh, (2010)). ICT integration in education in Kenya appears to indicate limited knowledge on the quantity and quality of research in the area of pedagogical integration of ICT in education (Gikonyo, (2012)). However, Tsai and chai, (2012) observed that research efforts have been devoted to exploring teachers' Technological Pedagogical Content Knowledge (TPACK). The TPACK framework, addresses the issues related to ICT integration from a knowledge perspective (Chai et al., (2011)).

Boaler (2013) found that the most frequently adopted activities by Mathematics teachers in her research study were exercises to practise skills or procedures, facilitators discovering Mathematics concepts and principles. She further reports that teachers reported to value a more traditionally oriented curriculum, as compared to Mathematics curriculum goals that focused on lifelong learning and connectedness. There is a need for clear education policy regarding teacher professional development courses and seminars that are focused on pedagogical practices on ICT.

2.6 Summary

Most of these researches were conducted in developed countries, where there are current and modern ICT infrastructures. Developing countries have empirically established the impact of ICT in teaching and learning of Mathematics. In the case of Kenya the research was conducted in rural settings where there were limited

infrastructures, the research has not yet been conducted in an urban setting where there are available and improved infrastructures. Research relating to this subject matter is necessary for the successful integration and adoption of mobile technology in the classroom environment in the future (Calkins, (2009)).

Teachers need to adopt technologies that will be useful in their daily teaching. The study concentrated on school and teacher level factors; they did not focus on infrastructure available in in-service and pre-service trainings. The ICT integration in Kenyan education appears to indicate limited knowledge on the quantity and quality of research in the area of pedagogical integration of ICT. To quantify pedagogical knowledge in integration of ICT, there is a need to identify organizational and philosophical factors that hinder the effective implementation of technology in teaching and learning and to conduct several researches in different secondary schools, located in different counties in Kenya, to be able to come up with a National Curriculum that will be adopted by secondary school teachers on use of ICT infrastructure.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the research methodology. The chapter includes, research design, variables, location of the study, sampling techniques and sample size, data collection method, pilot study, validity and reliability, administration of research instruments, logistical and ethical considerations and data analysis method. The last sub-section provides the procedure applied in analyzing data.

3.2 Research Design

The study adopted a descriptive survey research design. A descriptive survey research design, finds out a phenomenon or characteristic associated with a subject population (Schindler and Cooper, (2003)). The main objective of descriptive survey research design is to give a description of the situation as it is (Malhotra, (1996)). The design is useful in both collecting qualitative and quantitative data. (Schindler and Cooper (2003)). It further describes this method of study based on a univariate question or hypothesis where it seeks to determine or state the existence of relationships between variables and characteristics of variables such as form, distribution, by attempting to answer the how, where, what and who questions. For this study these variables included ICT infrastructure, levels of ICT integration in teaching and learning Mathematics and teachers and students related challenges.

3.3 Variables

The dependent variables included the use of ICT in teaching and learning Mathematics, the independent variables included integrated ICT infrastructures. The intervening variables included the teacher knowledge and confidence, teacher competence, teacher comfortability (attitude and belief) accessibility, and administrative support.

3.4 Location of the Study

The study was carried out in Nairobi County, which has a well-developed physical infrastructure such as electricity and internet. The researcher chose Nairobi County because it has a good number of schools that have well equipped computer laboratories and computer literacy class is compulsory for all Form one and two students, throughout the County.

3.5 Target Population

Population defines the whole set of objects or events under investigation about which we wish to make inferences (Schindler and Cooper, (2003)). The target population of this study comprised the sixty government secondary schools, a total number of two thousand, seven hundred and seventy five (2775) form three students, sixty head of Mathematics department (60) and sixty Mathematics teachers (60) as shown in Table 3.1. Target population refers to all members of a target/specified set of elements. The study was conducted in government secondary schools because government schools have the highest number of students. Nairobi County has a total of sixty government secondary schools.

Table 3.1: The Sampling Grid

Sampling Grid			
Target population		Sample	Percentage
Schools	60	12	20%
Mathematics Teachers	60	12	20%
Students	2775	275	10%
Heads of Mathematics department	60	12	20%
Total	2955	311	70%

3.6 Sampling Techniques and Sample Size

a) Schools Sample

Simple random sampling was used to select twelve government secondary schools out of the sixty secondary schools in Nairobi County. This constituted 20% of the target population, which was the recommended sample size. Gay, (1992) acknowledges that, the minimum acceptable sample of survey is between 10% and 20% for a small population. Simple random sampling was used because it involves giving a number to every subject or member accessible population, placing the numbers in a container and then picking any number at random.

b) Teachers Sample

Purposive sampling was used to select twelve Mathematics teachers out of the sixty form three Mathematics teachers available in the selected schools. Purposive sampling was used, so as to enable the researcher to make a judgment that was to provide the best information to achieve the objectives of the study (Kumar, (2005)). The study used purposive sampling because the researcher was interested in finding out challenges and opportunities in integration of ICT in teaching and learning Mathematics, identifying levels of ICT integration in teaching and learning Mathematics and identifying pedagogical practices in teaching Mathematics.

c) Students Sample

Simple random sampling was used to select two hundred and seventy five (275) out of the two thousand, seven hundred and seventy five form three students (2775). This constituted 20% of the target population, which was the recommended sample size. (Gay, (1992)) acknowledges that, the minimum acceptable sample of survey is between 10% and 20% for a small population. Simple random sampling was used because it involves giving a number to every subject or member of the accessible population, placing the numbers in a container and then picking any number at random. The study used form three students because, the researcher assumed that all form three students were computer literate and also according to the Kenyan secondary school national curriculum that states that form three students should have basic computer software.

d) Heads of Department Sample

Simple random sampling was used to select twelve head of Mathematics Department out of the sixty heads of Mathematics departments. The number of Mathematics heads of department constituted 20% of the target population, which was the recommended sample size, according to Gay, (1992) who acknowledges that the minimum acceptable sample of survey is between 10% and 20% for a small population. Simple random sampling was used because it provides a sample that is highly representative of the population being studied.

3.7 Research Instruments

Data for this study was collected using an observation checklist, a structured interview schedule, and a questionnaire that was developed by the researcher on the basis of research objectives. Structured questions are objective. Unstructured questions were used because they provided more information as the respondents expressed their thoughts freely (Saunders, Lewis and Thornhill, (2005)).

3.7.1 Teachers Questionnaire

The teachers' questionnaire (see Appendix A) was appropriate for the study because of its ability to collect a large amount of information in reasonable time space, which allowed measurements for or against factors influencing successful integration of ICT in teaching and learning of Mathematics. A questionnaire is a research tool comprising a number of questions soliciting specific responses from subjects concerning the given field of the study. The questionnaire contained both open and closed-ended questions. Open ended questions allowed the respondent to provide

answers freely they choose without having to select from the concrete option. The close-ended questions were used to allow the respondent to provide a unique or anticipated opinion on the study. The questionnaire did not request any personal information such as respondent name or contact details. It was divided into several sections that highlighted general information about the respondent in relation to the study.

