EFFECTS OF INFORMATION AND COMMUNICATION TECHNOLOGY USE ON STUDENTS' ACHIEVEMENT AND ATTITUDE IN MATHEMATICS

BY

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THIS RESEARCH THESIS IS SUBMITTED TO THE SCHOOL OF EDUCATION IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF EDUCATION IN MATHEMATICS EDUCATION IN THE DEPARTMENT OF CURRICULUM AND INSTRUCTION OF UNIVERSITY OF ELDORET, KENYA.

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DECLARATION

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This work is dedicated to Prof. Patrick Kafu of The University of Eldoret for the immense work in Education Technology in Kenya.

ABSTRACT

One of the most critical concerns in national examinations in Kenya since independence in 1963 is poor performance in Mathematics. This study is designed to investigate the effects of Information and Communication Technology (ICT) on students' achievements in mathematics and attitude towards mathematics. This thesis used quasi-experimental design, a field study carried out on Students from Day Secondary Schools from Tiriki East Division, Hamisi Sub-County in Vihiga County of Kenya. The purpose of this study was to determine the effects of integrating ICT in teaching and learning to improve performance of mathematics in Secondary School Education in Kenya. The objectives of this study were: i) To determine the effects of ICT use on students achievement in mathematics ii) To investigate how ICT influences male and female students' achievement in mathematics and iii) To investigate the effects of ICT on students attitude towards mathematics. A total of 452 students with a sample of 256 respondents comprising 104 female and 152 male respondents participated in the study. The sample involved twelve classes comprising of Form four students from four of the nine mixed Day Secondary Schools in the Division. Two of these schools, the only Day Secondary Schools in the Division with computers for learning, were selected into the experimental group. The other two schools were selected into the control group because they have three streams in each class just like the schools selected into the experimental group. In the experimental group, all students were taught how to determine median and quartiles of a given set of data using a computer program. The control groups were taught the same content as experimental group using the traditional methods. A paper and pencil test on the achievement was administered to both groups before and after the treatment. Another instrument, the questionnaire, testing attitude was given to students to respond to before and after the treatment. Data collected was analyzed using mean, standard deviation and one-way Analysis of Variance (ANOVA). The information was presented in form of bar graphs, pie charts and tables. The findings showed that ICT integration in teaching improves the achievement in mathematics of Secondary School students but has no significant effect on the attitude towards mathematics. The study therefore recommends the Government of Kenya in collaboration with Schools Board of Management, Education stakeholders and well-wishers to equip Secondary Schools with computers for learning. Further research should be conducted on the effects of ICT use in Secondary Schools over a long period of time on students' attitude towards mathematics

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CHAPTER ONE

INTRODUCTION OF THE STUDY

1.1: Introduction

This chapter discusses the background information of the study, the statement of the problem and the purpose of the study. It also highlights the research objectives, research questions, the hypotheses, justification and the significance of the study. Finally, it discusses assumptions of the study, scope, limitations of the study, conceptual and the theoretical frame-work that was employed in the study.

1.2: Background to the Study

In the era of fast technological advancement, keeping up with the latest innovations and inventions that technology can offer is essential in order to be relevant now and in the future (Lim and Noraini, 2006). To achieve this goal, learners must be actively involved in the learning process, which is contrary to the traditional method of teaching. Students have continued to post low mean scores in mathematics at Kenya Certificate of Secondary School Education (KCSE) level. For instance, in 2010, the mean score for mathematics in the nine day secondary schools in Tiriki East Division was 2.245. This mean score dropped to 2.147 in 2011 and improved to 2.5960 in 2012 in the same schools. These low mean scores in mathematics affect the overall mean performance of the students since it is a compulsory subject for grading that students learn in schools in Kenya. Traditional teaching approaches, which include the ‘talk and chalk’ method, lecture and teacher demonstration portrays a teacher as a dominant element in the teaching and learning process. A change from traditional methods of teaching to innovative methods like ICT use possibly has a potential to change the trend in the performance of mathematics. In the traditional teaching methods, students are unable to extract necessary information from a given data and hence cannot interpret answers and make credible conclusions. Therefore, classrooms seldom involve students in mathematical communication and in making logical reasoning. They emphasize more on how much the students can remember and less on how well they can think and reason. Learning of mathematics, therefore, becomes uninteresting and boring (Jacobs and Philipp 2010).

In Kenya, many students are not able to comprehend what their mathematics teachers teach because mathematics content is taught with the intention of completing the syllabus and preparing students for examinations (SMASSE Project, 2008). Little or no regard is given to how well the students understand mathematical concepts because the traditional methods of teaching allow little opportunity for students to explore mathematical patterns and processes (Nooriafshar, 2009). The processes and patterns which students need to understand mathematics is integral part of ICT use and in this case of this study, the computers used in the 21st Century.

Computers are electronic devices that use software programs to facilitate communication between its hardware and the user. Computers can be used to acquire, store, process, transmit and disseminate information. ICT use elicit student's participation in the learning process and, therefore, generate theoretical data that lead students to apply higher order thinking skills in various problem solving skills. In this case, students find meaning and understanding of what they learn in mathematics classes. They become active and willingly participate positively in mathematics lessons. This enhances interest in mathematics, making it lively, a recipe for deeper learning, which is an essential ingredient for success. Deeper learning is a process by which a person becomes capable of thinking what was learned in one situation and applying it to a new situation (Broad, 2005).

Another aspect of concern in mathematics class is the attitude of the students towards mathematics. Despite the importance of mathematics in the present ever-demanding, innovative and dynamic society, the attitude of students and teachers towards mathematics is negative (Mbogua and Komen, 2012). Negative attitude towards learning many topics in mathematics leads to low appreciation of these topics which consequently results in low achievement in the subject. Reasons that have been attributed to negative attitude towards the subject include (a) inability of students to visualize what they have learnt (b) students perception of some topics as tedious, time consuming and boring (c) teaching methods.

Studies have shown that innovative teaching methods motivate learning and students interest that leads to positive attitude towards the subject. Momanyi, Norby and Strand (2006) gave credence to the use of ICT as a way of eliciting students' participation in the learning process. The use of ICT changes the perception of teaching methods and creates a positive attitude towards mathematics in students since it makes students active in the teaching and learning process.

Information and Communication Technology (ICT) tools generally have a positive impact on learning but the expectations that ICT could in some ways revolutionize processes at school have not yet been realized. This goes beyond the use of computers by teachers since it is not only personal computers and the internet but also digital cameras, mobile phones and other technologies that help to change teaching processes. Clearly, ICT has not revolutionized teaching methods so far in Kenya since the use of ICT is mostly focused on supporting the subject content, but ICT-based activities by students, has far more to do with consuming than producing. However, the impact of integrating ICT in teaching can be measured by students' engagement, creativity and by the fact that less time is wasted during teaching and learning process. Education stakeholders in Kenya typically view ICT as a valuable tool for pedagogical development but very few of them actually experience this impact (Elnord, 2006). Therefore, changes for improvement and development have to be undertaken in dealing with such enormous challenges accruing from technological advancements in the world today. By implication, the order of treatment of many topics in mathematics would need to change so that learners do not end up memorizing mathematics procedures in the classroom but be able to apply knowledge gained in classroom later in life in subject areas like commerce, logistics and engineering. Hence, the significant impact of mathematics as opined by Smith (2004) is to develop and improve students' mathematics skills and abilities to reason logically, think critically, make decisions, forecast weather and read maps effectively. Achievement in mathematics is thus very critical both for learners as well as for nation's building. Mbogua and Komen (2012), attribute poor performance in mathematics to students' attitude towards the subject. Adera, (2004) found that attitude can be changed if individuals develop a motivated interest towards a situation. Against this background, it is critical to investigate how the use of computers in the teaching of mathematics can impact on students' achievement and attitude towards the subject. The premise of this study, therefore, is to investigate the effects of ICT method of teaching on students' achievement in mathematics and attitude towards it.

1.3: Statement of the Problem

Mathematics is a subject that has high relevance in the economy, industry, national development and individual's personal life. Despite the critical role of mathematics, especially in the present era, students' achievement and attitude in the subject for several years has been very poor. Research by Umoinyang (1999) has shown that the teaching methods used do not promote students understanding and attitude in the subject as students continue to perceive mathematics as difficult and boring.

Mathematics is an activity-based subject which demands full participation of the students in the teaching and learning process hence the need to explore strategies that will involve students creatively, reflectively and socially. Efforts made through research in Kenya by Mbogua and Komen (2012) to improve students' achievement and create positive attitude towards mathematics have so far proved abortive or merely demonstrated that choice of teaching methods affects students' achievement and attitude in the subject. Therefore, this study investigated how ICT use in teaching affects students' achievement in mathematics and attitude towards this subject.

1.4: Purpose of the Study

The purpose of this study was to investigate the effects of Information and Communication Technology (ICT) use on students' achievement in mathematics and attitude towards this subject.

1.5: General Objective

The general objective of this study was to investigate the effect of ICT on students' achievement in mathematics and attitude towards this subject among Day secondary schools students in Tiriki East Division, Vihiga County of Kenya.

1.5.1: Specific Objective

The study was guided by the following specific objectives:

(1) To determine the effects of ICT use on students achievement in mathematics.

(2) To investigate how ICT influences male and female students' achievement in mathematics.

(3) To investigate how ICT use affects students' attitude towards mathematics in the experimental group

1.6: Research Questions

The study sought to answer the following research questions:

1. What will be the mean achievement scores of Secondary School students taught selected topics in Mathematics using ICT method and those taught the same topics using the traditional methods?
2. What is the effect on sex, of mean achievement scores in mathematics, of Secondary School students taught selected topics in Mathematics using ICT and those taught the same topics using the traditional methods?
3. What will be the mean difference in attitude towards Mathematics of Secondary School students taught selected topics in Mathematics using ICT and those taught the same topics using the traditional methods?

1.7: Hypotheses (P>0.05)

The following null hypotheses were tested for significance between various variables in the study:

Ho_1: There is no significant difference in the mean achievement score of Secondary School students taught some selected topics in Mathematics using ICT and those taught the same topics using the traditional method.

Ho_2: Sex has no significant effect on Secondary School students' achievement in Mathematics.

Ho_3: There is no significant difference in the attitude towards Mathematics between Secondary School students taught some selected topics in Mathematics using ICT materials and those taught the same topics using traditional methods.

1.8: Justification of the Study

ICT tools such as computers, projectors, printers, e-blackboards and mobile phones have been available to teachers for use in integration of teaching and learning in schools. The use of ICT in education has the potential to enhance quality of teaching and learning, research productivity of teachers and students, management and effectiveness of institutions (Kashorda, Waema, Omosa and Kyalo, 2007). ICT use in Kenyan Secondary Schools is an aspect to be given high considerations. The use of these ICT tools, especially the computer, will make teaching and learning more activity-based as compared to use of traditional methods of teaching. It captures the interest of learners and makes teaching and learning livelier, both to learners and teachers. Students therefore view mathematics as a subject that is easy to learn and with relevant applications while in school and thereafter.

1.9: Significance of the Study

Emerging concern within education sector in Kenya is the integration of Information and Communication Technologies (ICT) in the provision of quality education. Specifically, it is the challenge of incorporating ICT into classroom for teaching and learning purposes. There is increasing need for students who are more informed and capable of making critical decisions in a technological world. After several years of effort, Kenya promulgated a National ICT Policy in January 2006 that aims to improve the livelihoods of Kenyans by ensuring the availability of accessible, efficient, reliable and affordable ICT services. Teachers, being the forerunners in executing the national educational policy, must abide by the needs to equip themselves with ICT knowledge and to deliver the Mathematics content in class. With the growing emphasis on technology, it is high time to strengthen pre-service teacher training and professional development in the use of ICT in the teaching of mathematics. Professional development courses enable Mathematics teachers to develop themselves on techniques of integrating ICT in the teaching of Mathematics in schools. A technology rich learning environment is characterized by collaborative and investigative approaches to learning, increasing integration of content across the curriculum and a significant emphasis upon concept development and understanding. The use of computers in schools enables teachers and students to teach and learn mathematics more meaningfully. This makes students develop positive attitude towards mathematics, find meaning of what they learn and apply it in various day-to-day life situations.

The Kenya Institute of Curriculum Development (KICD), a body mandated to drawup and revise syllabi in Kenya, should integrate ICT tools in the content they develop. This will enhance better teaching methods that are in line with the ever-changing technological world. The study will also sensitize the school management board members on the need to equip schools with the necessary modern technologies that foster effective learning in schools in their annual strategic plans. This will ensure that students learn with optimal advantage using the modern technology. Finally, as Kenya gears to have its people ICT literate, the findings of this study will help teachers and high school graduates, develop positive attitude towards shift from analogue system to digital era. The cost of training teachers and other human resource will greatly reduce, therefore, giving priority to other areas that require development.

1.10: Assumptions of the Study

This study assumes that all Public Secondary Schools in Kenya possess computers needed for teaching and learning in the ICT age and positive impact has not been seen in the teaching and learning of mathematics. The study also assumes that Public Day Secondary Schools do not utilize ICT facilities for teaching due to time constraints. It also assumes that Form four students have been taught most of the topics in the syllabus using the traditional methods and that little or no ICT integration have been used in the teaching and learning process. Finally, the study assumes that the low achievement in mathematics in Day Public Secondary Schools in Tiriki East Division is a true reflection of the performance of mathematics in Day Secondary Schools at KCSE in other regions of Kenya.

1.11: The Scope and Limitations of the Study

The focus of this study is the effects of ICT on students' achievement in mathematics and the attitude towards this subject in Public Day Secondary Schools in Tiriki East Division, Hamisi District, Vihiga County in Kenya.

1.11.1: The Scope of the Study

ICT is a broad subject and discipline. It is a subject that has many applications in Education and Industry. The study focuses on the use of ICT in Education and specifically integration of ICT in teaching. Although there are many learner-centered methods of instruction that could improve students' performance in mathematics this study only concentrated on integration of ICT materials and related resources in teaching and learning of mathematics.

1.11.2: Limitations of the Study

The sample group for this study was confined to a particular educational geographical location, therefore, the findings may not actually represent all the students, hence could be regarded as institution specific. Restrictions in time and finances limited the extent of the research findings. This may have affected the credibility and reliability of the study; hence the findings from the study can be used for further research. Nevertheless, the findings from this study provide positive impacts on issues related to the integration of ICT in the secondary school education program in Kenya.

1.12: Conceptual Framework for ICT Integration

In planning for ICT integration, policy makers need to begin by clarifying overall national education policy, objectives and approaches as this serves as the rationale and road map for technology integration in education system. Farrell and Wachholz (2003), found three different approaches of integrating ICT in teaching and learning of mathematics in class: (i) teaching ICT as a subject to develop a labour force with ICT skills (ii) integrating ICT across the curriculum to improve teaching and learning of mathematics (iii) using ICT to foster learning of mathematics anywhere as part of the development of a knowledgeable society in which citizens are ICT savvy. For the purpose of this research, integration of ICT in the syllabus to improve teaching and learning is the premise of this study. Ng, Miao and Lee (2008) identified four broad approaches for the development of a model for ICT integration for teacher development. As teachers of mathematics move through each stage, they develop increasing capabilities to integrate ICT in their day-to-day teaching activities and students develop positive attitude towards the subject that will enhance performance in mathematics.

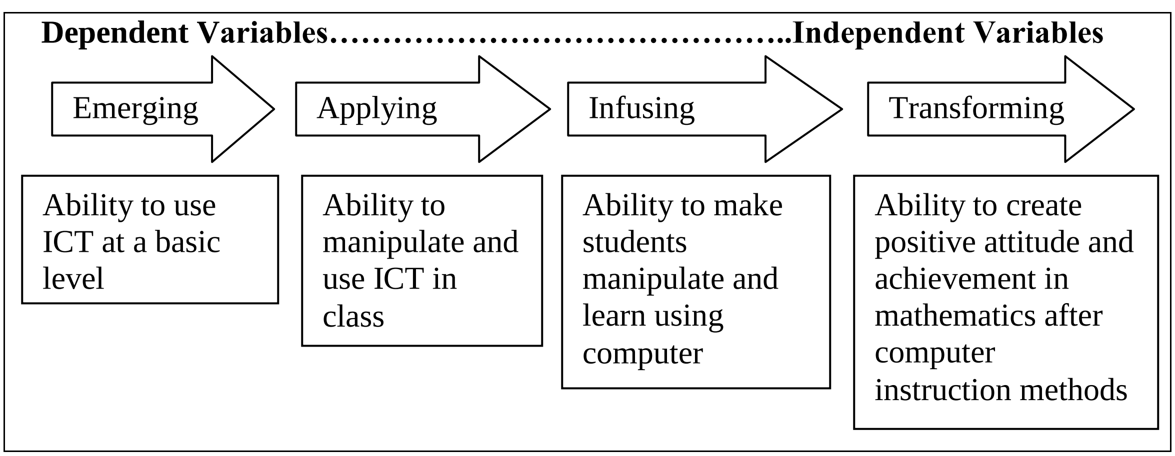

Figure 1.1: Conceptual Framework. Source: Author, 2014

Emerging stage: Teacher development focus is the use of ICT to supplement traditional methods. The teacher and the students are discovering ICT tools, general functions and uses. It arouses curiosity and creates a slow shift away from the traditional methods of teaching.

Application stage: The focus of this stage is the development of digital literacy and how to use ICT tools to enhance better performance and attitude in mathematics. It involves use of general and particular applications of computers.

Infusing stage: The focus of this stage is the use of ICT to guide students through complex problems and manage dynamic learning environments. Teachers help students understand how change of one variable in a concept affects the other. They are able to use computers to solve real life mathematical problems.

Transformation stage: Students are able to change a situation by themselves using a computer program. They are able to apply knowledge obtained through ICT teaching in general and particular applications. They are able to solve day-to-day problems with little assistance from the teacher.

The conceptual framework therefore, focuses on both the learner and the teacher, on the need to use ICT tools to better teaching and learning process. It shows the most effective way of integrating ICT in schools for teaching as a process advancing from one stage to the other. It offers effective way for a smooth transition from teacher-centred approach towards learner-centred approach.

1.13: Theoretical Framework

The present study is based on Constructivists theory of learning by Fosnot (1996) and the Activity theory Approach by Cole and Engestrom (1993). These theories, when integrated effectively with ICT tools, make teaching and learning student-centred. A student-centred classroom, is lively and has potential of improving achievement in mathematics and also boosts the attitude towards the subject

1.13.1: Constructivist's Theory of Learning

Constructivism is a theory of knowledge that argues that humans generate knowledge and meaning from an interaction between their experiences and their ideas. In past centuries, constructivist ideas were not widely valued due to the perception that children's play was seen as aimless and of little importance. Jean Piaget did not agree with these traditional views; however he saw play as an important and necessary part of the student's cognitive development and provided scientific evidence for his views.

Constructivism theory of learning view learning as a process of knowledge construction, with concept development and comprehensive understanding as the goals. Constructivism is a movement that combines cognition from a developmental perspective with other important issues, such as motivation, self-directed learning, and a focus on the social context of learning (Phye, 1997). There are two main aspects of constructivism. First, learning is a process of knowledge construction instead of absorption. Learning, in constructivists' view, requires the building of conceptual structures through reflection and abstraction (Ndlovu, 2013). Since each learner has to construct his or her knowledge, concepts cannot be transmitted from teacher to learner by means of words (Schank, 1997). Learning occurs only when the learners are actively involved in the construction and reorganization of concepts. The use of words through lecture method in the teaching of mathematics has not brought about positive impact on students' achievement and attitude and it clearly shows that activity-based teaching through the use of ICT may be more relevant. Secondly, knowledge is highly related to the environment in which the learner experiences and constructs the knowledge. Therefore, constructivists emphasize cognitive experience in authentic activities. The context does not need to be real world of work; however, to be authentic, learning activities should employ the type of tasks that are the ordinary practices of the culture (Duffy and Jonassen, 1992). Thus the emphasis on cognitive experience in authentic activities could be promoted if ICT is appropriately integrated as a teaching strategy.

Another main aspect of constructivism is similar to situated learning. Situated learning takes the theory of social and ecological interaction as its basis and emphasizes the information structures in the contents of people's interactions (Greeno, 1997:5). During classroom instruction with ICT tools, learners construct their own view of the learning process as perceived by the constructivist's social interaction in groups, enabling them to argue and think through the problem instead of copying teacher's procedure. During the activity in groups with a computer, students have opportunity to articulate their ideas and revisit the mathematics concepts in different forms.

One of the recommendations of constructivism is to engage students in building objects (Kafai and Resnick, 1996). This approach assists learners in constructing theoretical concepts because it creates the means building physical displays that allow explicit representation of key theoretical constructs. This approach serves several purposes. First, it becomes possible to manipulate these objects and observe the effects, and by doing so the presentation of the concept is visible. Secondly, manipulating objects allows learners to raise their own questions, generate their own hypotheses, and then test the hypotheses (Fosnot, 1996). Third, objects displayed ensure that individuals talk about the same thing and have visible references for the discussion (Resnick, 1986). These characteristics can be addressed effectively if computers are used for teaching of mathematics. Students will learn to manipulate concepts and ideas to generate meaning that is applicable in their day-to-day activities. As students encounter problems outside school environment, they are able to apply knowledge achieved in class to solve them rather than shying away from them. In constructivism, constructing an understanding requires that learners have the opportunities to articulate their ideas, test those ideas through experimentation and consider the relationships between the phenomena that they are examining and other applications of the concept (Julyan and Duckworth, 1996). The opportunity for learners to discuss and clarify their experiences is essential, because it encourages self-organization and reflective abstraction which is the driving force of learning (Fosnot, 1996).

A constructivist classroom is seen as a community engaged in activity, reflection and conversation (Fosnot, 1996). Starting with the assumptions that knowledge is constructed and that the environment in which the construction takes place is highly related to the knowledge. Spiro, Feltovich, Jacobson and Coulson (1992) proposed a Cognitive Flexibility Theory which asserts that for students to achieve advanced knowledge acquisition, multiple presentations that revisit the same concepts in different contexts, at different times and for different purposes are essential for obtaining mastery. The concepts of this theory can be addressed by ICT use by teachers of mathematics in classrooms. Computers allow learners to review a given concept several times for better understanding without suffering effects of fatigue and boredom experienced by the traditional methods of teaching. ICT allow students to effectively continue learning after the classroom interaction with the teacher. This is a quality of mathematics teaching that enhances high retention and mastery of learnt concepts.

Perkins (1992) proposes two variations of constructivism: BIG (Beyond the Information Given) constructivism and WIG (Without Information Given) constructivism. A teacher using a BIG approach would directly introduce the concepts, provide examples, and then engage students in activities that challenge them to apply and refine their initial understanding through the use of multiple applications and examples. This approach presents information to the learners but stresses the need to go beyond the information given. This dimension integrated with a computer is effective in the learning of mathematics because students are prompted to search for the solutions to problems using ICT tools like the internet. The method therefore makes students active in the teaching and learning process hence learning becomes student-centered. In contrast, a WIG approach would not present the concept; it is a discovery-learning approach to teaching. Instead, learners would be presented with phenomena and then encouraged to explain the phenomena with their existing knowledge. Learners would discover for themselves, and the teacher would scaffold the process without providing answers. In Perkins' (1992), view an exclusive WIG approach is inefficient and ineffective and fails to present past achievements to students. However, mathematics teaching using WIG instruction would not engage students in learning the processes of discovery and idea construction. Therefore, the use of both dimensions with ICT tools creates active learning environment in a mathematics class.

1.13.2: The Activity Theory Approach

Activity theory has been used in designing human-computer interactions in order to provide a clear operational framework for designing Constructivists Learning Environments (CLE). Activity theory has its roots in the classical German philosophy of Kern and Hegel in 1780 and early 1800 and it focuses on the fact that learning is a conscious process that emerges from activity. The interaction of human activity and consciousness, the human mind as a whole, with the environment, is an important aspect of the activity theory. Activity theory provides a versatile tool to inquire into various aspects of educational technology. It focuses attention on the processes by which activities are shaped by their context (Lim and Chai, 2003). A model of the second-generation activity system was formulated by Cole and Engestrom (1993) and is represented in figure 1.2 below

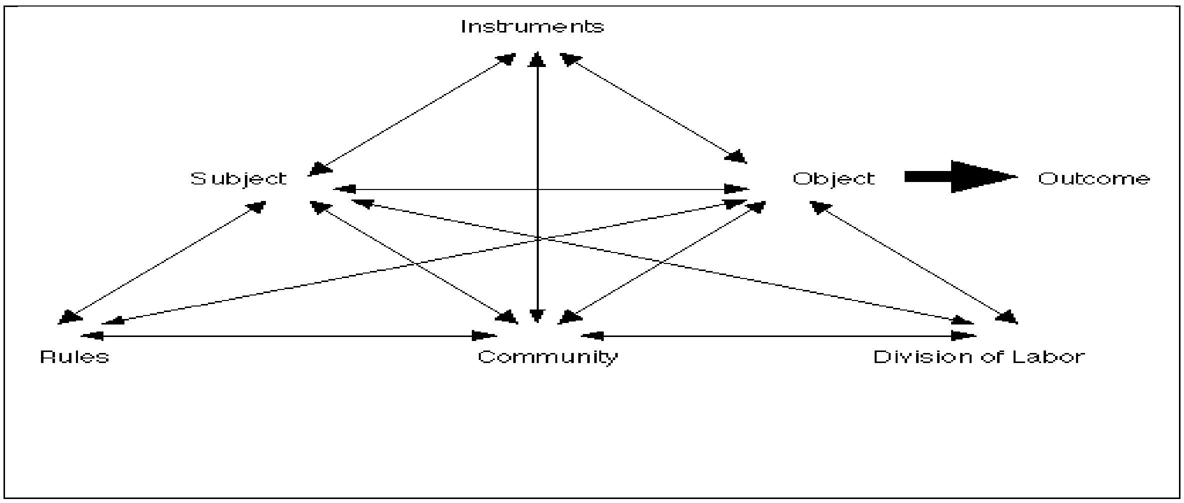

Figure 1.2: Second generation activity system (Source: Cole and Engestrom, 1993)

The subject node refers to the individual or group whose agency or point of view is taken in the analysis of the activity. The activity of the subject is directed towards the object node or goal and is transformed into outcomes with the help of physical and symbolic external and internal tools which mediate the object into an outcome (Cole and Engestrom, 1993). Thus, the object embodies the meaning, motive and purpose of the system. The base of the triangle represents the contextual characteristics of the activity system. The community node refers to the participants who share the same general object with the subject. The division of labour node refers to how tasks are divided between community members (horizontally as well the vertical division of power and status). Rules are explicit or implicit regulations, norms and conventions that constrain actions and interactions within the activity system (Centre for Activity Theory and Developmental Work Research, 2003). In the context of this research into the use of ICT, each node can be identified in table 1.1 below.

Table1.1: Second generation activity system (Cole and Engestrom, 1993):

Node	**Teachers**
Subject	Include teachers ideological and practical beliefs about teaching and learning, their teaching experience, attitude, knowledge and skills about ICT
Object	The objective or goal of using ICT in the learning and teaching process e.g. how to manage the use of ICT in ways that enhance specific students' learning outcomes.
Tools	Physical and semiotic tools directly related to curriculum content, classroom discourse and communication; classroom management and assessment; other ICT resources and non-ICT tools.
Rules	School policies and procedures, expectations of students and teachers by the school and wider education system.
Community	School leaders, parents, external professional development providers, students, middle-management (librarian, technicians and support staff). The play a role in the provision of computers, their use, safe keeping and maintenance of these computers.
Division of labour	The different roles and responsibilities of students and teachers, the cooperation among staff and the support of the administration on the use of computers in the teaching of mathematics.
Out-come	Effects on the use of ICT in the learning and teaching process. What actually happens?

Source: Centre for Activity Theory and Developmental Work Research, 2003

In activity systems, equilibrium is an exception; tensions, disturbances, and local innovations are the rule and the engine of change (Cole and Engestrom, 1993). The implementation of new technologies creates tensions and disturbances in the activity system in the form of resistance to achieving the object. In addition, the adoption of a new technology often leads to aggravated secondary tensions where some old elements of the activity system collides with the new one leading to disturbances and conflicts that may give rise to innovative attempts to change the activity (Engestrom, Miettinen, and Punamaki, 1999).

Activity theory will be used in this study to describe how the uptake and use of ICT causes tensions within the activity system. These tensions arise from advice from school leaders and professional development activities. The resolution of these tensions is critical to support teachers to progress their pedagogical development using ICT.

1.14: Definition of Operational Terms

Compulsory subjects: - Subjects that learner must be taught since they have direct impact in day-to-day life.

Day Secondary school: - Secondary schools where learners come in the morning learn during the day and go back home.

ICT: - Technologies that are used for acquisition, processing, storage and presentation of data.

INSET: - In-service Training Course for teachers of Science and Mathematics.

Low achievement in mathematics: - These are low grade below D in continuous assignment tests, terminal exams and KCSE.

Methods of teaching: - All the techniques a teacher uses in class to enhance effective teacher/learner interaction process.

Resources: - All apparatus, tools and people involved in the teaching and learning of mathematics in the school.

Respondents: - All individuals a researcher will use to collect data for the study.

School administration: - Principal, deputy principal, heads of departments and teachers responsible for day-to-day academic running of the school.

SMASSE: - In-service course offered during April and August school holidays to all science and mathematics teachers to enhance better performance in the subject.

Stakeholders: - Anybody in the population with interest in academic performance of the school.

1.15: Summary

The chapter clearly discusses the background of the study elaborating the statement of the problem as effects of ICT on students' achievement in mathematics and attitude towards this subject. It also explains the purpose of the study including the objectives and the research questions used in the study. It has also the importance of integrating ICT in teaching and learning the present age students in Secondary Schools in Kenya. The chapter also discusses the theoretical framework used which includes the constructivist's theory of learning and the activity theory approach. Finally, it gives the definition of operational terms used in the study.

CHAPTER TWO

LITERATURE REVIEW

2.1: Introduction

This chapter presents general and related literature reviews. The general literature review presents all the Information and Communication tools that are available for use in education. It explains how ICT tools can effectively be integrated in Education sector to make teaching and learning more efficient. It finally shows how traditional methods of teaching are ineffective as compared to the current ICT innovative methods. In the related literature review, the trend of performance in the national mathematics examinations and how ICT method of teaching can be integrated to improve the performance in the subject. The chapter quotes various scholars showing that ICT method of teaching improves the attitude of students towards mathematics. Therefore the chapter presents the general literature review, the related literature review then the summary.

2.2: General Literature review

General literature review includes definition of Information and Communication Technologies (ICTs), ICT integration to learning and ICT use in Education. It also discusses the importance of learning mathematics and a comparison between traditional and ICT methods of teaching mathematics.

2.2.1: Information and Communication Technology (ICT)

Information and communications technology (ICT) refers to a diverse integration of communication devices or applications, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning (Perron, Taylor, Glass and Margerum-Leys, 2010). The importance of ICT, lies less in the technology itself than, in its ability to create greater access to information and communication in underserved populations. This is particularly because of the fears that unless less technologically advanced areas have a chance to catch up; the increasing technological advances in developed nations will only serve to exacerbate the already-existing economic gap between technological 'have' and 'have not' areas (Schubert and Leimstoll, 2006). In the past few decades, information and communication technologies have provided society with a vast array of new communication capabilities. For example, people can communicate in real-time with others in different countries using technologies such as instant messaging and video-conferencing. Social networking websites like Facebook allow users from all over the world to remain in contact and communicate on a regular basis (Ashrafi and Murtaza, 2008).

Modern information and communication technologies have created a 'global village' in which people can communicate with others across the world as if they were living next door. For this reason, ICT is often studied in the context of how modern communication technologies affect society (Beniger, 2009). While the importance of ICT use for development cannot be underestimated, it should not be seen as a panacea that will solve problems of unemployment or social exclusion in the near future. This observation is of particular relevance to young people, because there is ample reason to question whether the adoption of technology-based development strategies will produce results of real benefit to all young people (Dewett and Jones, 2001).