3.7.2 Students Questionnaire

The students' questionnaire (see Appendix B) was appropriate to the study as it offered an effective way of collecting information on the use of ICT in teaching and learning Mathematics. The students' questionnaire contained closed-ended questions which enabled the researcher to categorize respondents into groups based on the options they had selected and open-ended questions which provided the researcher with an opportunity to gain insight to all the opinions concerning the study.

3.7.3 Interview Schedule for Head of Departments

Interviews involved the researcher raising questions relevant to the study objectives. The study adopted a structured interview schedule; it enabled the interviewer and the respondent to have freedom in the process of interaction to reveal emotions, opinion and attitude. The researcher used an interview schedule to investigate issues in an in-depth way to discover how teachers and learners think and feel about their levels integration of ICT, challenges and opportunities influencing successful integration of ICT in teaching and learning Mathematics; and pedagogical practices in teaching and learning Mathematics.

3.7.4 Observation Checklist

Observation is an activity of a living being, such as human, which is necessary in order to give knowledge of the environment through the senses which often later involve the recording of data via the use of scientific instruments. The observation checklist included coded items on the condition of the items. Observation checklist enabled the researcher to obtain first-hand information on the ICT facilities in the schools to find out the level of integration of ICT in teaching and learning Mathematics in the schools.

3.8 Pilot Study

A pilot study was carried out in one of the government secondary schools in Nairobi County that was not involved in the main study, in order to develop and test reliability of the research instruments. This was done to determine the validity and reliability of the questionnaire and the interview schedule on the study. The researcher administered questionnaires to 10% of form two students. The researcher further interviewed the head of Mathematics department.

3.9 Validity of the Study

Validity is the degree to which a test measures; what it is supposed to measure. All assessment of validity was subjected to opinions based on the judgment of researchers and experts (Best, (2005)). The researcher used a pilot questionnaire to assess its clarity as well as improve the items. According, to Best (2005), content validity of an instrument is improved through the researcher's judgment. However validity in the study was concerned with the evaluation of levels challenges and

opportunities influencing integration of ICT in teaching and learning Mathematics, using a field test.

3.10 Reliability of the Study

Reliability is the degree to which a test consistently measures whatever it measures. Reliability is therefore used to focus on the degree to which empirical indicators of theoretical concepts are stable or consistent across two or more attempts to measure them. Cronbach's alpha α coefficient was used by the researcher to measure internal consistency of the study, in the survey instruments, to gauge their reliability. A reliability of 0.770 was achieved on the teachers' questionnaires and 0.705 on students questionnaire; this showed that the MTQ and SQ were fit for the study.

Cronbach's α is defined as

$$\alpha = \frac{K}{K-1} \left(1 - \frac{\sum_{i=1}^K \sigma_{Y_i}^2}{\sigma_X^2} \right)$$

Where

σ_X^2 is the variance of the observed total test scores, and

$\sigma_{Y_i}^2$ the variance of component i for the current sample of persons. If the items are scored 0 and 1, a short cut formula is

$$\alpha = \frac{K}{K-1} \left(1 - \frac{\sum_{i=1}^K P_i Q_i}{\sigma_X^2} \right)$$

Where

P_i is the proportion scoring 1 on item i , and

$$P_i Q_i = 1 - P_i.$$

3.11 Data Collection Procedures

Logical and ethical issues were considered in collection of the data required for the study.

3.11.1 Ethical Consideration

The study maintained ethical standards. Certain ethical issues were addressed in conducting the study. Considerations of these ethical issues were necessary for the purpose of ensuring the privacy of the participants. Among the significant ethical issues that were considered in the research process were consent, confidentiality and anonymity. The researcher was required to relay the importance and objectives of the study, including the aim and purpose of the study, in order to ensure consent of the selected participants. By explaining the importance of the study, the respondent was able to answer questions as required.

3.11.2 Logistical Consideration

The researcher was given permission by the Graduate School of Kenyatta University, to proceed with the study after the proposal had been approved by the Department of Educational Communication and Technology. The researcher presented a of permission from the graduate school to the Ministry of Education to acquire a research permit, another visit was made to the Nairobi TSC County Director Office in order to seek permission to proceed with the research. Collective

administration was employed during the research when issuing questionnaires to students and teachers. The researcher made an appointment with the Deputy Head teacher on when to conduct an interview with the Mathematics Head of Department in the school. The same day the researcher conducted the interviews, and also filled the study observation check list by going round the school computer laboratory to confirm infrastructure available in the school.

3.12 Data Analysis

The data analysis was guided by the research questions of the study. The data collected were coded by assigning numbers systematically to the response's from the (MTQ and SQ), observation schedule and the interview schedule. Data analysis procedures involved both qualitative and quantitative data. Data code sheets were created from these instruments and then keyed into the statistical package for social sciences (SPSS) computer package for easier and more accurate analysis. Most of the questions generated quantitative data which were measured at the nominal scale. Qualitative data were grouped into similar themes in line with the research questions. Quantitative data were analysed using descriptive statistics like frequencies, mean and percentage (Amuko, Miheso, Ndethui, (2015)).

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION

4.1 Introduction

This study focused on challenges and opportunities influencing integration of information communication and technology in teaching and learning Mathematics in secondary schools in Nairobi County. This chapter presents data analysis, presentation and discussion on the findings. It contains descriptive statistics such as frequencies, percentages and tables. The findings of the study were based on the research objectives of the study which were.

- a. To determine the levels of ICT integration in teaching and learning Mathematics.
- b. To identify challenges and opportunities influencing, ICT use in teaching and learning Mathematics.
- c. To identify pedagogical practices in teaching Mathematics using ICT.

4.2 Background Information of the Respondents

Respondents to the items used in this analysis included form three student, form three Mathematics teachers and Mathematics heads of department. Gender, age and experience were included to provide information on their background characteristics.

4.2.1 Teachers Background Information

Teachers were required to indicate their gender, age and teaching experience as a source of their background information. This was to establish their experience, age and gender.

Figure 4.1 reveals that 58.3% of the respondents were aged 22-29 and above and most of the Mathematics teachers were found in this category. Thirty three point three per cent (33.3%) of the teachers were between the ages of 35-39 years, 8.3% of the Mathematics teachers were above the ages of 40 years. The findings indicated that younger teachers were more responsive in using ICTs facilities than older teachers. This coincides with the claims of Jimoyiannis, Tsiotakis, Roussinos and Siorenta, (2013) that younger teachers had higher confidence levels and were more positive towards ICT in education than senior teachers.

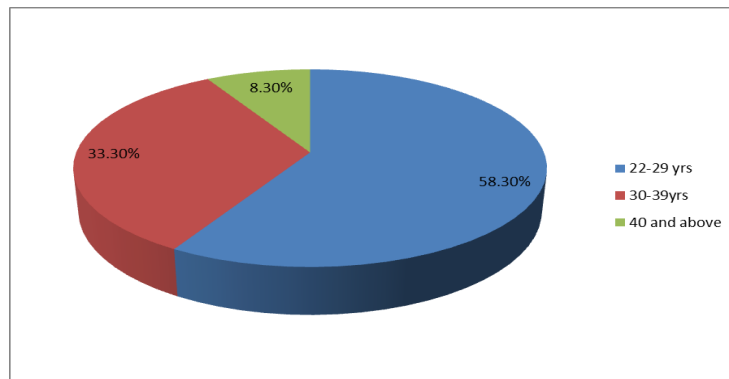


Figure 4.1: Teachers' Age

Figure 4.2 shows that 16.7% of the Mathematics teachers were male and 83.3% of the Mathematics teachers were female. These results suggest that Mathematics teaching in Nairobi County secondary schools is done mainly by female teachers. Findings contradict Jimoyiannis, Tsiotakis, Roussinos and Siorenta (2013) that

stated, male teachers held a more positive attitude towards ICT in education while female teachers held a more neutral or negative attitude.