2.2.2: ICT Integration to Learning

Information and communications technologies (ICTs) are computer based tools used by people to work with information and communication processing needs of an organization. Its purview covers computer hardware and software, the network and other digital devices like video, audio, cameras, which convert information (text, sound and motion) into digital form (Moursund and Bielefeldt, 1999). The potentials of ICT to facilitate students' learning to improve teaching and enhance institutional administration, has been established in literature (Kazu and Yavulzalp, 2008). The use of ICT as a tool for enhancing students' learning, teachers' instruction and as catalyst for improving access to quality education in formal and non-formal settings has become a necessity. Recognizing the impact of new technologies on the workplace and everyday life, teacher education institutions should try to restructure their education programs and classroom facilities, in order to husband the potentials of ICT in improving the content of teacher education. ICT as a tool within the school environment include use for school administration and management, teaching and learning of ICT related skills for enhancing the presentation of classroom work, teaching/learning repetitive tasks, teaching/learning intellectual, thinking and problem solving skills, stimulating creativity and imagination; for research by teachers and students, and as communication tool by teachers and students (Derbyshire, 2003). Successful integration of ICT in the school system depends largely on the competence and the attitude of teachers towards the role of modern technologies in teaching and learning. Thus, experienced teachers, newly qualified, and student-teachers need to be confident in using ICT effectively in their teaching (Kyriakidou, Chrisostomou and Bank, 2000). Simply having ICT in schools will not guarantee their effective use. Regardless of the quantity and quality of technology placed in classrooms, the key to how those tools are used is the teacher and therefore teachers must have the competence and the right attitude towards technology (Kadel, 2005).

In Kenya, serving and student-teachers need to be skilled in the use of ICT and also to be able to critically evaluate strategies for the acquisition and the appropriate application of ICT in diverse curriculum area (Mwangi, Nozaki, Ejima and Umeda, 2013). Major ICT competencies required by teachers were highlighted by Kirschner and Woperies (2003) to include competency in making personal use of ICT; mastery of a range of educational paradigms that make use of ICT; competency in making use of ICT as minds-tools; competency in using ICT as tool for teaching, competency in mastering a range of assessment paradigms which involves use of ICT; and competency in understanding the policy dimensions of the use of ICT for teaching and learning. Pre-service teacher education should focus on the need for student-teachers to have ICT skills for their own use in the preparation of materials for teaching and learning activities; the need to facilitate the direct use of ICT in students' learning activities within the classroom situation; and the need for teachers to develop in their students a critical awareness of ICT applications and the social implications (Mwangi *et al*, 2013).

Pelgrum (2001) observed that in developing countries, in particular Kenya, use of ICT has generated a whole set of wild speculations about the necessity of educational reforms that will accommodate the new tools. The government has responded to the challenges by initiating national programs to introduce computer in the education sector. Well-wishers and NGO's donated computers and schools have started using them haphazardly. Teachers of mathematics cannot use them effectively for teaching since they are not trained. Saul and Zulu, (1994) remarked that in many cases ICT is introduced in a project not as a means but an end. For example computers are provided in schools without supplementary measures to enable educators to develop positive attitude towards the new tools and use them. There is no training and preparation for the teachers of mathematics on how to use them.

The integration of ICT in the learning system is very low in Kenya. Baylor and Ritchie (2002) stated that 'Regardless of the amount of technology and its sophistication, technology will not be used unless stakeholders have the skills, knowledge and attitude necessary to infuse into the system'. This implies that the stakeholders in the education sector should become effective agents in making use of the technology in the execution of their academic programs. Policy makers in the education sector including principals should first be sensitized on the use of ICT and accept its use before infusing it in the teachers of mathematics and students.

2.2.3: Information and Communication Technology (ICT) use in Education

There are many definitions of ICT, but it can broadly be defined as technologies that facilitate the acquisition, storage, processing, transmission and dissemination of information in all forms including voice, text, data, graphics and video by electronic means (Michiels and Van Crowder, 2001). This definition mainly focuses on the importance of the intersection between information technology, information content and telecommunications in enabling new forms of knowledge production and interaction.

ICT allows people to generate and disseminate information, therefore, playing an active role in the process of interaction between professionals, learners, policy makers, peers and other education stakeholders (Leach, Ahmed, Makalima and Power, 2005). In the definition of the ICT in education, four main elements are taken into consideration: ICT as an object that refers to learning about Information and Communication Technology, an assisting tool, a medium for teaching and learning and finally a tool for organization and management in schools (Jager and Lokman, 1999). ICT has very strong effect in education and it provides enormous tools for enhancing teaching and learning. ICT supports teaching and learning processes in a range of disciplinary fields such as the construction of new opportunities for interaction between students and knowledge, accessing information, online training, computer classes, distance education, web-learning, virtual learning and e-Learning (Punie, Zinnbauer and Cabrera, 2006). ICT has a useful effect on teaching and learning if it is used under right conditions with suitable sources, training and support. ICT also offers the potential to meet the learning needs of individual students, to promote equal opportunity, to offer learning material, and also promote interdependence of learning among learners (Leach *et al*, 2005).

Venkatesh, Croteau and Rabah, (2014) indicated that while teaching mathematics at K-12, using calculators in testing and instructions, students developed the necessary operational skills in understanding mathematics concepts. In addition, installation of computers in secondary schools showed positive relation between use of computers in the classrooms and the students' attitudes towards learning (Wishart and Blease, 1999). Bransford, Sherwood, Hasselbring, Kinzer, and Williams (1990) reports that, video-based instruction in mathematics courses increased students' memorization and application process in mathematics. Similarly the use of computers provided better learning experiences (Wenglinsky, 1998). Integrating ICT to mathematics curricula has advantages such as time saving, effective teaching, improved data interpretation skills

and developing problem solving skills (Tinio, 2002). Doppen (2004) reports that, a computer assisted social study instruction helped high school students develop more interactions among themselves and that it enhanced students' interest during the course. Similarly, Saye and Brush (2002) noted that technology assisted learning environments supports more disciplined inquiry into ill-structured problems, which implies that the use of technology fosters students' interactions among themselves and with the curriculum material in order to make inquiry happen. Computers in instructions, fosters students' critical and higher order thinking skills. In the view of Glasser (1986), students are motivated when the computer-assisted instruction is provided through guided-teaching.
Roblyer and Edwards (2000) suggests reasons why teachers should integrate ICT in mathematics education, namely: (1) Motivation (2) Distinctive instructional abilities (3) Higher productivity of teachers (4) Essential skills for the Information Age (5) Support for new teaching techniques. In order to use ICT in classroom effectively, teachers' attitude towards technology should be positive and they should be trained in using the modern technologies in the field of education. Chin and Hortin (1994) stated that the teacher clearly must act as the 'change agent' in the relationship between technology and the student.

During the process of combining ICT with education, teachers' attitude towards using knowledge besides their talent and desire will be a crucial point affecting the results of application. The basic agent for establishing and working this system is the teacher. It is argued that successful integration of ICT in education enables teachers to transform instruction from teacher-centered to student-centered where learners may interact with their peers and use the computers for their own learning needs. However, many teachers do not regard themselves fully-equipped, comfortable and sufficient in using ICT in educational settings, and they feel more confident with their traditional teaching styles (Hawkins, 2002).

From the above literature, it is clear that the use of ICT in schools has a potential of impacting positively to the performance of students. This is clearly substantiated by the many studies done in different and diverse settings which show that the use of ICT in teaching as an instructional resource, positively affects the performance of the learners (Ittigson and Zewe, 2003). According to these studies, the main advantages of use of ICT in schools are:

1. Through ICT, images can easily be used in teaching and improving the retentive memory of students.
2. Through ICT, teachers can easily explain complex instructions and ensure students' comprehension.
3. Through ICT, teachers are able to create interactive classes and make the lessons more enjoyable, which could improve student attendance and concentration.

However, there seems to be some few limitations to the use of ICT in teaching. These include:

1. Setting up the ICT devices requires trained technical staff.
2. Most ICT resources are too expensive to afford.
3. ICT resources can be hard for teachers to use especially without experience and training in using these tools.

These limitations can be easily overcome by instigating the right strategies in the educational arena.

Though the merits of ICT use in educational system are evident, little has been done to integrate ICT in the teaching and learning process especially in developing countries (Beniger, 2009). This means that the students cannot function effectively in the current dynamic, information-rich and continuously changing environment. To meet these challenges, learning institutions must embrace the new technologies and appropriate ICT tools for learning. They must also move towards the goal of transforming the traditional paradigm of learning.

2.2.4: Importance of Learning Mathematics

Students require knowledge and skills that will help them live a full life in the society of the information age; the 21st century. Agwagah (2008) defines mathematics as the study of topics such as quantity, structure, space and change. These topics provide the major sub-divisions of mathematics into: arithmetic, algebra, geometry and statistics. These major disciplines within mathematics arose out of the need to do calculations in commerce and industry. Thomaskutty and George (2007) contend that mathematics cannot be considered as a classroom discipline only and reflecting on this, James (2005) supports that not only an academician, a scientist, an engineer but a shopkeeper, a grocer, a housewife, a sportsman and any employee needs mathematics. Obodo (2004) quotes Galileo who said mathematics is the language with which God wrote the universe.

Thomaskutty and George in Agwagah (2008) identified seven educational values of mathematics that includes, utilitarian values, disciplinary values, cultural values, social values, moral values, aesthetic values and recreational values. The practical or utilitarian values of mathematics seem to have been given greater emphasis in our society and in the school mathematics curriculum than other values. According to Odili (2006), the utilitarian aspect of mathematics in preparing students for useful living include counting, notations, addition, subtraction, multiplication, division, weighing, measuring, selling and buying. Every student on completing secondary education should have clear idea of numbers and a comprehension of both the very large and the very small numbers. Students should understand the way numbers is used to measure lengths, volume, weight, area, density, temperature, speed, acceleration and pressure. Estimation and approximation help them to check economic waste in everyday life. He further highlighted that economy of modern living and the technology of modern selling requires a housewife to be able to estimate quickly which of two different prices, offers, sizes or measures is better and be able to see through many of the tricks of the trade. The study of mathematics forms in the students the habit of clarity, brevity, accuracy, precision and certainty in expression and this goes a long way in giving the much-needed unity in every nation. When conflicts arise at homes, offices, market places and playgrounds over an issue, the success in any persuasion depends on a logical argument. The idea of logic, where the validity of conclusions rests upon, will help to eliminate frequency of conflicts in our society.

According Odili (2006), the importance of mathematics to individuals in their daily undertaking is so enormous that the knowledge of mathematics is an indispensable tool for a successful and balanced human existence on earth. Mathematics helps man to sharpen his understanding religious concepts. Such concepts as eternity, heaven, spirit life, power, salvation, wisdom, strength, light, hope, faith, righteousness, glory, blessing, truth, grace, peace, neighbourhood, sun and death can each be defined with mathematical rigor and precision (Osah-Ogulu and Odili, 2000). In commercial sector, the daily running of businesses, modern development and advances in commercial matters and business connections depends very heavily on expert's use of mathematics knowledge. That is, in preparing individuals for life, the power of mathematics in character building through active involvement, personal success and opportunities for stimulating curiosity, self- expression and self-criticism are considered. Therefore, knowledge of Mathematics is a necessity for every individual if they are to contribute towards the prosperity of Kenya because it pervades all aspects of life. The integration of ICT in the teaching and learning of mathematics in school is important since it ensures that students acquire the necessary skills to be able to succeed in life. The importance of studying mathematics lies in its potential to produce a mathematically informed society who makes better economic and political decisions about risk, policy, and resource allocation. In addition, mathematics enables students to use logical thought, formulate a problem in a way which allows for computation and decision, to make deductions from assumption easily and to use advanced concepts (Mwakapenda, 2001).

Studies have shown that the efficiency of teachers in teaching mathematics can be greatly enhanced by the use of ICT in the process (Barham, 2014). However, using ICT for teaching and learning mathematics in schools institutions should involve more than just epistemological considerations since the student is not just a 'cognitive subject'. This, in my view is because the integration of ICT in teaching mathematics requires a deep transformation of classroom management and representations of mathematics. This implies that the integration is a process rather than a one-time action. Consequently, learning institutions should initiate the process slowly, maybe with few classes and then advance it gradually to the entire institution.

2.2.5: Traditional and ICT Methods of Teaching

Mathematicians of the seventeenth century such as Newton and Descartes, viewed mathematics as a tool to organize, communicate, and convince others of their hypothesis and their original intent was not to establish mathematics as an independent study. However, once science and technology expanded, mathematical horizons, the refinement of mathematics into neat and logical categories occurred. Concurrently, computations became too complex as to necessitate the reductionism of mathematics. Complex problems were reduced to elementary principles and specific skills and explicit, precise languages for each mathematical field evolved. What followed was the creation of formulas capable of creating reproducible solutions and the establishment of rules for efficient calculation of problems. Memorization of facts as well as the ability to follow rules, execute procedures, and plug in formulas was lauded and only those students capable of absorbing, accumulating and regurgitating received items of information in this manner exceled in traditional mathematics classrooms (Hiebert, 2003). The teacher's role in traditional classrooms is to provide clear, step-by-step demonstrations of each procedure, restate steps in response to student questions, provide adequate opportunities for students to practice the procedures, and offer specific corrective support when necessary and the ultimate mathematical authority is the textbook from where the answers to all mathematical problems are known and found (Smith, 1996; 390-91). This method is often boring for students because their only job in the classroom is to passively sit and watch the teacher work mathematics problems on the board. The student watches, listens, and copies what the teacher does and he/she begins to feel that mathematics is pointless and of little value to them in real life. It becomes a subject they are forced to study in school and one that is useless to them in real life situations.

In direct opposite to traditional mathematics, the behaviorist approach, reform-oriented mathematics focuses on a constructivist perspective. While behaviorism emphasizes student's passive absorption of observable behaviors, constructivism asserts that individuals approach a new task with prior knowledge, assimilate new information and subsequently, construct their own meaning (Amit and Fried 2002). As learners construct their own understanding based on the relationship between prior knowledge, existing ideas, and new experiences, they must be encouraged to wrestle with new ideas, to work and fit them into existing networks, challenge their own ideas and those of others so as to subsequently enlarge the framework from which new ideas may be formulated (Van De Walle, 2007). Once the teacher accepts that the learner must actively explore mathematical concepts in order to build the necessary structures of understanding, it then follows that teaching mathematics must be reconceived as the provision of meaningful problems designed to encourage and facilitate the constructive process (Schifter and Fosnot 1993). These concepts of constructivist's theory of learning are captured in the ICT method of teaching as Ittigson and Zewe (2003) cites that technology is essential in teaching and learning mathematics.

ICT improves the way mathematics should be taught and enhances student understanding of basic concepts. Many researchers have carried out studies to evaluate the benefits of using ICT in mathematics. Becta (2003) summarized the key benefits as ICT promotes greater collaboration among students, encourages communication and the sharing of knowledge. ICT gives rapid and accurate feedbacks to students and this contributes towards positive motivation and attitude. It also allows them to focus on strategies and interpretations of answers rather than spend time on tedious computational calculations. ICT also supports constructivist pedagogy, where students use technology to explore and reach an understanding of mathematical concepts which promotes higher order thinking and better problem solving strategies. Students would then use technology to concentrate on problem-solving processes rather than on calculations related to the problems (Ittigson and Zewe, 2003).

From the literature review, it is evident that the lecture method is predominant in most of the mathematics teaching in Kenya (Mwei, Wando and Too, 2012). This has caused the performance of student in the subject to drop drastically since they don't grasp the concepts taught (Mbogua and Komen 2012). This is mainly because in lecture method, the teacher acts as the sole instructor and the students as empty urns. Clearly, for successful teaching of mathematics, there is a dire need of integration of ICT into the mathematics classroom for students to have clear knowledge and understanding of the existing mathematics concepts taught by teachers.

2.3: Related Literature Review

This section presents a students' achievement in mathematics at KCSE level in Kenya. It also discusses ICT role on students' achievement in mathematics, students' attitude towards mathematics and the use of ICT method of teaching.