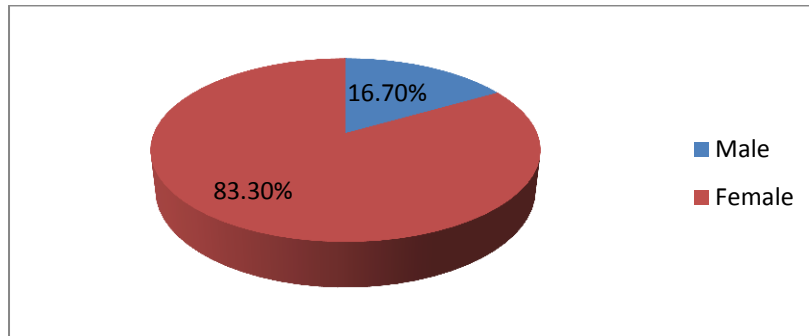


Figure 4.2: Teachers Gender

Figure 4.3 shows that 25% of the respondent had 1-2 years teaching experience in using ICT, 16.7% had 3-4 years, while 58.3% had 5 years and above teaching experience in using of ICT. This shows that Mathematics teachers have been using ICT in teaching Mathematics in their lessons for at most 5 years. This coincides with the findings of Jimoyiannis, Tsiotakis, Roussinos and Siorenta, (2013), that less experienced and the veteran teachers were positive about ICT in education compared to the highly experienced teachers, who were mainly more negative.

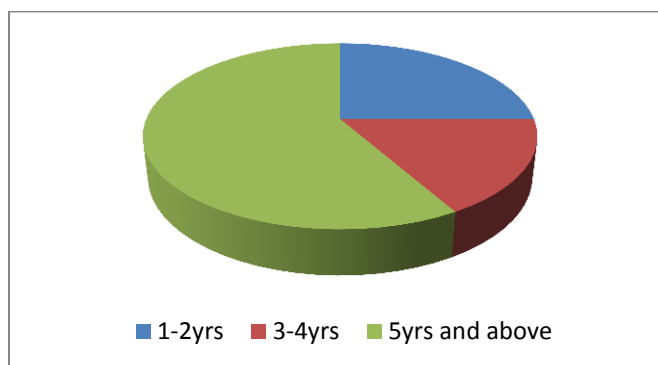


Figure 4.3: Teachers Experience in Using Computers

4.2.2 Students Background Information

According to (Afshari, et al., (2009)) female student users, compared with male students, are more inclined to hold negative reactions to computers and such differences may have resulted in the different ways of using computers. Computer use and expertise have been associated with masculinity, and therefore, gender socialization serves to act negatively on female computer interactions. They further indicated that boys aged 13-16 had already acquired a gender stereotyped view of computer users. Generally, Boys receive more support from teachers and parents, and are more likely to be the main computer uses at home than girls. Students were required to indicate their age and gender as a source of their background information as represented on Figure 4.4 and 4.5 respectively.

Figure 4.4 shows that most the students were aged 17 years representing 77.7% of the total student respondents, followed by 16 years and 18 years who were equal with at least 8.2%, finally, 19 years were the least with 6%. The study indicates that most of the students were 17 years.

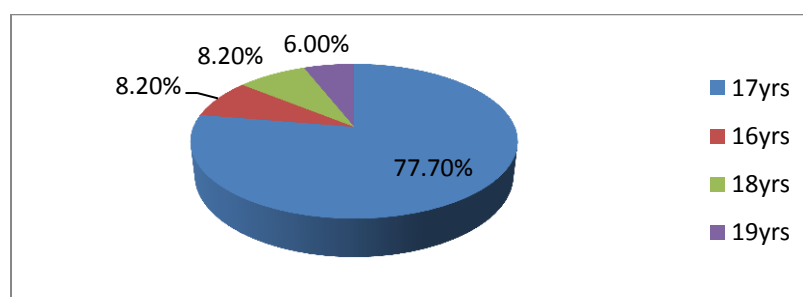


Figure 4. 4: Students Age

Figure 4.5, shows that 58.7% of the students were male while 41.7% were female.

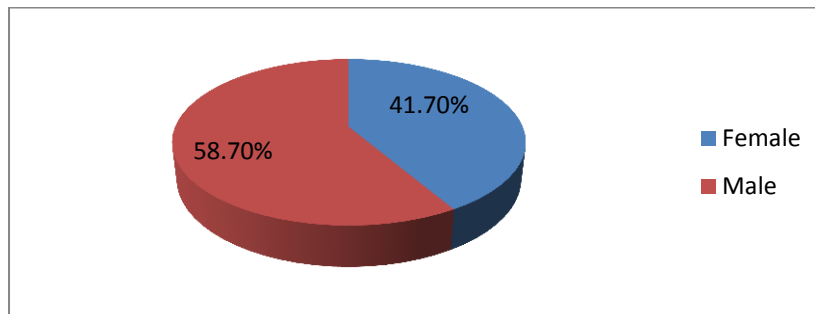


Figure 4.5: Students Gender

4.3 Levels of ICT Integration in Teaching and Learning Mathematics

ICT knowledge and skills level of Mathematics teachers determine effective curriculum delivery. The study sought to find out levels of ICT integration in teaching and learning Mathematics. From Table 4.1, it can be observed that 66% of the respondents strongly agreed that the schools had adequate mathematics software packages.

In addition, up to 58% of the respondents disagreed that that Mathematics teachers have adequate skills and knowledge to integrate ICT in Mathematics. On access to online information during Mathematics lessons, 42% of the respondents agreed that they could access online information. Forty one per cent (41%) of the respondents agreed to have extensively used computers and calculators in teaching Mathematics. Respondents were however neutral to the use of computer applications such as word, spreadsheet and internet. Fifty per cent (50%) of the respondent strongly disagreed that ICT should be a stand-alone subject and should not be used in Mathematics classes. The finding reveals that levels of technology in pedagogy in Mathematics education at secondary level are still wanting and not up-to-date. Teachers should have positive attitude towards ICT infrastructure in their teaching. This coincides

with (Buabeng-Andoh, (2012) and Amuko, Miheso and Ndethiu, (2015)) statement that, positive attitudes towards computer use by school teachers are important to ensure the integration of the technology is effectively carried out in the school curriculum and also during teaching and learning.

Table 4. 1: Levels of ICT Integration in Teaching and Learning Mathematics

Levels of ICT Integration in Teaching and Learning Mathematics	Responses %			
	S/A 1	A 2	D 3	S/D 4
a) My school has adequate Mathematics software packages.	66	08	17	9
b) Mathematics teachers have skills and knowledge to integrate ICT in mathematics teaching.	09	33	-	58
c) Teachers can access online information during mathematics lessons.	25	42	25	-
d) Mathematics teachers use computers and calculators extensively in their teaching.	34	41	25	-
e) Teachers use applications such as word processing, spreadsheets and the internet during Mathematics lessons.	25	25	25	25
f) f) ICT should be a stand -alone subject and not used in Mathematics classes.	09	16	25	50

4.3.1 Use of ICT on teaching and Learning Mathematics

The study sought to find out if learning with ICT has an influence on understanding of ideas and concepts in Mathematics class.

From figure 4.6, findings indicates that, 38.7% of the students strongly agreed that ICT has an influence on their understanding of Mathematics; while 27.5% of the students indicated that they agreed that ICT assisted them to understand Mathematics better. However, 33.8% of the students were of the opinion that ICT has no influence on their understanding of Mathematics.

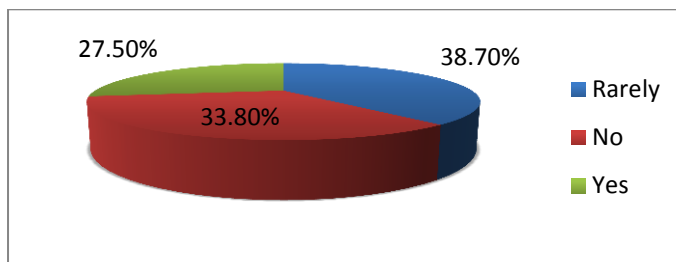


Figure 4.6: Influence of ICT on Understanding Mathematics

4.3.2 Use of Calculators

Calculators are considered to be valuable tools in checking students' manipulations during a Mathematics lesson. This study was interested in finding out how frequently students used calculators in learning Mathematics.

As shown in Figure 4.7, the study found that, 74% of the students use calculators frequently in their Mathematics learning, while 9% of the students do not use calculators frequently while learning Mathematics.

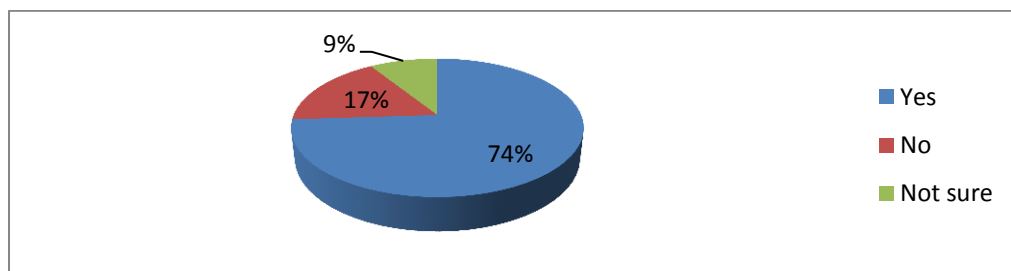


Figure 4.7: Uses of Calculators

4.4 Challenges and Opportunities Influencing Integration of ICT in Teaching and Learning Mathematics

ICTs infrastructures, training and seminars are costly and financial plans are essential for secondary schools to catch up with rapid changes and improvement in hardware, software and networks (Amuko, Miheso and Ndethiu 2015)). This study finding indicated that, the contributing opportunities and challenges which influenced integration of ICT in teaching and learning Mathematics from the respondents. The findings are presented in Table 4.2.

Notably, 41% of the respondents agreed that Mathematics teacher's lacked technical support in regards to ICT integration. Forty two per cent (42%) of the respondents strongly agreed that the current Mathematics curriculum does not allow enough time to integrate ICT in teaching. Forty two per cent (42%) of the respondents strongly disagreed that schools are not interested in integrating ICT in the Mathematics curriculum, because they lack competent and confident teachers. From the interview schedule 41.5% of the heads of departments mentioned that teachers in their schools haven't fully embraced the use of ICT in teaching Mathematics due to limited resources and lack of confidence (Amuko, Miheso and Ndethiu (2015)). Forty six per cent (46%) of the respondents agreed that Mathematics teachers lacked training opportunity for ICT integration and knowledge acquisition in teaching and learning Mathematics. In addition, Mathematics teachers' lack of support from the school administration was agreed by 46% of the respondents. Lack of ICT skills and knowledge in Mathematics was agreed by 45% of the respondents. Finally, 41% of the respondents indicated that there was lack of adequate ICT infrastructure in

teaching and learning Mathematics (Amuko, Miheso and Ndethiu (2015)). Findings reveal that Mathematics facilitators are not adequately prepared to handle technology infrastructure's in Mathematics lessons. This is because the current training programmes do not include enough time for them to become comfortable with the software, nor does it includes support to help them troubleshoot during the early implementation stages and the training experience is not tailored to their needs (Watson, (1999)).

Table 4.2: Challenges and Opportunities of ICT Use in Mathematics

Challenges and Opportunities in Integration of ICT in Teaching and Learning Mathematics	Responses %			
	S/A	A	D	S/D
a) Mathematics teachers lack technical support regarding ICT integration.	17	41	17	25
b) There is inadequate time to integrate ICT in teaching Mathematics curriculum.	42	16	-	42
c) Schools are not interested in integrating ICT in Mathematics curriculum because they lack competent and confident teachers.	08	09	42	41
d) Lack of training opportunities for ICT integration in teaching and learning Mathematics.	18	46	18	18
e) Mathematics teachers lack of ICT skills and knowledge.	18	45	09	28
f) Mathematics teachers lack support from the school administration.	18	46	27	18
g) Mathematics teachers lack experience in using computers.	09	46	27	18
h) Inadequate ICT infrastructure for teaching and learning Mathematics.	41	16	34	08

4.4.1 Challenges in Learning both Mathematics Content and Computer Technology

Difficulties in the use of ICTs and Mathematics software are related to the weakness of a teacher's knowledge about what technologies are available and how they can be used during learning Mathematics. This was to establish the challenges in learning both Mathematics content and computer technology (Amuko, Miheso and Ndethui, (2015)).

The major challenge students experienced was lack of technical know-how and support while learning Mathematics with ICT, it was mentioned by 43.5% of the students. This result indicates that students were willing to use ICT but lacked technical support from the teachers. Learning with ICT was not brain storming and this affected their way of thinking and reasoning was mentioned by 23.4% of the learners, they further indicated that when using ICT in learning, it only gave them one answer (Amuko, Miheso and Ndethui, (2015)).

In addition, 9.7% indicated that most of the computers hang and this caused students to overcrowd on one computer while, 6.7% indicated electricity was a challenge because it caused power surge, rendering computers useless and also inconvenienced their learning, 16.7% mentioned that they experienced no challenge since they never used computers during Mathematics lessons. This shows that there are some students who cannot access computers at all or they cannot operate computers due to negative attitude towards ICT infrastructure (Amuko, Miheso and Ndethui, (2015)).