2.3.1: Students' Achievement in Mathematics

There is widespread interest in improving the level of mathematics performance in schools. Apart from the economic benefits of preparing young people for the numeracy demands of modern work place and raising the overall skill levels of the work force, there are also social benefits tied to improving access to post- school education for young people and training opportunities. The interest in raising levels of performance has led to a focus on identifying the range of factors that shape performance as well as understanding how these factors operate to enhance the performance of students by gender. In Kenya, while a small proportion of secondary schools continue to offer satisfying well-rounded mathematics education programs, majority of schools fall short of providing for the learning needs of their students. Academic performance in key subjects in the curriculum like mathematics and sciences at the Kenya Certificate of Secondary Education (KCSE) examinations has not been satisfactory for quite a long time (Republic of Kenya, 1999). Ramari (2004) also supports that performance in mathematics has also been generally poor. Siringi (2010) reported that performance in key curriculum subjects like Mathematics and Sciences at KCSE examinations has not been satisfactory for quite a long time. Njoroge (2004) decries that poor performance in mathematics as worrying for the fact that it is one of the key subjects expected to turn Kenya into an industrialized country by the year 2030. The need to improve the performance of mathematics in secondary schools in Kenya is therefore necessary. Modern teaching methods need to be introduced to supplement the traditional methods of teaching. This gap can effectively be addressed by integrating ICT tools in the teaching and learning of mathematics in schools.

Several reasons have been given to account for these variations in performance in mathematics. Dugger (2004) attributes poor performance in mathematics to unfair distribution of qualified teachers in the country. Odhiambo (2000) identifies the root cause of poor performance in Mathematics, as poorly prepared teachers while Miheso (2012); Ngeno and Changeiywo (2007) found out that, ineffective, teacher-centered teaching methods and learners’ negative attitudes towards the subject as the main factors.

The Third International Mathematics and Science Study (TIMSS) in Australia showed that students' background variables influence differences in achievement in mathematics. Classroom and school variables also contributed to performance substantially (Lamb and Fullerton, 2001). These findings imply that several factors contribute to performance in mathematics than have been identified. Better teaching methods, including integrating ICT tools in teaching, among other factors can be advanced to improve performance in the subject.

In Kenya, mathematics is a compulsory subject in both Primary and Secondary school curricula. The general objectives of secondary school mathematics as out-lined by the Kenya Institute of Education (2002) are to enable the students to: (1). Develop a positive attitude towards learning mathematics. (2). Perform mathematical operations and manipulations with confidence, speed and accuracy. (3). Think and reason precisely, logically and critically in any given situation. (4). Develop investigative skills in mathematics. (5). Identify, concretize, symbolize and use mathematical relationships in everyday life. (6). Comprehend, analyze, synthesize, evaluate and make generalization so as to solve mathematical problems. (7). Collect, organize, represent, analyze, interpret data and make conclusions and predictions from its results. (8). Apply mathematical knowledge and skills to familiar and unfamiliar situations. (9). Appreciate the role, value and use of mathematics in society. (10). Develop a willingness to work collaboratively. (11). Acquire knowledge and skills for further education and training. (12). Communicate mathematical ideas.

The existing literature on the performance of students in mathematics clearly shows that these objectives have not been met. While the objectives are laudable, the reality is that performance in mathematics in KCSE is dismal and has been deteriorating (Ayodo, 2009). This implies that the present teaching methods used by teachers in teaching mathematics are ineffectual and thus there is a urgent change of teaching strategy to improve the delivery and retention of mathematical concepts by the student. In this perspective, better performance in mathematics can be easily attained by the integration of ICT methods in teaching mathematics. This will obviously be effective since the tactic has been proved successful in other countries which suffered similar fate in the past (Delen and Bulut, 2011).

2.3.2: ICT role on Students' Achievement

Bransford, Brown and Cocking, (2000); Roschelle, Pea, Hoadley, Gordin and Means (2000) posited that a number of features of new technologies are consistent with principles of the science and mathematics learning and hold promise for improving education. They contend that new information and communication technologies can bring exciting curricula based on real-world problems into the classroom and provide scaffolds and tools to enhance learning. They cite interactivity of technology in learning of mathematics as a key feature that enables students to receive feedback on their performance, test and reflect on their ideas, and revise their understanding. Bransford *et al*, (2000) caution that the positive impact of technology does not come automatically as much depends on how teachers use ICT in their classes. Wenglinsky (1998) found out a negative relationship between the frequency of use of school computers in class and school achievement. On the other hand, Wenglinsky found that certain uses of technology had a positive effect on achievement for instance the use of computers for learning games was positively related to mathematics achievement. Teacher's professional development in the use of ICT and its use to teach higher-order thinking skills were positively related to mathematics achievement. Kulik (1994) meta-analysis study revealed that on average, students who used ICT-based instruction scored higher than students without computers. The students also learn more in less time and like their classes more when ICT-based instruction was included. Research in classroom by Schofield and Davidson (2002), documented that some teachers were beginning to use technology to change pedagogy and curriculum. In developing countries like Kenya, the use of computers is part of an instructional shift toward constructivist approaches to teaching and learning within a context of school improvement or reform. Instead of focusing solely on increasing the acquisition of facts related to specific subject areas, teams of students are engaged in solving complex, authentic problems that cross disciplinary boundaries. Instead of dispensing knowledge, teachers set up projects, arrange for access to appropriate resources, and create organizational structures and support that can help students succeed. These approaches move the concept of learning beyond rote memorization of facts and procedures toward learning as a process of knowledge creation (Bransford *et al*, 2000). Constructivism envisions a learning process in which students set their own goals, plan their learning activities, and monitor their current levels of mastery and understanding in preparation for lifelong learning. It moves concepts of school beyond the notion of a place where knowledge is imparted, to one of classrooms, organizations, and societies as knowledge-building communities (Scardamalia and Bereiter, 1994).

Sosin, Blecha, Agarwal, Bartlet and Daniel (2004) constructed a database of 67 sections of introductory economics, enrolling 3,986 students, taught by 30 instructors across 15 institutions in the United States of America during the spring and fall semesters of 2002. They found significant but small positive impact on students' performance due to ICT use but they showed that some ICT seem to be positively correlated to the performance while the others did not. Fuchs and Woessman (2004) used international data from the Programme for International Student Assessment (PISA) and showed that while the bivariate correlation between the availability of computers and students' performance is strongly and significantly positive, the correlation becomes small and insignificant when other student environmental characteristics are taken into consideration. The analysis of the effects of these methodological and technological innovations on students' attitude towards the learning process and on students' performance seems to be evolving towards a consensus according to which an appropriate use of digital technologies in higher education can have significant positive effects both on students' attitude and achievement. Attwell and Battle (1999) examined the relationship between having a home computer and school performance, and their findings suggested that students, who have access to a computer at home, for educational purposes, demonstrated improved scores in reading and mathematics. Evidence from the teachers and student interviews indicated that, over the life of the study, the students developed a broader appreciation of the nature and utility of mathematical activity, in particular from one dominated by number and computation to something that was fun, used to solve problems and to be used in life (Norton and Cooper, 2006). If one considers mathematics to be a fixed body of knowledge to be learned, then the role of technology in this process would be primarily that of an efficiency tool by helping the learner to do the mathematics more efficiently. However, if we consider the technological tools as providing access to new understandings of relations, processes and purposes, then the role of technology relates to a conceptual construction kit (Olive and Makar, 2010, p. 138).

Technology can therefore the nature of school mathematics by engaging students in more active mathematical practices such as experimenting, investigating and problem solving that bring depth to their learning and encourage them to ask questions rather than only looking for answers. It clearly shows that ICT plays a major role in improving the performance of students in various subjects under all settings. Research has shown that students who have a wider exposure to ICT learning resources seems to perform far much better than those who have little or no exposure to ICT resources(Fuchs and Woessmann, 2004). This is mainly because the use of ICT improves concept retention, changes attitude towards the subject and eases content delivery process. Thus, ICT instructional media should be intergraded in the teaching systems to improve student performance.

2.3.3: Students' Attitude towards Mathematics and use of ICT

Attitudes refer to one's positive or negative judgment about a concrete subject. Attitudes are determined by the analysis of the information regarding the results of an action and by positive or negative evaluation of these results (Ajzen and Fishbein, 1980). Weidmann and Humphrey (2002) opines that investigation into students' attitude and perspective towards mathematics not only inform teachers, parents and administrators about students' needs, but also serve as catalyst for reform in mathematics education. There are also conflicting evidence showing that students' high performance in mathematics may not necessarily be associated with positive attitude towards mathematics and mathematics learning. Beaton and Robitaille, (1999) results of Third International Mathematics and Science Study revealed that, while Japanese students outperformed students from many other countries in mathematics, they displayed relatively negative attitude towards the subject (Mullis, 2000).

Gender difference in attitude towards mathematics influenced some researchers to study some affective variables as mediators of gender differences in Mathematics achievement (Nuttall, Casey and Pezaris, 2005). However, little consensus existed among researchers regarding the influence of affective variables on gender and mathematics achievement. Affective refers to student's feelings about mathematics, aspects of the mathematics classroom or about themselves as learners of mathematics. Some studies reported statistically significant effects of affective variables on the learning of Mathematics (Pierce, Stacey and Barkatsas, 2007), while others indicated no relationship between attitude variables and mathematics achievement (Papanastasiou, 2000). Even among those studies that found a significant relationship, there was still a controversy regarding the educational implications of the results. For example, some researchers concluded that although statistically significant, the mean effect size for the relationship between attitude towards mathematics and achievement in mathematics was not strong enough to have useful implications for educational practice (Pierce et al, 2007). One explanation for inconsistent findings regarding the relationship between attitude and Mathematics achievement was that such a relationship existed only with respect to particular mathematics content areas (Pierce et al, 2007) and for specific affective variables.

Studies have shown that factors such as motivation and attitude have impacted on students' achievement (Cote and Levine, 2000). Tymm (2001) investigated 21,000 students attitude towards mathematics and suggested that the most important factors were the teacher and students' academic level, while age, gender and language were weakly associated with attitudes. Webster and Fisher (2000) study revealed that rural and urban students' attitude in mathematics and career aspiration positively affected their performance. Altermat, (2002) found that students' attitude changes could be predicted and influenced by types of classmates. The student's attitude towards an academics subject is a crucial factor in learning and achievement in that subject. Whether a student views himself or herself as a strong or weak person in a specific subject may be an important factor in his or her academic achievement. Papanastasiou (2000) showed that there is a positive relation between attitude and mathematics achievement. Students who have positive attitudes towards Mathematics have a better performance in the subject.

On the other hand, literature suggests that lack of adequate training and experience is one of the main reasons why teachers do not use technology in their teaching. This also eventuates in teachers' negative attitude towards computer and technology. In addition, lack of confidence leads to reluctance to use computers by the teachers (Kumar and Kumar, 2003). Attitude of pre-service and in-service teachers towards computer and technology skills can be improved by integrating technology into teacher education (Zammit, 1992). Findings have revealed that a significant relationship exist between computer attitude and its use in institutions for pre-service teachers (Khine, 2001), and also for serving teachers in the affective attitude, general usefulness, behavioral control, and pedagogical use (Yuen and Ma, 2002). Attitude is a major predictor of future computer use among teachers. Lee (1997) study indicated the importance of appropriate responses to the trainee's feelings about using ICT as one of the factors critical to success. Thus, there is the need to take care of the emotional needs of student teachers as attitude is a major predictor of future ICT use. Student teachers have positive attitude and are highly enthusiastic about interactive whiteboards as an important feature of teaching and learning, and this motivated them to practice using the technology (Kennewell and Morgan, 2003).

In Kenya, studies done by Odera and Ochanda (2011) looked at the relationship between teacher factors and student mathematics achievement as factors affecting mathematics performance but did not consider students attitude. Studies have established close links and affinities between teachers' attitude and their use of ICT. More positive attitudes towards the computer were associated with a higher level of computer experience (Garland and Noyes, 2005). Students' confidence on ICT can be explained through the attitude and behaviors of their teachers. Teachers' behavior is a critical influence on students' confidence and attitude towards ICT as they provide important role model to their students (Derbyshire, 2003).

The above reviewed literature shows that students attitude towards mathematics is largely negative. This is contributed by the existing conceptions by students that mathematics is a difficult subject. This perception is debatable since the problem is not with the student or the subject but majorly with the teacher and the instructional method. A rapid change of teaching method applied in teaching mathematics is imperative. The use of ICT approaches in teaching mathematics should be adopted. This will change the student's attitude towards the subject since they will easily grasp concepts and readily pass examinations.

2.4: Summary

The chapter presents overview of the literature review on ICT, students' achievement in mathematics and the attitude towards mathematics. The general literature review indicates that there are various ICT tools that are available in the modern technological world. These tools can only be used by teachers for teaching if they are available in schools. Due to lack of these facilities in schools, teachers have continued to teach using ineffective traditional methods. The lecture method, teacher demonstrations and other traditional methods do not help students to conceptualize facts. Students end up cramming formulas and reproduce them during examinations with poor application skills. Teachers give students assignments and homework in mathematics to demonstrate activity-based program which are often not. The actual activity-based teaching involves students in class during teaching rather that after class. This helps students to conceptualize concrete ideas that can easily be applied later with little effort. Hence in the related literature review, ICT method of teaching is found to improve achievement in mathematics. It also makes teaching and learning of mathematics lively and therefore creates a positive attitude towards the subject.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1: Introduction

This chapter presents the research design, variables of the study, research methodology, the area of study, target population, sample and sampling techniques. It also discusses the research instruments, pre-testing of the research instruments, reliability and validity of the research instruments. Finally it presents ways of controlling extraneous variables, instructional procedure, ethical considerations, data presentation, data interpretation and analysis.

3.2: Research Design

A research design is the structure of research. Orodho (2003) defines research design as the scheme outline or plan that is used to generate answers to research questions. For this study the researcher used quasi-experimental pre-test-post-test control group design. While a random assignment experiment may represent the most rigorous way to establish what works for school time programs, it is often not possible or appropriate to conduct a study that involve intact groups. Quasi experimental non-equivalent control group design was therefore used because the study used intact classes (Shadish and Luellen, 2005). According to Christensen, Johnson and Turner (2011), it is advisable to employ non-equivalent control group design when administrative decisions like school regulations prevent random assignment of subjects to treatment and control groups.

3.3: The Area of Study

The study was conducted at Tiriki East Division of Hamisi Sub-county, Vihiga County in Kenya (See Appendix I). It is a rural settlement in the western part of Kenya with approximate population of 66,181 people according to the 2009 National population and housing census. Hamisi is inhabited by subsistence farmers growing maize and bananas in small scale. The average acreage per family is less than one quarter of an acre. Few people grow tea as their main cash crop. The region was selected for study due to familiarity and easy access by the researcher.

3.4: The Target Population

The population comprised of the KCSE candidates from public Day Secondary Schools in Tiriki East Division totaling to 444 students. These are forth form students who were to sit Kenya Certificate of Secondary Education in the year 2013. There are twelve public secondary schools in Tiriki East Division. Out of these, nine are public day secondary schools namely: Friends School-Muhudu (68), Ishiru (36), Imusutsu (98), George Khaniri (52), Friends School-Shamakhokho (31), Kaptik (59), Friends School-Kaimosi Demonstration (31), Makuchi (36) and St. John’s-Cheptech (41).

3.5: Sample and Sampling Technique

Out of the nine day secondary schools in Tiriki east division, four have three steams in each class, three have two while the other two are single streamed. The schools equipped with computers were only two. Therefore, purposive sampling was used to select the two schools into the experimental group. In addition, the computer equipped schools were 3-streamed hence the schools in the sample were triple streamed. The minimum recommended number of students in a stream is 40 hence a total of 240 respondents were expected to participate in the experimental group. On the other hand, the control groups were purposively selected from the remaining seven secondary schools; 2-triple streamed 3-double streamed and 2-single streamed. To ensure equal replication of subjects into the sample, the remaining two-three-streamed schools were then selected into the control group. The number of subjects in the control group was expected to be 240.

In total, the researcher used twelve intact classes; six for experimental group and six for the control group. The treatment group was taught how to determine mean, median and quartiles in mathematics using ICT method while the control group was taught the same using traditional method.

3.6: Research Methodology

Research methodology is a way to systematically solve the research problem. It is a science of studying how research is done systematically. In it, the various steps that are generally adopted by a researcher in studying his/her problem along with the logic behind them are studied. The study used quantitative research design technique that gives measures producing numerical or quantifiable data. Instruments used in this study are mainly the questionnaire and tests that yield numerical data. This study used quantitative approach because it involves the generation of data in quantitative form or measurement of quantity or amount. The main research instruments that were used are the questionnaire Likert-type response questions and quantitative achievement test items.