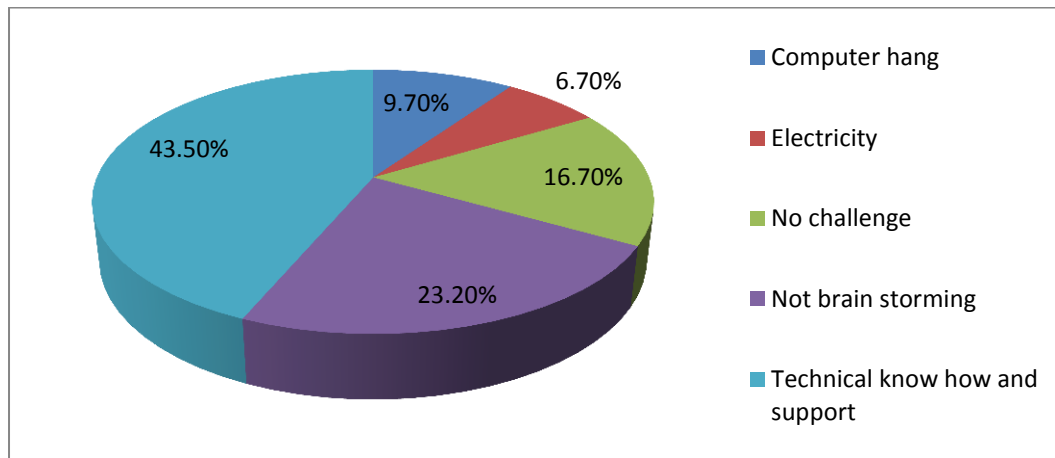


Figure 4.8: Challenges in using ICT in Learning both Mathematics Content and Technology

4.4.2 Use of the Internet in Performing of Mathematics Task

Students have general ICT skills; however, they do not get the same advantage while using online resources, during their Mathematics lessons. This study was interested in finding out if the use of internet contributes to their learning and performance of Mathematics task.

Figure 4.9 indicates that 24.2% of the students did not have any idea because they never used the internet during Mathematics lesson. This shows that that the students did not have access to the internet. Twenty one point two (21.2%) mentioned that internet assisted them in getting formulae which they were not familiar with while 40.9% mentioned that the internet made their understanding easier, while the use of internet to search for questions and application in Mathematics was mentioned by 13.8% of the students. The study revealed that most students have access to the internet during Mathematics lessons.

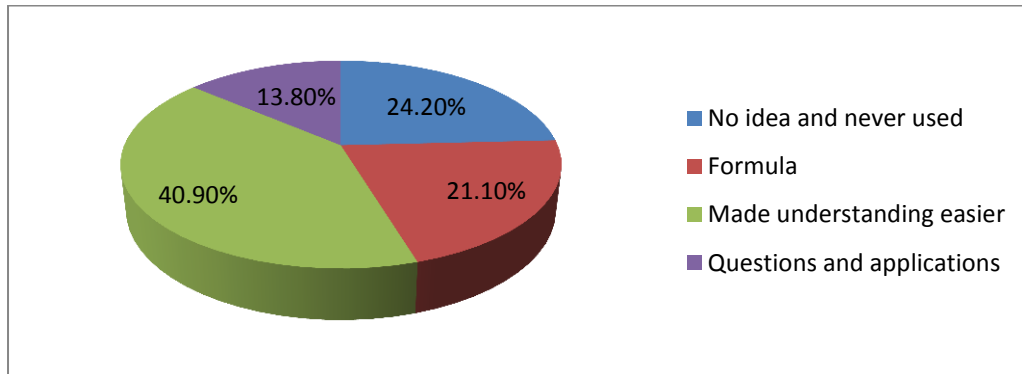


Figure 4.9: Use of Internet in Performing Mathematics Task

4.4.3 ICT Facilities for Learning Mathematics

The effective use of ICT in teaching and learning Mathematics motivates both the learners and the teachers (Amuko, Miheso and Ndethiu, (2015)). This study sought to identify the conditions of ICT facilities for learning Mathematics in the schools as shown in Figure 4.10 below.

The study revealed that 22.3% of the students considered that utility of ICT facilities in the school were excellent, while 44.2% of the students indicated that the utility of ICT facilities was good. Finally, 33.5% of the students rated the use of ICT facilities in their school as poor. The study revealed that most secondary schools used ICT facilities during Mathematics lessons.

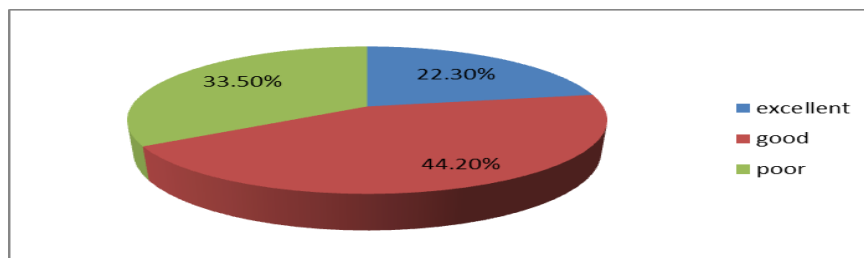


Figure 4.10: ICT Facilities for Learning Mathematics

4.4.4 Availability of Mathematics software

Training enables teachers to acquire knowledge and skills on how to use Mathematics software effectively (Amuko, Miheso and Ndethiu, (2015)). This study sought to find out from learners whether their Mathematics teachers used Mathematics software effectively.

Figure 4.11 indicates that 57.2% of the students were of the opinion that Mathematics teachers did not use Mathematics software effectively during Mathematics lessons. This is an indication that teachers lacked knowledge on how to use Mathematics software.

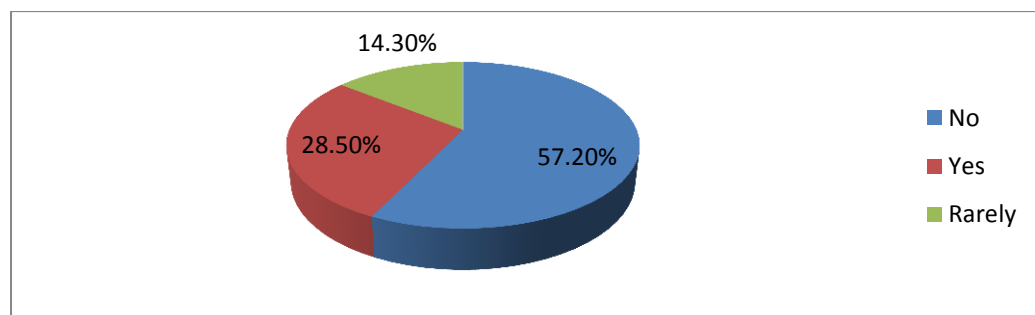


Figure 4.11: Availability of Mathematics software

4.4.5 Adequate ICT Infrastructure

Effective teaching and learning Mathematics using ICT is determined by the availability of ICT infrastructure in the schools. The study was interested to find out from the students if their schools had adequate ICT infrastructure as shown in Figure 4.12 below. The establishment for ICT use and integration in Mathematics education in secondary schools requires renovation and innovation of ICTs infrastructures because of its newness. The study on adequacy of ICT resources in integrating ICT tools in teaching and learning of Mathematics as shown on Figure 4.12 revealed that 26.8% of the students agreed that they had very large computer labs with very many

functional computers that could cater for students needs in the school. Seventy three point two (73.2%) of the students indicated that there were inadequate ICT infrastructures in their schools, the reasons given included the following: The calculators that they were using didn't belong to the school, but they were their own personal belongings. Computers were not enough and majority of the ones available were not in use due to technical problems causing them to use the functional ones in shifts. Students had to overcrowded on one computer making learning difficult for them (it affected their concentration). They also lacked smart boards and projectors; and most of the computers were not connected to the internet (Amuko, Miheso and Ndethiu, (2015)).

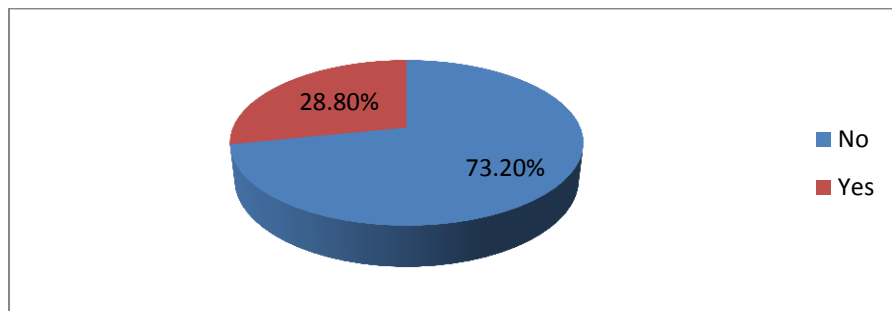


Figure 4.12: Adequate ICT infrastructure

4.5 Pedagogical Practices in Teaching and Learning Mathematics.

Teacher education enables teachers to earn knowledge and skills in ICT use and integration. This was of central importance to his study as it identified pedagogical practices in teaching and learning Mathematics from the respondents.

According to Table 4.3, 64% of the respondents strongly agreed that, Mathematics teachers can choose technologies that enhance what they teach, how they teach and

what students learn. In addition, 64% of the respondents strongly agreed that they could provide leadership in helping others to coordinate the use of Mathematics content, technologies, and teaching approaches in their schools. Those schools should come up with ways to agree by 73% of the respondents. Thirty six (36%) of the respondents agreed that there was inadequate Mathematics pedagogical focus in ICT preparation programmes, while 54% of the respondents agreed that Mathematics teachers lacked pedagogical and content knowledge about ways to integrate ICT in Mathematics lessons. This reveals that there were a variety of ICT infrastructures that were available for use and teachers were willing to use but due to lack of proper training on their use, they were unable to use them effectively. Using technology effectively requires teachers to have a wide repertoire of teaching approaches to call upon. Teachers must be proficient in using ICT not only to support their professional productivity and development, but mainly, to effectively integrate ICT into instruction and learning. Effective teacher preparation is an important factor for successful integration and sustainability of ICT in education (Amuko, (2015)).

Table 4.3: Pedagogical practices in Teaching and Learning Mathematics

Pedagogical Practices in Teaching and Learning Mathematics	Responses %			
	S/A	A	D	S/A
a) Mathematics teachers can choose technologies that enhance what they teach, how they teach and what students learn.	64	36	-	-
b) I can provide leadership in helping others to coordinate the use of Mathematics content, technologies, and teaching approaches at my school.	64	36	-	-
c) Schools should set up incentives programmes to encourage and facilitate the pedagogical integration of ICT.	73	09	18	-
d) There is inadequate Mathematics pedagogical focus in ICT preparation programmes.	27	37	18	18
e) Mathematics teachers lack pedagogical and content knowledge about ways to integrate ICT in Mathematics lessons.	09	55	18	18

4.5.1 Time for Learning Mathematical and the Computer Technology

With regard to whether there was adequate time for learning both technology and Mathematics content, majority (60.2%) of the students agreed with reasons given including there being enough time to use ICT when learning Mathematics, that is, during their free study time they could use computers to explore more ideas on how to perform Mathematics task. Thirty nine per cent (39.8) said , there was not adequate time, because they could not

multi task at the same time, they were not used to explanation done by the computers using projectors, the explanation done using the projectors took them a lot of time to internalize, and they were used to chalk and board.

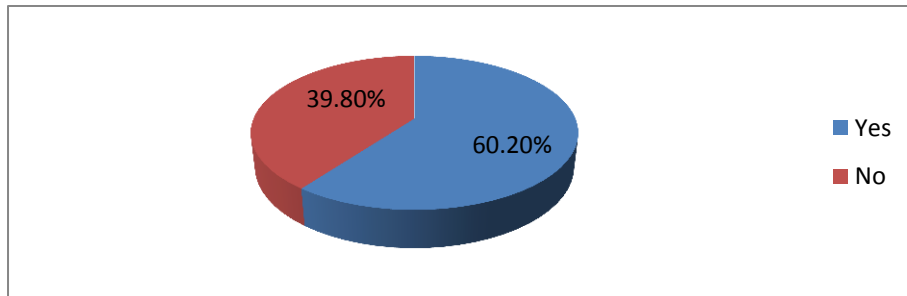


Figure 4.13: Time for Learning Mathematics and the Computer Technology

4.5.2 Opportunities of Learning Mathematics with ICT

In co-operate learning, the role of the teacher is to support students in every aspect of their learning. Figure 4.14 shows that 59.5% of the students indicated that there were opportunities to co-operate with other learners during Mathematics lessons with assistance of ICT, reasons including that they were able to understand Mathematics concepts well and, exchange ideas and also that there were individual benefits such as high concentration span during Mathematics discussions. Forty point five (40.5%) of the students said no, there was no opportunity to cooperate with other learners giving reasons including that some learners have difficulties in operating some of the ICT infrastructures, while others lacked knowledge on how to use the internet.

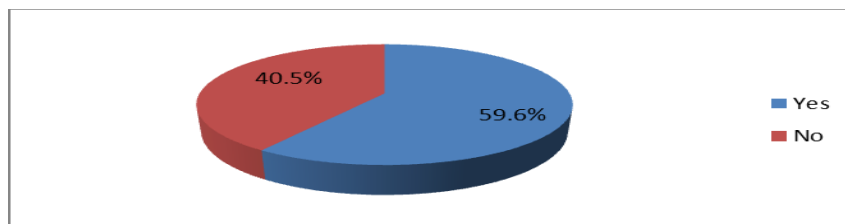


Figure 4.14: Opportunities of Learning Mathematics with ICT

4.6 Discussions of Findings

4.6.1 Levels of ICT Integration in Teaching and Learning Mathematics

Learning with useful integration tools can lead to functional understanding of Mathematical concepts as well as develop a broader understanding of the nature of Mathematics (Varghese, (2012)). This concedes with the student's findings whereby, 27.5% of the respondents strongly agreed and 38.7% agreed that learning with ICT has an influence on their understanding of ideas and concepts in a Mathematics class. However findings from the interview schedule indicated that 41.5% of the teachers haven't fully embraced the use of ICT in the teaching Mathematics in addition, 33.3% of the teachers disagreed that they used applications such as word processing and spreadsheets while teaching Mathematics. According to Rogers's (2003) diffusion theory stage three, Mathematics teachers and learners must decide to adopt ICT in teaching and learning Mathematics. Teachers can use calculators to provide activities that help students develop their Mathematical understanding about concepts such as place value and, the meaning of operations and estimation, and it is each classroom teacher's responsibility to select appropriate activities and times for using calculator for instruction (Lucas and Cady, (2012)).