3.7: Research Instruments

Primary data was collected using a set of questionnaire and an assessment test. The researcher designed a Quantitative Mathematics Attitude Test Scale (QMATS) (Appendices II and III), as a questionnaire, to collect data on attitude of students towards mathematics. In addition, he used Quantitative Mathematics Assessment Test (QMAT) (Appendix IV) to collect data on students’ achievement in mathematics before and after the treatment.

3.7:1: Quantitative Mathematics Assessment Test (QMAT)

QMAT was developed by the researcher based on the KCSE standard pattern for setting mathematics test. It comprises of:

i. A test of students' knowledge on statistical analysis of data.
ii. Calculations of various measures of dispersion.
iii. Applications of various measures of central tendencies and dispersion.

Validation of QMAT - The QMAT was validated by three teachers of mathematics from the selected secondary schools. They were asked to:

a. Assess the suitability of the items for the intended subjects' i.e. form 4 students.
b. Whether the test items in the instruments are in consistent with the lesson plans (See Appendix V).
c. Whether the instructions given lead the students to appropriately attempt the test items.

These teachers were also provided with a photocopy of the KIE mathematics syllabus to assist them respond appropriately to the above task.

3.7:2: Quantitative Mathematics Attitude Test Scale (QMATS)

QMATS was developed by the researcher from review of literature. It comprised of a 28-item Likert-type response format. 17 items were positively-cued while 11 items were negatively-cued on 5-response options. The response formats were of the type: 2i) **SA** – Strongly Agree ii) **A** – Agree iii) **N** – Neutral iv) **D** – Disagree and v) **SD** – Strongly Disagree.

The respondents were required to express the degree of their agreement or disagreement with each of the statements by a tick (√) in the appropriate column (See Appendixes II and III).

Validation of QMATS - QMATS was validated by the researcher's supervisor in the School of Education, Department of Curriculum and Instruction at the University of Eldoret. In addition, it was also validated by four heads of Mathematics Departments in the sampled secondary schools. Questions on the assessment were as follows:

i. Are items statements ambiguous or vague which may make interpretation of scale difficult?
ii. Do the statements appropriately measure the level of attitude towards mathematics in students?
iii. Do the statements overlap in meaning?

These statements were considered to have face validity and also sample students' attitude in mathematics.

3.8: Pre-testing the Instruments

The QMAS was pre-tested by administering it to 31 candidates in Friends Secondary School - Shamakhokho in Tiriki East Division. This school was not selected for the study. The data collected was used to estimate the reliability of the instrument.

3.9: Reliability of the Research Instruments

Reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials.

3.9.1: Reliability of QMAT

The scorer reliability estimate for QMAT was established using the scores obtained from the pre-test. Pearson-product moment correlation reliability estimate was used in order to determine the similarity of two independent markers of the students' scripts. The researcher made photocopies of the students answer scripts and distributed the photocopied papers and the original scripts to two different makers with whom the researcher had discussed the marking scheme with. Pearson-product moment correlation coefficient was used to determine the reliability of the instrument. The coefficient of reliability of the instrument was 0.85 which was considered high enough to ascertain the reliability of the instrument and having a good internal consistency.

3.9.2: Reliability of QMATS

The internal consistency of this instrument was established using the trial-testing scores from response of 31 secondary school mathematics students at Friends Secondary School-Shamakhokho. The Cronbach alpha reliability coefficient method was used to determine the reliability of the instrument. A reliability test is a method of making the test reliable by pre-testing the instrument. Pre-testing identifies errors found in the study instrument which can later be corrected. Moreover, pre-testing of instruments helps to estimate time needed to administer the instrument. The test retest reliability of instrument was assessed by administering it to the same people on two different occasions and calculating the Cronbach coefficient between the scores. The value of the alpha coefficient ranges from 0 to 1 and is used to describe the reliability of factors extracted from questions with two possible answers, a higher value greater than 0.7 shows that the questionnaire is more reliable.

Table 3.1: Reliability test analysis for questionnaire

Variable	Cronbach's alpha coefficient	No. of items/ Objective
i). I am not good in mathematics	0.811	3
ii). Confidence level in mathematics	0.745	11
iii). Difficulties while handling mathematics problems	0.824	6
iv). Challenges faced while learning mathematics in school	0.798	8

The coefficients obtained were all greater than 0.7 (Table 3.1). A conclusion was therefore drawn that the instruments had an acceptable reliability coefficient and were appropriate.

3.10: Validity of Data

Validity was used as a measure of the degree to which data obtained from an instrument meaningfully and accurately reflects or represents a theoretical concept (Golafshani, 2003). This approach is used because there is no criteria or domain of the concept generally accepted as an adequate measure of a concept.

3.11: Variables of the Study

According to Mugenda and Mugenda (1999), the independent variable is one which can be manipulated in order to determine its effect on another variable while the dependent variable indicates the total influence arising from the effect of the independent variable.

The study has three variables for which two are independent while the other dependent. The independent variables of this study were the students' achievement in mathematics and attitude towards mathematics while the dependent variable was the ICT method of teaching.

3.12: Control of Extraneous Variables

The researcher attempted to control two extraneous variables namely the teacher variable and initial group variable as follows:

3.12.1: The Teacher Variable

To control the teacher variable, a uniform teaching program was used for teachers who were involved in the teaching. To avoid personality influence that may arise if different teachers teach students in the control and the experimental groups, same teachers were used in handling both groups. The lesson plans prepared by the researcher (See Appendix V) as well as student's activities and type of questions meant to motivate the students were discussed between the researcher and the teachers prior to their use in class. This discussion included:

a) Familiarization of teachers activities that were used to engage the students
b) Review of the lesson plans (See Appendix V) prepared by the researcher.
c) Familiarization of teachers on how to evaluate the students' progress at different stages of activities to ensure they adequately employ appropriately reasoning patterns at each stage.

This session lasted for two days. The test items were not shown to the teachers beforehand.

3.12.2: Initial Group Difference

Since intact classes were randomly composed, the control for the non-equivalence of such intact classes was established using analysis of covariance i.e. the covariance of the pre-test and the post-test scores.

3.13: Instructional Procedure

The control and experimental groups were taught using lesson plans (See Appendix V) specifically designed for them. Administration of test and the questionnaire to the students in various schools were done by teachers teaching mathematics in respective schools. The actual teaching using ICT (for the experimental group) and traditional method (for the control group) was also done by the same teachers.

3.13.1: Control Groups

During the study, the following lesson instructions were used for teaching students in the control groups. They were developed to ensure uniformity in teaching of all students in this group.

Lesson 1

The following steps elaborate how the lesson plan in Appendix V was used:

Step 1

i. Lesson is introduced by reviewing the previous knowledge on determination of mean of simple grouped data. The data used shows the number of electronic devices in homes of various students.
ii. The teacher works out mean of given set of data.

Step 2

i. The teacher defines median using simple ungrouped data.

ii. The teacher, demonstrate how to determine median of a simple grouped data using data of masses of students in a form four class of a particular school.

iii. The teacher draws the cumulative frequency curve on the chalkboard and demonstrates to students how to determine median from it.

Step 3

i. Teacher allows students to determine median in their exercise books of grouped data showing the number of letters in page 60 of 'the enemy of the people' story book using cumulative frequency curve.

ii. The teacher checks students' responses and assist needy students appropriately.

Step 4 (Homework assignment)

The teacher writes one question on the board showing the ages of form four students in a particular school to be done as homework.

Lesson 2

The following steps elaborate how the lesson plan in Appendix V was used:

Step 1

i. Teacher introduces the lesson by reviewing determination of median of data given out as homework assignment in the previous lesson.

ii. Teacher works out on the board, the upper and lower quartiles of ungrouped data showing ages of ten students from a particular school in order to define quartiles.

Step 2

i. A grouped frequency table showing each of the 60 students asked to draw using free hand a line of length 20cm is used to demonstrate on the chalkboard how to determine upper and lower quartiles.

ii. The teacher demonstrates on the board how to determine upper and lower quartiles of grouped data in (i) above using cumulative frequency curve.

iii. The upper and lower quartile values are then used to determine the interquartile range.

Step 3 (Home assignment)

i. The teacher draws on the chalkboard board a frequency distribution table showing marks score in the latest Math test by form four students in a particular school.

ii. To be taken as home assignment, the students copy the table and determine the upper quartile, lower quartile and the interquartile range of this data.

3.13.2: Experimental Groups

During the study, the following lesson plan was used for teaching students in the experimental group. It was developed to ensure uniformity in teaching of all the students in this group.

<u>**Lesson 1**</u>

The following steps elaborate how the lesson plan in Appendix V was used:

Step 1

i. Students collect data on the number of electronic devices between TV, radio, fridge, computer and electric iron box; they own in their homes.

ii. Students work out the mean of above in small groups.

iii. Later, students use MS-Excel software to determine mean of their heights of all students in class.

Step 2

i. Students define median of a given set of data.

ii. Using a weighing balance, students collect data of masses of all students in class.

iii. Students then tabulate the data in a frequency table.

iv. Students work out of the data collected.

v. A step-by-step procedure is projected on the screen using PowerPoint showing how to determine median of the data already collected.

vi. Students draw a cumulative frequency curve and determine the median of their masses using a computer.

Step 3

i. Students count the number of words in one page essay of page 60 in the story book ‘The enemy of the people’.

ii. Students tabulate the data in a frequency table and a computer program used to determine the median of the number of words in the page.

Step 4 (Homework assignment)

Students collect data on their ages in class. Each student is then required to make a frequency table, draw a cumulative curve and determine the median age using a computer software.

<u>Lesson 2</u>

The following steps elaborate how the lesson plan in Appendix V was used:

Step 1

i. Using a computer, students review the previous lesson on determination of median.

ii. A computer slide, showing the worked out home assignment for the previous lesson is displayed on the screen for students to make necessary corrections.

iii. Students collect data of ages of few students in the class.

iv. Students arrange the data ascending order and use it to define upper and lower quartiles.

Step 2

i. Students draw using free hand a line of approximately 20cm.
ii. Using rulers, students then measure the length between the starting point and the end of the line drawn.
iii. Students use data from their classmates to make a grouped frequency table.
iv. A PowerPoint presentation is displayed on the screen showing step-by-step procedure of determining upper and lower quartiles of grouped data.
v. Students then draw electronically cumulative frequency curves and use it to determine upper and lower quartiles of the length of the lines drawn.
vi. Students work out the inter-quartile range from the results obtained in (v)
vii. A computer slide, showing a question to be worked out by the students is displayed.

Step 3 (Homework assignment)

i. Students collect data on marks scored in the latest English test.
ii. They then use the data in (i) above to make a grouped frequency table.
iii. Students are assigned to determine upper and lower quartiles and compute the inter-quartile range.

3.14: Ethical Considerations

Ethics is a branch of philosophy, which deals with one's conduct and serves as a guide to one's behavior (Cacciattolo, 2015). In this research, the respondent made their decisions to participate based on adequate knowledge of the study. All the participants in the research remained anonymous and their individual identity was a salient feature in the research. The research also provided the respondent with information on the purpose of the research, the expected duration of participation and the procedure to be followed.

3.15: Data Collection

Data was collected using two instruments: Quantitative Mathematics Assessment Test (QMAT) that was used to collect data on achievement in mathematics while the Quantitative Mathematics Attitude Scale (QMATS), a questionnaire, was used to collect data on attitude towards mathematics before and after teaching students in treatment and control groups using ICT and traditional methods respectively. These instruments were developed by the researcher using the KCSE model Mathematics test papers format for the QMAT and 'Attitude change test items', a paper presented during the SMASSE Cycle One INSET at Moi Girls High School, Vokoli (2005) for the QMATS. The control and the experimental groups sat thirty-minute Quantitative Mathematics Assessment Test (QMAT) administered by their subject teachers before the start of the study. Each respondent was also issued with a QMATS to fill and was collected immediately. The two groups sat for the same QMAT after the treatment and filled the QMATS questionnaire too.

3.16: Data Analysis

Data on achievement in mathematics was analyzed using measures of central tendencies and dispersion which include the mean, standard deviation and one-way Analysis of Variance (ANOVA). On students' attitude towards mathematics, data was analyzed using mean, variance, descriptive statistics and Logistic Regression Tables.

Exploratory and descriptive data summary was done using Microsoft excel 2010 and Minitab 14. Frequencies, means, standard error and percentages were computed from the data. Bar graphs with error-bars, pie-charts and table of mean attitude of students with standard deviation were generated to explore the data for any observable differences in the computed values of frequencies, means and percentages in the compared variables. Testing hypothesis was done with Minitab 14 to compute for any significant difference in the mean scores for different schools sampled, for the two tests that were used (pre-test and posttest group) and also for the Control group and experimental group. Since each had one parameter to be tested, and the data was a continuous data of score, one-way analysis of variance was used to test the hypothesis of no difference in scores for each parameter.

3.17: Summary

This study used quasi-experimental non-equivalent pre-test post-test control group design. The independent variables of this study were the students' achievement in mathematics and attitude towards mathematics while the dependent variable was the ICT method of teaching. The study used quantitative research design technique. Instruments used in this study were a set of questionnaire and tests, which were validated by the researcher's supervisor and the heads of Mathematics Departments in the sampled Secondary Schools. The instruments were subjected to trial-testing and there reliability determined. The chapter also outlines how the study controlled extraneous variables and the development of the instructional procedures used in both the experimental and the control groups. These instructional procedures were used in line with the lesson plans (See Appendices V and VI) to ensure uniformity in the teaching method in all experimental and control groups. Finally, the chapter explains how the collected data was analyzed, presented and interpreted.

CHAPTER FOUR

DATA ANALYSIS, INTERPRETATION, PRESENTATION AND DISCUSSION

4.1: Introduction

The chapter presents the achievement of students in control and experimental groups, performance according to sex in control and experimental groups and finally the analysis of students' attitude towards mathematics.

4.2: Achievement of Students in Control and Experimental Schools

Based on the data collected using the Quantitative Mathematics Assessment Test (QMAT) during the study, the achievement of students in mathematics was analyzed as shown below:

4.2.1: Number of Male and Female Students in Control and Experimental Groups

The number of students examined in the schools were as shown in the figure 4.1. Control group had 74 male and 55 female students while the experimental group had 78 male and 49 female students. In general, male students were more than the female students in both control and experimental groups. Kenya, over the past few decades, has made remarkable achievements in increasing access to education, especially in regions that were historically favoured by the colonial educational, economic and political policies. However, partly because of the out-right discrimination of selected regions and partly because of the colonial gender ideology, the country has yet to record gender parity in all the regions (Chege and Sifuna 2006). They continue to observe that, obstacles to female education that are often region-specific seem to hinge on various factors that include perceived irrelevance and opportunity costs linked to educating girls and cultural beliefs and practices that portray girls education as an unwelcome challenge to male hegemony. Others are school cultures whose hidden curriculum serves to alienate girls, disempower them and eventually push them out of the system. Also formal curriculum perpetuates traditional gender boundaries and employment opportunities that do not favour female labour. Moreover, there are socio-cultural attitudes, expectations and definitions that characterize successful womanhood in terms of feminine qualities of subservience and domestic roles.