The calculator is an essential element in the teaching and learning of Mathematics. Functional use means that calculator use in activities such as computation, drill and practice and checking paper and pencil work (Lucas and Cady (2012)). Thirty four per cent (34%) of the respondent strongly agreed and 41% agreed that they used calculators extensively in their teaching. Seventy four per cent (74%) of the students were in agreement with the teachers that they frequently used calculators

while learning Mathematics. This was confirmed by the observation schedule whereby 100% of the schools had scientific calculators.

From the observation checklist, teachers could adopt the use of mobile phones because they have a wide range of features. Mobile phones have calculators and could also function like desktop computers/ laptops. They have features such as Wi-fi and Bluetooth. These features could enable students to learn Mathematics through co-operative learning. Students and teachers can also discuss and share information with the aid of a Blue tooth. Students can access assignment or revision questions through the use of Wi-fi. The phone also has the capability of storing a large amount of data with the aid of a memory card.

4.6.2 Challenges and Opportunities in Integration of ICT in Teaching and Learning Mathematics

For successful integration of ICT into the Mathematics curriculum, it is essential to have knowledge of the existing software that is used by Mathematics teachers UNESCO (2007). One of the major problems is that the educational software is often isolated and not integrated with the textbooks that many teachers use (Kaffash, Kargiban, Kargiban and Ramezani, (2010)). Findings indicated that 57.2% of the students did not agree that their Mathematics teachers used the Mathematics software effectively during Mathematics lesson. From the observation schedule, it was observed that half of the schools had Mathematics software which they had downloaded from search engines such as Google and Dog-pile.

From the research findings, 41% of the teachers indicated they lacked adequate ICT infrastructure in teaching and learning Mathematics. This coincides with the claims

of Peeraer and Van Petegem, (2011) and Kukali (2013) that surrounding computer hardware was the most serious factors affecting implementation. Teachers reported that computers were not enough for learning Mathematics. Forty one per cent (41%) agreed that Mathematics teacher's lacked technical support in regard to ICT integration. Similarly, 73.2% of the students indicated that there was an inadequate ICT infrastructure in their school and some were not functional forcing them, to use the functional ones in shifts. Students had to overcrowd on one computer making learning difficult for them (it affected their concentration). In addition, 9.7% of the students indicated that most of the computers hang and this caused students to overcrowd on one computer. Breakdown of a computer causes interruptions and if there is lack of technical assistance, then it is likely that the regular repairs of the computer will not be carried out resulting in teachers not using computers in teaching. The effect is that teachers will be discouraged from using computers because of fear of equipment failure since no one would give them technical support in case there are technical problems (Amuko, Miheso and Ndethiu, (2015)). If teachers are discouraged to use ICT then, they are likely not have experience in using them during teaching Mathematics and this was agreed by 46% of the respondents. This is due to lack of training opportunities on how to integrate ICT in their teaching as cited by 50% of the respondents. This coincides with the findings of Bingimlas (2009) and Kukali (2013), that there were not enough training opportunities for teachers on the use of ICT in classroom environment. Due to the short duration during training, most teachers don't acquire enough skills and knowledge to teach Mathematics using ICT as stated by 50% of the respondents. It will be very difficult for teachers who have not acquired adequate skill and

knowledge, to teach Mathematics using ICT in the required time allocated in the time table, Kukali, (2013) stated that mastering technology requires time. Notably, 42% of the respondents strongly agreed that Mathematics curriculum did not allow enough time to integrate ICT into their teaching. If teachers get support from the school administration, the challenges they are experiencing during integration of ICT will be minimal.

4.6.3 Pedagogical Practices in Teaching and Learning Mathematics

A wide variety of technologies can mediate interaction, but it is how these technologies are used to support collaborative practices that make the difference in teaching and learning. The use of technologies to support collaborative learning practices requires new ways of learning and teaching and a new mind set about what is to do Mathematics (Hoyles and Lagrange, (2009)). The findings indicated that 64% strongly agreed that Mathematics teachers can choose technologies that enhance what they teach, how they teach and what students learn.

Most ICT teacher professional development initiatives tend to focus on technological aspects (i.e., how to use various tools) while pedagogical and instructional issues (i.e., why and how to use those tools to enhance learning) are often taken for granted (Jimoyiannis et al., (2013)). Twenty seven (27%) of the respondents strongly agreed and 36% of the respondents agreed that there is inadequate Mathematics pedagogical focus in ICT preparations programmes. In addition, application of ICT in school settings has been driven more by technology rather than by the demands of pedagogy and didactics of the particular subject matter (Jimoyiannis et al., (2013)).

The findings should enlighten teachers, parents, students and all education stakeholders to ensure both teachers and learners develop a positive attitude toward ICT in teaching and learning Mathematics. ICT will boost Mathematics performance of the learners, if teachers will be given the opportunity and support from the community and educational stakeholders. Teachers should be well trained during their pre-service training. They should also be in-serviced at least after every two years at district level so as to ensure that all teachers have been trained. The training should be conducted during school holidays for at least two weeks. The government should invest heavily in the ICT infrastructure, because ICT infrastructures motivate learners and when learners are motivated they are in apposition to perform well in their studies. Lastly, ICT will enable the government of Kenya to achieve it Vision 2030 plan in the education sector.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The purpose of this study was to investigate challenges and opportunities influencing integration of ICT in teaching and learning Mathematics in secondary schools in Nairobi County. This chapter presents a summary of the research findings, conclusion, recommendations of the study and suggestions for further research.

5.2 Summary of the Findings

The following is a summary of the findings based on the general research questions of the study.

- a. What are the levels of ICT integration in teaching and learning of Mathematics?
- b. What are challenges and opportunities influencing the use of ICT in teaching and learning Mathematics?
- c. Which pedagogical practices are used in teaching Mathematics using ICT?

Findings indicated that there were low levels of ICT integration in teaching and learning Mathematics in secondary schools in Nairobi County, whereby three quarters of the respondents indicated that there was need to purchase Mathematics software which could be downloaded for free from search engines. The respondents were neutral on the use of application such as word processing, spreadsheets and the internet, this is an indication that computer applications are not widely used in Mathematics teaching and learning. Students were in agreement that learning with

ICT has a great impact on their understanding of ideas and concepts during Mathematics lessons. Most schools relied on one form of ICT infrastructure calculators; this shows that there were low levels of ICT integration in teaching and learning Mathematics.

The study also identified the challenges and opportunities influencing the use of ICT in teaching and learning Mathematics. The study found that ICT infrastructures were limited in most of the schools and Mathematics teachers did not attend to seminars and frequent training programmes on how to use ICT in teaching and learning Mathematics. Most of the ICT infrastructures were not well maintained due to lack of technical support from a professional technician.

On pedagogical practices that are used in teaching and learning Mathematics, over a half of the teachers could choose technologies that enhance what they teach, and what students learn. However, majority of the teachers felt that they were not adequately prepared through ICT preparation programme to use ICT in teaching and learning Mathematics.

5.3 Conclusions

This study has resulted in three main conclusions as follows. First, based on the findings that ICT has a great impact on their understanding of ideas and concepts during Mathematics lessons, it is logical to conclude that teachers have come to appreciate the fact that ICT improves teaching and learning of Mathematics in secondary schools, but also motivates learners and teachers. Teachers will continue to use ICTs in their classrooms despite the many challenges affecting

implementation of ICT in teaching and learning Mathematics. Most of the challenges that teachers face affect students understanding and knowledge. Second, the challenges facing teachers in their resourcefulness are many and affect them on both school and professional level. Third, based on pedagogical knowledge and practices, teachers are expected to develop their technological skills and knowledge and use ICTs in their classrooms. Pedagogical practices seem to be a challenge to teaching and learning of Mathematics in secondary schools and impact on traditional classroom practices

5.4 Recommendations

1. Trained teachers to integrate ICT in teaching and learning Mathematics do not have time to act as technicians (repair computer hardware and software) and teachers at the same time .There is need for the government to set funds a side for all secondary schools, in Kenya to employ full time computer technicians alternatively the Ministry of Education or the TSC to employ at least one computer technician per school and also to in-service them after every six months, because technology changes after every six to eight months.
2. There is need for the government to establish ICT training centres and resource centres in each district. This will enable all Mathematics teachers to receive training on new ICT infrastructure and also it will enable them to improve their technological and pedagogical knowledge in teaching Mathematics.
3. The government should allow students to carry mobile phones to schools, strictly for learning Mathematics and other subjects respectively, because mobile phones

will be cheap to maintain, unlike computers which consume a lot of large storage space. Mobile phones don't require electricity constantly once they are charged; they can be used in a double lesson.

4. There should be a uniform training programme on integration of ICTs in all teaching subjects for all student teacher trainees in colleges and university. The programme should be able to prepare teacher trainees to be able to integrate ICT in their teaching in secondary schools.

5.5 Areas for Further Research

The researcher is of the opinion that further research can be carried out in the following areas.

- 1) This study can be replicated in other counties in order to give a reflection of the country. This will facilitate better decision making on ways of improving Mathematics teaching and learning and enhance Mathematics performance in Kenya.
- 2) A study to be done on ICT pedagogical practices in teachers training colleges and universities in Kenya.
- 3) A study to be conducted on the effectiveness of using smart phone in teaching and learning Mathematics.

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APPENDICES

APPENDIX I: TEACHERS QUESTIONNAIRE

Part I: Background Information

Kindly answer all the questions either by ticking in the boxes or writing in the spaces provided.

1. What is your age?

25 -29 years

30 -34 years

35 -39 years

40 years and over

2. Your gender:

Female

Male

3. For how long have you served as a teacher?

Less than 5 years

6-10years

11-14years

15 years and over

4. For how long have been using computers in teaching Mathematics?

.....

Part II: Levels of ICT Integration in Teaching and Learning Mathematics

Please tick the numeric value corresponding to your personal opinion for each statement.

	Strongly agree	Agree	Disagree	Strongly disagree
a) My schools has adequate Mathematics software packages				
b) Mathematics teacher have adequate skills and knowledge to integrate ICT in Mathematics.				
c) Teachers can access online information during Mathematics lesson.				
d) Mathematics teachers can access online information during Mathematics lesson.				
e) Teachers use application such as word processing, spreadsheets and the internet during Mathematics lesson.				
f) ICT should be a stand-alone subject and not used in Mathematics classes.				

Part III: Opportunities and challenges in Integration of ICT in Teaching and Learning Mathematics.

Please tick the numeric value corresponding to your personal opinion for each

	Strongly agree	Agree	disagree	Strongly disagree
a) Mathematics teachers lack of technical support regarding ICT integration.				
b) There is inadequate time to integrate ICT in Mathematics curriculum.				
c) Schools are not interested in integrating ICT in Mathematics curriculum because they lack competent and				

confident teachers.				
d) Lack of training opportunities for ICT integration in teaching and learning Mathematics.				
e) Mathematics teachers' lack of ICT skills and knowledge.				
f) Mathematics teachers lack support from the school administration.				
g) Mathematics teachers do not have enough experience in using computers.				
h) Lack of adequate ICT infrastructure in teaching and learning Mathematics				

Part IV: Pedagogical Practices in Teaching and Learning Mathematics.

Please tick the numeric value corresponding to your personal opinion for each statement

	Strongly agree	Agree	disagree	Strongly disagree
a) Mathematics teachers can choose technologies that enhance what they teach, how they teach and what students learn.				
b) I can provide leadership in helping others to coordinate the use of Mathematics content, technologies, and teaching approaches at my school.				
c) There is inadequate Mathematics pedagogical focus in ICT preparation programs.				
d) Mathematics teachers lack pedagogical and content knowledge about ways to integrate ICT in Mathematics lessons.				

Part V: Open Question

1. How do you feel, about using ICT in Mathematics?
-

APPENDIX II: STUDENT QUESTIONNAIRE

Part 1: Background Information

Kindly answer all the questions by either ticking in the boxes or writing in the spaces provided.

1. Age
2. Form.....

Part II: Levels of ICT Integration in Teaching and Learning Mathematics.

1. Learning with ICT has influenced my understanding of ideas and concept in a Mathematics class.
 Yes No Rarely
2. We use calculators and computers frequently for learning Mathematics
 Yes No Rarely

Part III: Challenges and Opportunities influencing integration of ICT in Teaching and Learning Mathematics

3. How does the use of internet contribute to the learning and performing Mathematics task?.....
4. How can you rate the use of ICT facilities in your school in learning Mathematics?
 Yes No Rarely
5. Teachers use Mathematics software effectively while teaching Mathematics.
 Yes No Rarely
5. Do you think your school has adequate ICT infrastructure?
 Yes No
 Give reasons for your answers.....
6. What challenges do you face while learning Mathematics with the use of ICT.....

APPENDIX III: INTERVIEW SCHEDULE

The following questions will guide the researcher during the interview schedule

1. What priority level do you give to resource allocation in your school
in order to enhance the use of ICT in teaching and learning Mathematics
students in your school?
2. To what extent has the use of ICT in teaching and learning
Mathematics influenced students' performance in your school?
3. Have teachers in your school acquired knowledge and skills in using
ICT for teaching and learning Mathematics?
4. Does your school have qualified technical personnel to support the use of
ICT in teaching and learning Mathematics?

APPENDIX IV: CHECK LIST

CHECKLIST				
	ITEM	CONDITION		
		Working in use	Working not in use	Not there
001	Desktop Computers			
002	Projectors			
003	Laptops			
004	Ipod			
005	Calculators			
006	Smart phones			
007	Internet Connection			
008	Mathematics software			
009	Electricity			
010	Standby generator			

APPENDIX VII: MAP OF KENYA