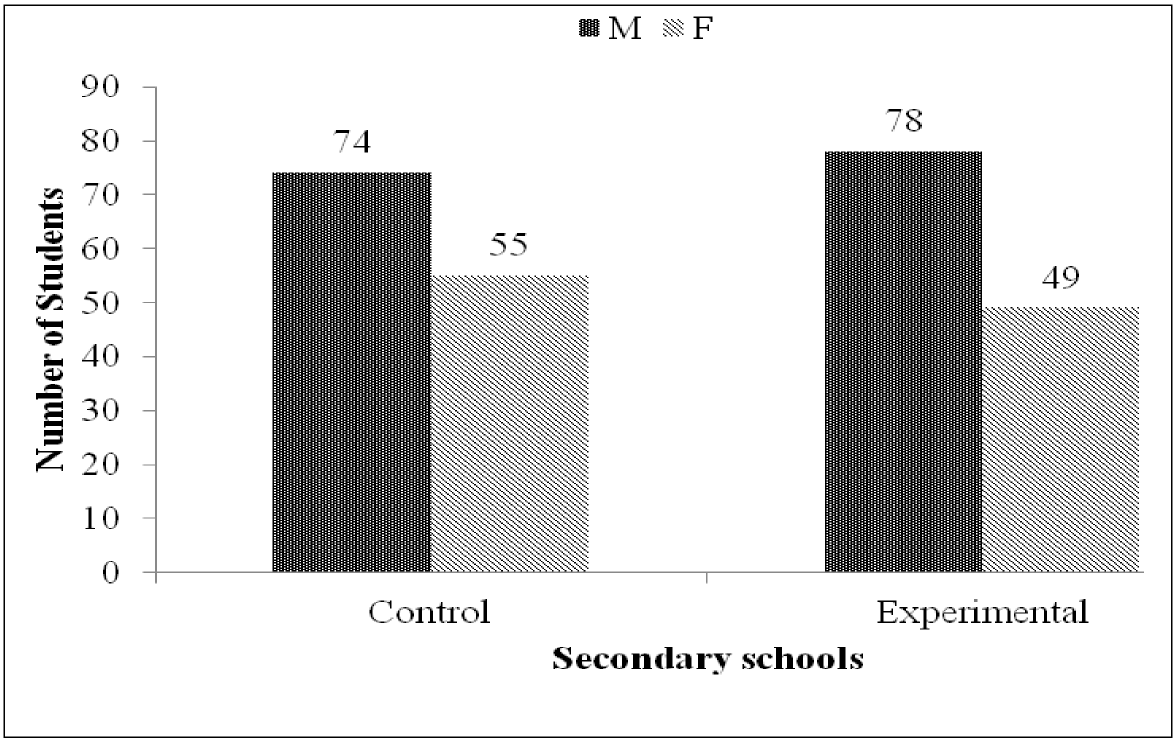

Figure 4.1: Number of male and female students in control and experimental Groups (Source: Author, 2014)

4.2.2: Pre-test and Post-test Mean Scores per Gender

There was no signifficant difference in the performance of male students compared to female students, for both pre-test and post-test examination, though male students seemed to perform better than the female students.There was however significant difference in the performance of students comparing the pre-test and posttest for the sampled group

(Control pre-test; 7.56/25 and 8/25, Control Posttest; 14.87/25 and 15.42/25 while Expreimental pre-test; 13.47/25 and 14.42/25, Experimental posttest; 17.92/25 and 19.06/25 for female and male students respectively) as shown in the standard error in figure 4.2 below. The mean score for students in post-test examination was higher than the mean score for pre-test examination for both control and experimental groups. The experimental group generally performed better than the control group in both pre-test and posttest.

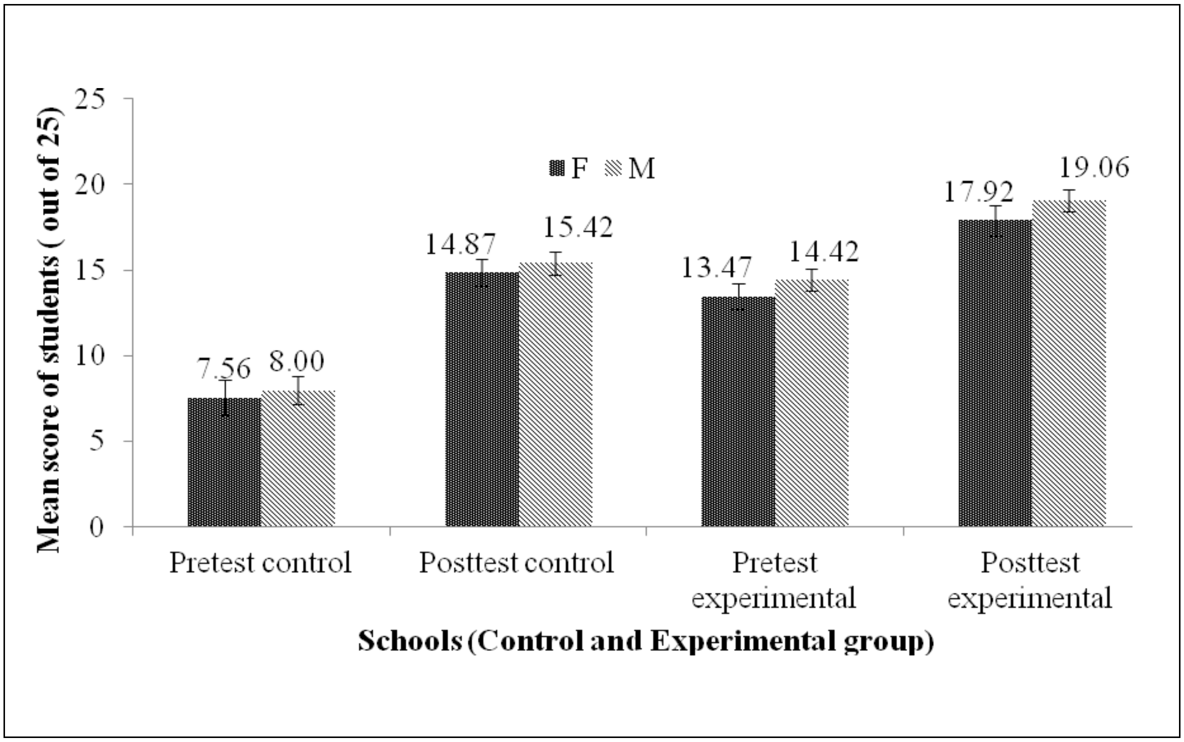

Figure 4.2: Pre-test and post-test mean score per gender (Source: Author, 2014)

4.2.3: Mean Scores for Pre-test and Post-test in Control and Experimental Groups

The mean score of students in both pre-test and post-test were as in the figure 4.3 below. Generally, posttest examination scores were better than pre-test in performance. The mean score for the pre-test control group was 7.81/25 and post-test control group was 15.05/25 while for the experimental group, the mean score for pre-test examination was 14.06/25 while for post-test examination was 18.65/25. It was observed that, the experimental group performed better than the control group when the mean performances of the two groups were compared without gender consideration. This implies that the use of ICT as a teaching method had a positive impact on the student's achievement in Mathematics. These findings are in line with those of a study conducted by Delen and Bulut (2011) who found out that students' exposure to ICT at home and school was a strong predictor of their performance in Mathematics. According to him, Students' exposure to ICT out of school time had a larger impact on their mathematics achievement than their exposure to ICT at school.

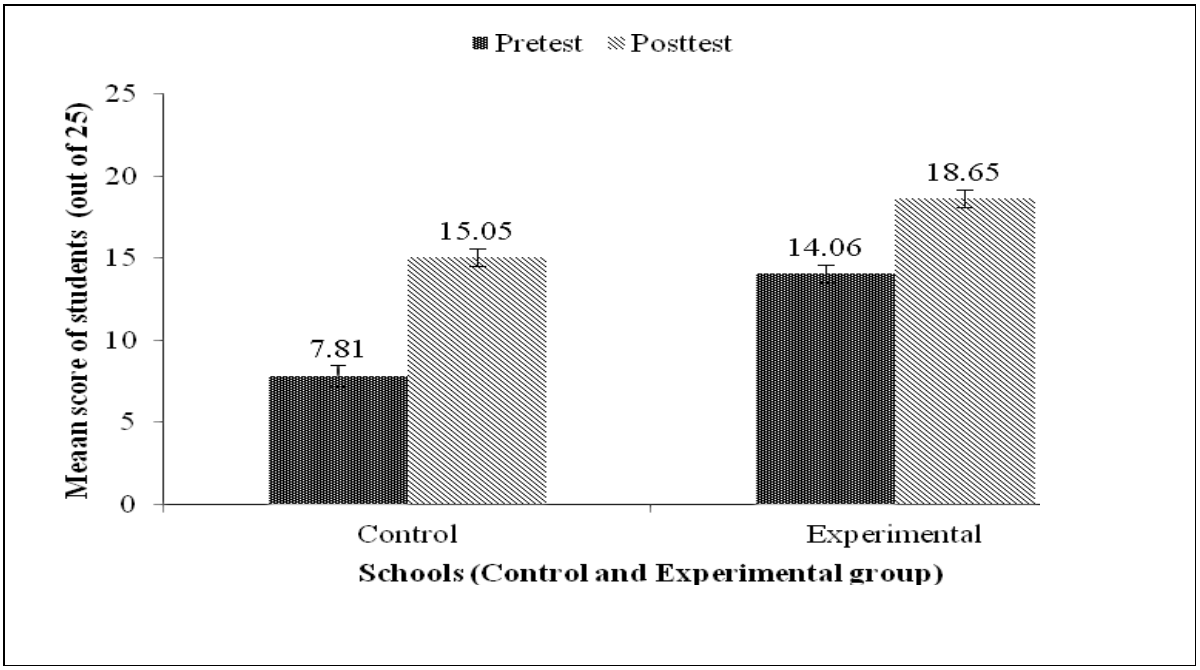

Figure 4.3: Mean scores of post-test and pre-test for control and experimental groups (Source: Author, 2014)

4.2.4: Performance in Gender for Control and Experimental Groups

In both control and experimental groups, male students performed slightly better than female students: male students control group; 11.32/25, experimental group; 16.8/25 while female students control group; 10.97/25 and experimental group; 15.65/25 as shown in figure 4.4.

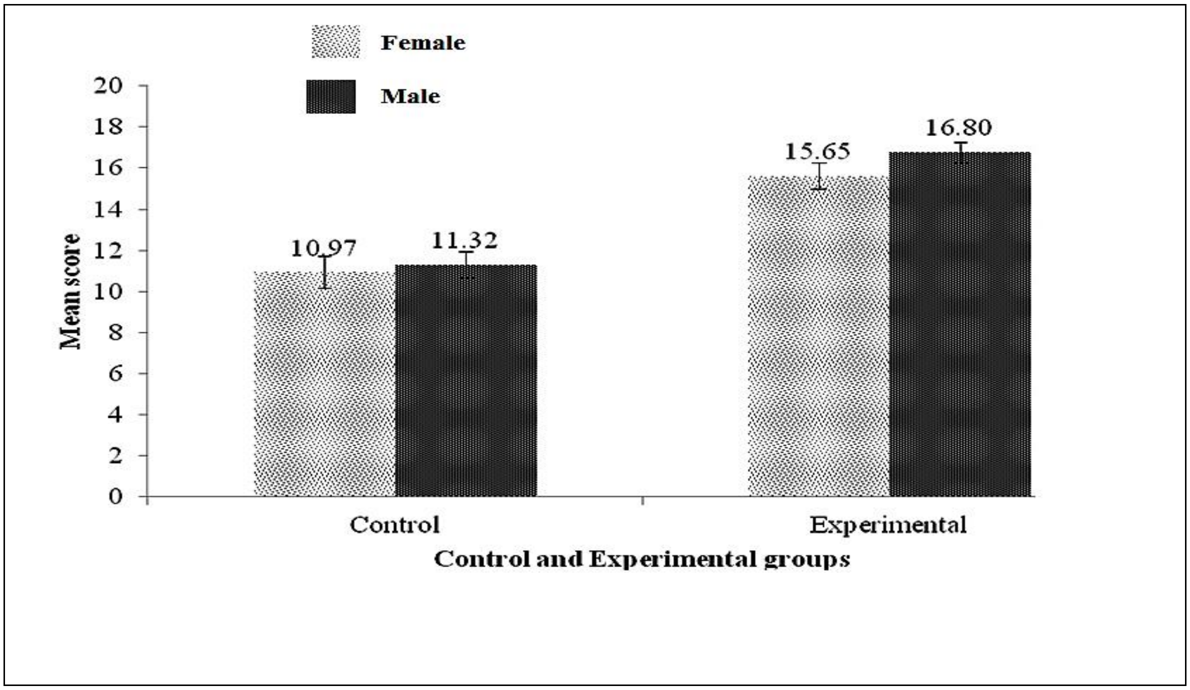

Figure 4.4: Performance in gender for control and experimental groups

(Source: Author, 2014)

Generally, the male students in the experimental and control group performed better than female students in both groups. Consequently, the null hypothesis $H0_2$ stating ‘Gender has no significant effect on secondary school students’ achievement in mathematics’ was rejected.

These results agree with those of a study conducted by Barkatsas, Kasimatis and Gialamas (2009) who studied the effects of gender on learning of secondary mathematics with technology. They found out that boys expressed more positive views towards mathematics and more positive views towards the use of technology in mathematics, compared to girls. In addition, they also found out that, high achievement in mathematics was associated with high levels of mathematics confidence, strong positive levels of affective engagement and behavioural engagement, high confidence in using technology and a strongly positive attitude to learning mathematics with technology. Low levels of mathematics achievement by the female was associated with their low levels of mathematics confidence, strongly negative levels of affective engagement and behavioural engagement, low confidence in using technology, and a negative attitude to learning mathematics with technology.

4.2.5: Overall Mean Performance in Control and Experimental Groups

Performance in pre-test and post-test were also compared as shown in Figure 4.5 and Figure 4.6 respectively. The students performed better in post-test examination than in pre-test examination for both control and experimental groups. The pre-test examinations mean score was 8/25 for the control group and 14/25 for the experimental group while in post-test, control group had a mean score of 16/25 and experimental group scored 19/25. The study therefore shows that ICT improves performance in mathematics concurring with Kulik's (1994) meta-analysis study revealing that on average, students who used ICT-based instruction scored higher than students without computers. The students also learn more in less time and like their classes more when ICT-based instruction was included.

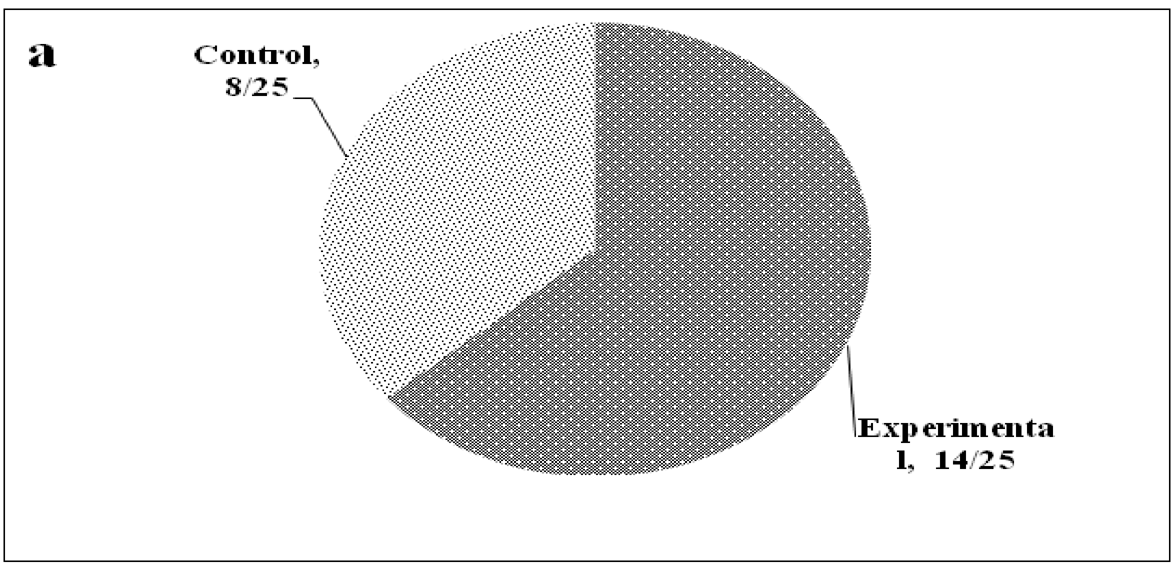

Figure 4.5: Overall mean performance in control and experimental groups (pre-test) (Source: Author, 2014)

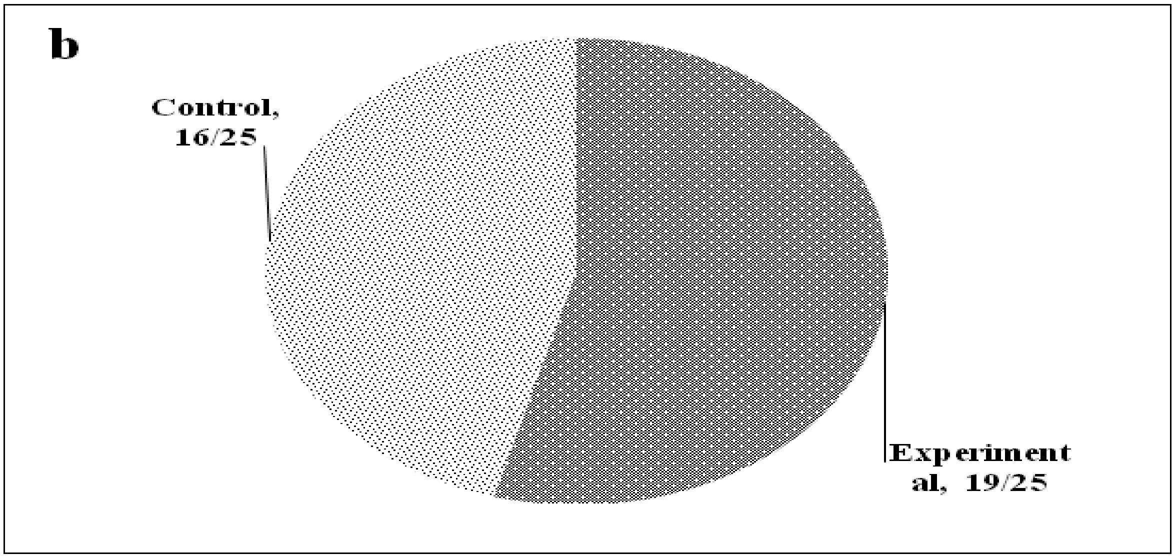

Figure 4.6: Overall mean performance in control and experimental groups (post-test) (Source: Author, 2014)

4.2.6: Percentage Performance in Experimental and Control Groups

In general, experimental (66%) group performed better than the control (45%) group in figure 4.6 below.

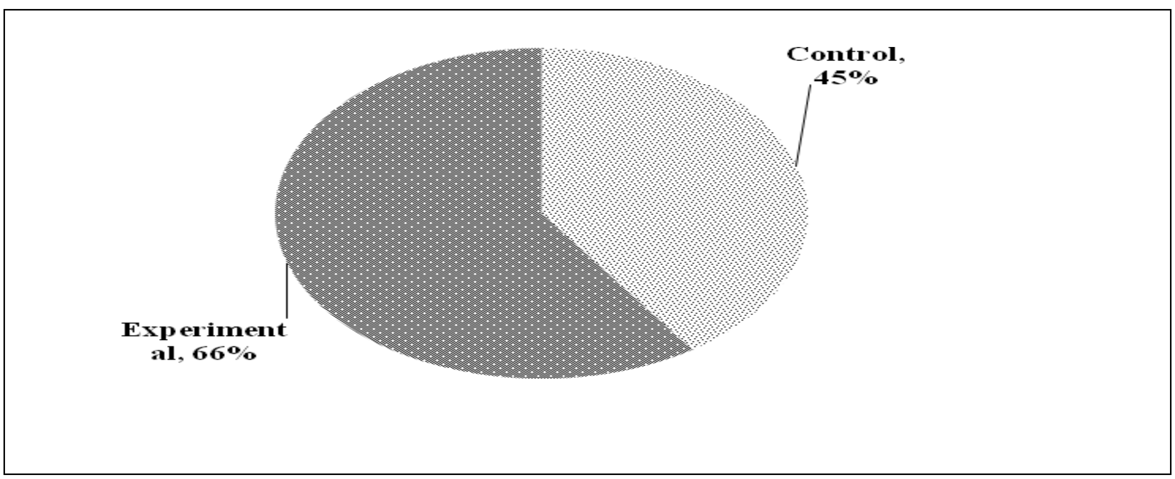

Figure 4.7: Percentage performance in control and experimental groups (Source: Author, 2014)

4.2.7: One-way ANOVA: Score versus School

Testing hypothesis for the difference in mean scores for the schools was done by use of one-way analysis of variance as shown in table 4.1 below. There was statically significant difference in the mean performance for the eight schools (See Appendix VII) F= 69.02 *df* =7 and p = 0.000.

Table4.1: One-way ANOVA: Score versus School

Source	**DF**	**SS**	**MS**	**F**	**P**
School	7	13349.7	1907.1	69.02	0
Error	488	13484.4	27.6		
Total	495	26834.1			
Individual 95% CIs For Mean Based on Pooled St Dev. = 5.257					

This means that there was a significance difference in performance between the schools in the experimental group (those which used ICT in teaching) and those in control group. This agrees with a study conducted by Ittigson and Zewe (2003) who cited that technology is essential in teaching and learning mathematics. ICT improves the way mathematics should be taught and enhances student understanding of basic concepts. Another study done by Becta (2003) summarized the key benefits of ICT in learning. According to him, ICT promotes greater collaboration among students and encourages communication and the sharing of knowledge. ICT gives rapid and accurate feedbacks to students and this contributes towards positive motivation.

4.2.8: One-way ANOVA: Score versus Test

One-way analysis of variance was also used to test the hypothesis of no significant difference in the pre-test and posttest scores as shown in table 4.2. This test too showed a significant difference; F = 102.63, *df = 1* and p = 0.000 (Table 4.2). Turkey simultaneous test showed that pre-test N= 256 and mean = 10.91/25 performed lower than posttest; N= 240 and mean = 17.015/25 (See Appendix VII)

Table4. 2: One-way ANOVA: Score versus Test

Source	DF	SS	MS	F	P
Test	1	4615.9	4615.9	102.63	0
Error	494	22218.1	45		
Total	495	26834.1			
Individual 95% CIs For Mean Based on Pooled St Dev. = 6.706					

This implies that the post – test (after treatment in the experimental group) results were better than the pre – test (before treatment). Consequently, the null hypothesis $H0_1$ stating ‘There is no significant difference in the mean achievement score of secondary school students taught some selected topics in mathematics using ICT and those taught the same topics using the traditional method’ was rejected.

These findings agree with those of Ahiatrogah, Madjoub and Bervell (2013) who conducted a study on the effect of computer assisted instruction (CAI) on the achievement of basic school students. Their results implied that there was a significant difference between the performance of students taught using the traditional methods of teaching and those taught using CAI methods.

4.2.9: One-way ANOVA: Score versus Treatment

Table 4 shows one-way analysis of variance test for significant difference in the scores between the control and experimental group performance. There was a significant difference in the performance of the two groups; F= 72.27, $df = 1$ and $p = 0.000$ (Table 4.3). Turkey simultaneous test showed that the control group generally performed lower than the experimental group; N= 238 and mean score =11.123/25 (for control) and N =258 with mean score of 16.388/25 (for experimental group) (See Appendix VII).

Table4.3: One-way ANOVA: Score versus Treatment

Source	DF	SS	MS	F	P
Treatment	1	3424.5	3424.5	72.27	0
Error	494	23409.6	47.4		
Total	495	26834.1			
Individual 95% CIs For Mean Based on Pooled St Dev.= 6.884					

This implies that performance in the experimental group was better than that of thecontrol group after the treatment. This finding contrasts with the findings of Wenglinsky (1998) who found that the frequency of school computer use and achievement were inversely related; student with greater school computer use performed less well than students with less school computer use.

4.3: Attitude of Students towards Mathematics

Basing on the data collected, using the Quantitative Mathematics Attitude Test Scale (QMATS) during the study, the attitude of students towards mathematics was analyzed and discussed as shown below:

4.3.1: Students' Attitude towards Mathematics in Pre-test Examination in Control and Experimental Group

The results for students' attitude were compared for pre-test, experimental and control group (See Appendix VIII). Most of the students either strongly agreed or agreed that they could get good grade in math as indicated by question 1. Though, for the Experimental group male students were more than female students in this assertion (20 male and 10 female) while in the control group, female students strongly agreed that they could get good results in math than male students (11 female and 7 male students). The female students agreed (10 female) that they had trouble in learning math (Q2) in the control group while most of the male students strongly disagreed (11 male) with this question in the experimental group. The female students also agreed (10) that they found math confusing (Q3) while male students were neutral (11). In control group, most of the female students agreed that they could handle any difficulty in math contrary to the experimental group whereby, most of the male students agreed that they could handle any difficulty in math (18) as observed in question 4.

The students in the control group however agree that they were not naturally good at math unlike in the experimental group where they strongly disagreed with this notion (Q5). However, the two groups also strongly disagrees that they have never felt able to learn math (Q6) and they either strongly agreed or just agreed that they have a lot of confidence when it comes to math (Q7), they also agreed that they liked to stick to math problem until they got it right (Q8) and they were interested to learn new things in math (Q9). Moreover, both groups agreed that they found math problems interesting and challenging (Q10) while they either agreed or remained neutral on whether they could become completely absorbed doing math (Q11). The students' response on question 12 showed that most of them disagreed in both groups that they were able to solve math problems without any difficulty. They also didn't understand how some people seemed to enjoy spending so much time on math problems (Q13). Both groups however strongly disagree with the notion that they would rather be given an answer than work a math puzzle (Q14) and also that; they have never been very excited about math (Q15).

The students either strongly agreed or just agreed in both groups that they enjoyed doing math (Q16). Furthermore, most of them strongly disagreed that math is always difficult for then (Q17). They tried to answer questions being asked in class (Q18) and enjoyed trying to solve new math problems (Q19), and that, if they made mistakes, they worked until they solved them (20). The students found working through examples less effective than memorizing given materials (Q21). In both groups, most of them either disagreed or strongly disagreed with the notion that they didn’t usually find time to check their own working to spot errors and correct them (Q22). They recognized the fact that high school math courses will be very helpful in most of their career fields of study (Q23). However, the students in the control group agreed that having to spend a lot of time on math problems frustrated them, a contrary opinion to the experimental group (Q24). Both of the groups however agreed that they found it helpful to test understanding by attempting exercises and problems (Q25) and that, mathematics was important in every day’s life (Q26). The students were generally neutral in responding to whether they preferred to work with symbols (Algebra) than with pictures (Diagrams and graphs) (Q27). They however disagreed that they would prefer to work on their own that in a group (Q28).

4.3.2: Students’ Attitude towards Mathematics in Post-test Examination in Control and Experimental Groups

In Appendix XIV, the students’ attitude toward math was evaluated after the post-test examination in both control and experimental groups. Most of the students in both groups considered themselves not generally good in math (Q1), though; they had a lot of confidence in math problems (Q2). In control group, most of them responded that they found math confusing while the experimental group in contrast, disagreed with the notion

(Q3). Both groups however agreed that they could handle any difficulty in math (Q4) and much more, they could get good results in math (Q5) The students also disagreed with the notion that they had never felt able to learn math (Q6). In both groups, the students also disagreed that they had less trouble in learning math that any other subject (Q7) and that no matter how much they study math, it is always difficult for them (Q8). Most of them were however neutral in the control group, for the response that they were able to solve math problems without any difficulty, while most students in experimental group were either neutral or disagreed with this idea (Q9). The students found math problems interesting and challenging (Q10) and could become completely absorbed doing math problems (Q11). However, most students in control group were interested to learn new things in math, unlike the experimental group where most of the students disagreed with this notion (Q12).

Furthermore, though in both groups, some students were neutral, the control group disagreed in contrast to the experimental group that they didn't understand how some people seem to enjoy spending so much time on math problems (Q13). However, majority in both groups enjoyed trying to solve new math problems (Q14) and much more, strongly disagreed that they have never been excited about math (Q15). Though most of the control group remained neutral, experimental group agreed that math was a subject they enjoyed doing (Q16). They both had majority students who liked to stick to math problems until the solved them (Q17), and spending a lot of time in math problems caused them frustration (Q18). Both of the groups strongly disagreed that they would rather be given an answer in a math puzzle that work it out themselves (Q19), if they made mistake, they worked until they corrected them (Q20). They also agreed that they tried to work the questions their teachers asked them in class (Q21). Though in both groups the majority disagreed with the notion that they don't usually find time to check their own work to find and correct errors, some men consented with this notion in the control group (Q22). Majority of the students also agreed in both groups that they found it helpful to test understanding by attempting exercises and problems (Q23). Both groups observed mathematics to be important in everyday life (Q24) noting that high school mathematics courses will be helpful no matter what career they decide to study (Q25).

The two groups also disagreed with the notion that they preferred working on their own rather than working in groups (Q26). Though most of them were neutral on whether they preferred working with symbols (Algebra) than working with pictures (diagrams and graphs) (Q27). Finally, majority in both groups found working through examples less effective than memorizing given materials (Q28).

4.3.3: Comparison of Pre-test and Post-test Attitude Examination for the Control Group

There was no much change in attitude when pre-test and post-test examinations were compared for the control group (See Appendix X). In both tests, the students strongly agreed that they could get good results in math (Q1). However, in pre-test examination, female students had trouble in learning math (Q2) unlike the post-test examination where both genders had no trouble in learning math. Both male and female students responded that they found math confusing (Q3). The students could handle any difficulty in math in both tests (Q4). However, in the pre-test examination, the students were not naturally good at math unlike in the posttest group where they strongly disagreed with this notion (Q5). In the two tests, the students strongly disagrees that they have never felt able to learn math (Q6) and agreed that they have a lot of confidence when it comes to math

(Q7), they also agreed that they liked to stick to math problem until they got it right (Q8) and they were interested to learn new things in math (Q9).

Moreover, both groups agreed that they found math problems interesting and challenging (Q10) and they could become completely absorbed doing math (Q11). The students' response on question 12 showed that most of them remained neutral on both examinations that they were able to solve math problems without any difficulty. They didn't understand how some people seemed to enjoy spending so much time on math problems (Q13). Both groups however strongly disagree with the notion that they would rather be given an answer than work a math puzzle (Q14) and also that; they have never been very excited about math (Q15).

The students agreed in both groups that they enjoyed doing math (Q16). However, most of them strongly disagreed that math is always difficult for then (Q17). They tried to answer questions being asked in class (Q18) and enjoyed trying to solve new math problems (Q19), and that, if they made mistakes, they worked until they solved them (20). The students found working through examples less effective than memorizing given materials (Q21).In pre-test examination, the students disagreed with the notion that they didn't usually find time to check their own working to spot errors and correct them (Q22). They recognized the fact that high school math courses will be very helpful in most of their career fields of study (Q23), and that, having to spend a lot of time on math problems frustrated them (Q24). They found it helpful to test understanding by attempting exercises and problems (Q25) and that, mathematics was important in every day's life (Q26). The students were generally neutral in responding to whether they preferred to work with symbols (Algebra) than with pictures (Diagrams and graphs) (Q27). They however disagreed that they would prefer to work on their own than in a group (Q28).

4.3.4: Comparison of Pre-test and Posttest Attitude Examination for the Experimental Group

The same observation was also noted for the experimental examination in that there was no much change in the attitude of the students in pre-test and posttest scores (See Appendix XI).

4.3.5: Effects of ICT as Teaching Strategy on Students' Attitudes towards Mathematics Experimental Group in comparison to the Control Group

The attitude of the students towards mathematics changed considerably much for pre-test and posttest, a comparison of the introduction of information and communication technology in math examination. In both cases, the students had confidence in getting good grade in math and consented that they had trouble in learning math just like any other subject. However, in the pre-test group, the students found math less confusing, unlike in the post test group where most of them either were neutral, as in the control group, or disagreed that math is less confusing as in the experimental group. Both groups however agreed that they were confident to handle any difficulty in math whenever they met them, though, more students in the post-test examination were positive on this notion than in the pre-test examination. In the control examination, the students agreed that they were not naturally good in math while the experimental group disagree with this notion, however, in the posttest examination, most students in both groups disagreed with the notion creating an impression that there was a change in attitude towards math after the information and communication technology was introduced. The students felt able to learn math in both pre-test and posttest examination and furthermore, majority had a lot of confidence to learn mathematics and could stick to a math problem until they get it.

There was however a change in attitude in the response on being interested to learn new things in math, though in both cases the pre-test control and experimental groups agreed that they are interested to learn new things in math, there was a contrast in the post-test experimental group in that, most of the students disagreed with this notion. In both examinations, majority of students found math problems interesting and challenging. Though in the pre-test examination, most students either agreed or were neutral on the response that they could become completely absorbed doing math problem, most of them agreed with this notion in the post-test examination, this also showed a positive attitude towards math after the introduction of information and communication technology. In both examinations, the students either disagreed or remained neutral in the response that they were able to solve math problems without much difficulty. There was also a change in attitude in the response that the students did not understand how some people seem to enjoy spending so much time on math problems. In pre-test examination, students in response agreed with this notion, but in the post-test, they either agreed or remained neutral as in the control group, or disagreed while others were neutral as in the experimental group. This observation also showed a change in attitude with the introduction of information and communication technology. The students however had positive attitude in both tests in that they would rather solve a math puzzle than be given the answer and further disagreed with the notion that they had never been excited about math. The contrast with the pre-test and post-test examination was however an unexpected response in control group, where students enjoyed doing math in pre-test examination but they had a neutral attitude toward math in the post-test examination. Both groups disagreed that math is always difficult to them no matter how much they studied it.

Experimental group attitude towards answering question given by their teachers also changed in the post-test, in that, in response, they had a positive attitude in the pre-test examination, while most of them disagreed with this notion in their posttest examination. They enjoyed trying to solve new math problems in both examinations and would work until they corrected any mistake they made in math. It was observed that, students preferred to memorize given materials than working through them. Much more, they strongly agreed with this notion in the post-test than pre-test examination. In both school settings, students do not usually find time to check their own working to find and correct errors, moreover, they strongly agreed that high school math courses were very helpful no matter what they decided to study. Though in the control group, most students considered being frustrated to spend a lot of time in math problems in both examinations, the experimental group either disagreed or strongly disagreed with this notion. Most of the students found it helpful to test understanding by attempting exercise and problems and more so, they agreed that mathematics is important in everyday life. Most of the students in pre-test control preferred to work with symbols while in the post-test examination, they were neutral on it, suggesting that, they were comfortable with both approaches and finally in both cases, the students prefer working in groups rather than on their own.

4.3.6: Ordinal Logistic Regression Test for Association of the Students' Attitude Response towards Mathematics in Control and Experimental Groups Pre-Test Examination

Ordinal Logistic regression was used to test for any association of the students' attitude towards math examination. Table 4.4 shows the results comparing the attitude of the students towards math examination in control and experimental groups pre-test examination. The students responded positively for most of the questions (73) and either strongly agreed (33) or strongly disagreed with some attitude questions (30). The least response was with those of neutral (11) stand. The estimate intercept of the logits cumulative probabilities for the responses; agree, disagree, neutral, strongly agree and strongly disagree represented by the constants (1, 2, 3and 4 respectively). The coefficient of -0.346 for group is the estimated change in the logit of the cumulative response probability when the experimental group is compared to control group, with the covariate of the number of students in the ordinal response (agree, disagree, neutral, strongly agree and strongly disagree) held constant.

The p-value for estimated coefficient 0.267, indicated that there was insufficient evidence to conclude that whether experimental or control group, had an effect upon the students' attitude towards math. The one estimate for each covariate for factor levels (experimental and control group pre-test examination)-0.045 and the p-value 0.290 also indicated that for most response, the two groups were not significantly different in the response. Pearson and deviance goodness-of-fit tests of p-vales 0.452 and 0.267 indicated that there is insufficient evidence to claim that the model does not fit the data adequately. The measure of association between the response (agree, disagree, neutral, strongly agree and strongly disagree) and the predictor variables (experimental and control group pre-test examination) showed a concordance of 53.4% concordance, 42% discordance and 4.7% tie. They were however not better predictive of the model with Simons' D, Goodman-Kruskal Gamma and Kendall's tau since their values were close to zero than 1.

Table4.4: Ordinal logistic regression; Students' response for control and Experimental pre-test examination

Pre-test Control and Experimental: Response A (73), D (13), N (11), SA (33) and SD (30)

Predictor	**Coef**	**SE Coef**	**Z**	**P**
Constant(1)	0.478	0.454	1.05	0.293
Constant(2)	0.811	0.456	1.77	0.076
Constant(3)	1.102	0.460	2.39	0.017
Constant(4)	2.161	0.485	4.45	0.000
Factor				
Experimental	-0.346	0.313	-1.11	0.267
Frequency	-0.045	0.043	-1.06	0.290

*Log-Likelihood = -219.862
*Test that all slopes are zero: G = 3.640, DF = 2, P-Value = 0.162

Goodness-of-Fit Tests

Method	**Chi-Square**	**DF**	**P**
Pearson	111.136	110	0.452
Deviance	118.762	110	0.267

Measures of Association: (Between the Response Variable and Predicted Probabilities)

Pairs	**Number**	**Percent**	**Summary Measures**	
Concordant	4800	53.4	Somers' D	0.11
Discordant	3777	42.0	Goodman-Kruskal Gamma	0.12
Ties	419	4.7	Kendall's Tau-a	0.08
Total	8996	100.0		

4.3.7: Ordinal Logistic Regression Test for Association of the Students' Attitude Response towards Response Mathematics in Control and Experimental Groups' Post-Test Examination

A similar interpretation indicating insufficient evidence to conclude that experimental or control group, had an effect upon the students' attitude towards math was also observed in the posttest examination (Table 4.5). The p-value for estimated coefficient 0.358, indicated that there was insufficient evidence to conclude that whether experimental or control group, had an effect upon the students' attitude towards math. The one estimate for each covariate for factor levels (experimental and control group posttest examination) -0.027 and the p-value 0.478 also indicated that for most response, the two groups were not significantly different in the response. However, Pearson and deviance goodness-of-fit tests of p-vales 0.031 and 0.012 indicated that there was sufficient evidence to claim that the model does not fit the data adequately. Therefore there was no significant attitude change with the use of ICT in teaching.

Table 4.5: Ordinal logistic regression; Students' response for control and experimental post-test examination

Posttest Control and Experimental: Response A (58), D (29), N (19), SA (27), SD (35)

Predictor	**Coef**	**SE Coef**	**Z**	**P**
Const(1)	-0.255	0.415	-0.62	0.538
Const(2)	0.461	0.415	1.11	0.267
Const(3)	0.934	0.420	2.23	0.026
Const(4)	1.746	0.437	4.00	0.000
Factor				
Experimental	-0.255	0.278	-0.92	0.358
Frequency	-0.027	0.038	-0.71	0.478

*Log-Likelihood = -257.553
*Test that all slopes are zero: G = 1.493, DF = 2, P-Value = 0.474

Goodness-of-Fit Tests

Method	**Chi-Square**	**DF**	**P**
Pearson	157.201	126	0.031
Deviance	164.433	126	0.012

Measures of Association: (Between the Response Variable and Predicted Probabilities)

Pairs	**Number**	**Percent**	**Summary Measures**	
Concordant	5561	51.2	Somers' D	0.07
Discordant	4804	44.3	Goodman-Kruskal Gamma	0.07
Ties	487	4.5	Kendall's Tau-a	0.05
Total	10852	100.0		

4.3.8: Ordinal Logistic Regression Test for Association of the Students' Attitude towards Mathematics in Experimental Group Pre-Test and Post-Test Examination

Ordinal Logistic regression was also used to test for any association of the students' attitude towards math in experimental pre-test and posttest examination (Table 4.6). The students responded positively for most of the questions (58) and either strongly disagreed (42) or strongly agreed with some attitude questions (35). The least response was with those of neutral (16) stand. The estimate intercept of the logits cumulative probabilities for the responses; agree, disagree, neutral, strongly agree and strongly disagree were represented by the constants (1, 2, 3and 4 respectively). The coefficient of 0.274 for group indicates the estimated change in the logit of the cumulative response probability when the students' attitude towards the pre-test examination was compared to the posttest examination, with the covariate of the number of students in the ordinal response (agree, disagree, neutral, strongly agree and strongly disagree) held constant. The p-value for estimated coefficient 0.316 indicated that there was insufficient evidence to conclude that the students' attitude in the pre-test and posttest experimental group had changed. The one estimate for each covariate for factor levels (experimental and control group pre-test examination) -0.049 and the p-value 0.139 also indicated that for most response, the students attitude in pre-test and posttest examination were not significantly difference.

Pearson and deviance goodness-of-fit tests of p-vales 0.814 and 0.490 indicated that there is insufficient evidence to claim that the model does not fit the data adequately. The measure of association between the response (agree, disagree, neutral, strongly agree and strongly disagree) and the predictor variables (pre-test and post-test examination) showed a concordance of 52.5% concordance, 43.4 % discordance and 4.1% tie. They were however not better predictive of the model with Simons' D, Goodman-Kruskal Gamma and Kendall's tau since their values were close to zero than 1.

Table 4.6: Ordinal logistic regression; Students' response for experimental pre-test and post-test examination

Pre-test and Posttest Experimental group: Response A (58), D (25), N (16), SA (35), SD (42)

Predictor	**Coef**	**SE Coef**	**Z**	**P**
Const(1)	-0.337	0.397	-0.85	0.397
Const(2)	0.269	0.396	0.68	0.498
Const(3)	0.645	0.399	1.62	0.106
Const(4)	1.572	0.414	3.80	0.000
Factor				
Pre-test	0.274	0.273	1.00	0.316
Frequency	-0.049	0.033	-1.48	0.139

*Log-Likelihood = -266.731
*Test that all slopes are zero: G = 3.032, DF = 2, P-Value = 0.220

Goodness-of-Fit Tests

Method	**Chi-Square**	**DF**	**P**
Pearson	119.282	134	0.814
Deviance	133.742	134	0.490

Measures of Association:(Between the Response Variable and Predicted Probabilities)

Pairs	**Number**	**Percent**	**Summary Measures**	
Concordant	6234	52.5	Somers' D	0.09
Discordant	5149	43.4	Goodman-Kruskal Gamma	0.10
Ties	488	4.1	Kendall's Tau-a	0.07
Total	11871	100.0		

4.4: Summary

The chapter discussed the analyzed results showing the achievement of students in control and experimental groups. I also elaborate clearly the number of male and female students who participated in the study. It has a bar chart showing a comparison in performance in pre-test against post-test and control against experimental groups according to the sex of the respondents. The chapter discussed the performance in mean scores between pre-test and post-test examination of respondents in both control and experimental groups. On achievement of students in mathematics, the chapter using a pie chart summarizes the findings of the overall performance in control and experimental groups. One-way Analysis of Variance on score versus School, score versus test and score versus treatment is also discussed.

Based on the objective of effects of ICT on students attitude towards mathematics, the chapter shows the analyzed results of pre-test and post-test attitude test in both control and experimental groups. It also presents analysis of data between pre-test and post-test in control group and in experimental group separately. To compare the effect of ICT on students attitude towards mathematics, the study compared the attitude test between experimental and control groups. To determine whether there is a significant effect on change of attitude towards mathematics, the chapter finally presents ordinal logistic regression tests for association on students' attitude response towards the subject.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1: Introduction

This chapter summaries finding of the study, make conclusions and recommendations according to the objectives of the study, corresponding research questions and hypotheses.

5.2: To Determine the Effects of ICT use on Students' Achievement in Mathematics

The study, based on this objective, sought to answer the question: What will be the mean achievement scores of Secondary School students taught selected topics in mathematics using ICT method and those taught the same topics using the traditional methods? The null hypothesis corresponding to the objective was: There is no significant difference in the mean achievement scores of Secondary School students taught some selected topics in mathematics using ICT and those taught the same topics using the traditional method.

5.2.1: Summary

The experimental group performed better than the control group in both pre-test and post-test examination. ICT method of teaching was used in the experimental groups while the control groups were taught using the traditional methods. This shows that ICT improved the achievement of students in mathematics.

5.2.2: Conclusions

Pre-test studies were conducted without the use of information and communication technology in the experimental group, while post-test was conducted after ICT was used in teaching. The performances in the post-tests were much better than the pre-test. Therefore, there is sufficient evidence to deduce that, ICT had a positive influence to students' performance in mathematics. Many studies have shown that information and communication technology better equip students and prepare them adequately to face examination with much more bold attitude than lack of ICT. Hence there is sufficient evidence to reject the null hypothesis that there is no significant difference in the mean achievement score of Secondary School students taught some selected topics in mathematics using ICT and those taught the same topics using the traditional method.

5.2.3: Recommendations

Based on the above conclusions in the study, the following recommendations were therefore made:

i. The government of Kenya, in collaboration with School Board of Management, should partner with Non-governmental organizations (NGOs) and well-wishers to provide ICT facilities for learning in Secondary Schools. ICT tools, according to the study, produces better results if used for teaching and learning in schools. The NGOs should be encouraged to invest more in schools by supplying computers to be used for teaching. The government, in their annual budget, should consider equipping schools with computers.

ii. The Kenya Institute of Curriculum Development (KICD) should design curricula that are activity based. Authors and publishers should also tailor their content to capture learning activities that are activity-based using ICT tools. This will ensure that students learn with maximum benefits as it captures the attention of most learners.

iii. Teachers should be re-trained through in-service to handle teaching in a modern way through integration of ICT. The SMASSE program can be strengthened to make it more activity-based to motivate teachers to attend. More ICT facilities also need to be supplied to these training centres to ensure effective and quality training for teachers.

5.3: To investigate how ICT influence Male and Female Students' Achievement in Mathematics

The study, based on this objective, sought to answer the question: What is the effect on sex, of mean achievement scores in mathematics, of Secondary School students taught selected topics in mathematics using ICT and those taught the same topics using the traditional methods? The null hypothesis corresponding to this objective was Sex has no significant effect on Secondary School students' achievement in mathematics.

5.3.1: Summary

The results showed that in both control and experimental group, the number of male students was generally more that of female students. This is the trend in most of the schools in the country, male students have been observed to have privilege of being educated by their parents more than the female students. These results therefore concurred with the consented idea that education is mostly given to male children more than the female. In both tests done, male students performed better than female students for the control group and the experimental group, their means score was higher than that of female students, though, no significant difference was observed when the range of the means scores were compared with standard error bars indicating that both genders were performing relatively the same.

5.3.2: Conclusions

From the findings of the study, more boys than girls access Secondary School Education in Kenya. Even though this is the case, performance in mathematics of male and female students is generally the same when ICT is used. This indicates that the performance of students were much more related to the environment where they were taught, either in control or in experimental groups but does not correspond to gender. Therefore there was sufficient evidence not to reject the null hypothesis that Sex has no significant effect on Secondary School students' achievement in mathematics.

5.3.3: Recommendations

Based on the above conclusion in the study, the Government of Kenya should enforce protective laws to ensure school-going girls attend school to acquire education. Girls should be given equal opportunity to education since achievement for both genders is the same. This can be done by strengthening the laws protecting girl-child from being denied access to education. Parents should be held responsible, by law, to educate both boys and girls equally and provide the necessary requirement for their learning.

5.4: To determine the Effects of ICT as Teaching Strategy on Students' Attitudes towards Mathematics in Control and Experimental Groups

The study, based on this objective, sought to answer the question: What will be the mean difference in attitude towards mathematics of Secondary School students taught selected topics in mathematics using ICT and those taught the same topics using the traditional methods? The null hypothesis corresponding to this objective was: There is no significant difference in the attitude towards mathematics between Secondary School students taught some selected topics in mathematics using ICT materials and those taught the same topics using traditional methods.

5.4.1: Summary

There was no much change in attitude of the students' response towards mathematics examination in the control pre-test and post-test examination. This was also observed with experimental group when pre-test and post-test examinations were compared. Ordinal logistic regression analysis in table 4.6 confirmed these assertions. However, the students mean performance indicated that the ICT technology resulted into better performance.

5.4.2: Conclusions

There was insufficient evidence to deduce any change in attitude of the students towards mathematics examination. The contrast to their response could have resulted into the students' response to attitude test which was conducted within one week before and after the tests and so, their response could not have changed much since the time period was short for them to realize any change in their attitude towards mathematics.

5.4.3: Recommendations

Based on the above conclusions in the study, the following recommendations were therefore made:

i. A further research study should be conducted on the impact of ICT on students' attitude in mathematics over a long period of time.

ii. A research on how other ICT software like gaming and simulations can impact on students' achievement in mathematics and attitude towards mathematics.

5.5: Summary

In the experimental groups, ICT has an impact on students' achievement in mathematics. Despite the fact that male students are more than female students in Secondary Schools, the study shows no significant difference in the achievement in mathematics when ICT tools are used in teaching. The results from this study therefore, favored the use of information and communication technology in academic institutions for improvement of students' performance. On the attitude of students towards mathematics, ICT exposure to students for a short period of time has less impact on their attitude. Results show no significant difference between pre-test attitude test and post-test attitude test in the experimental group.

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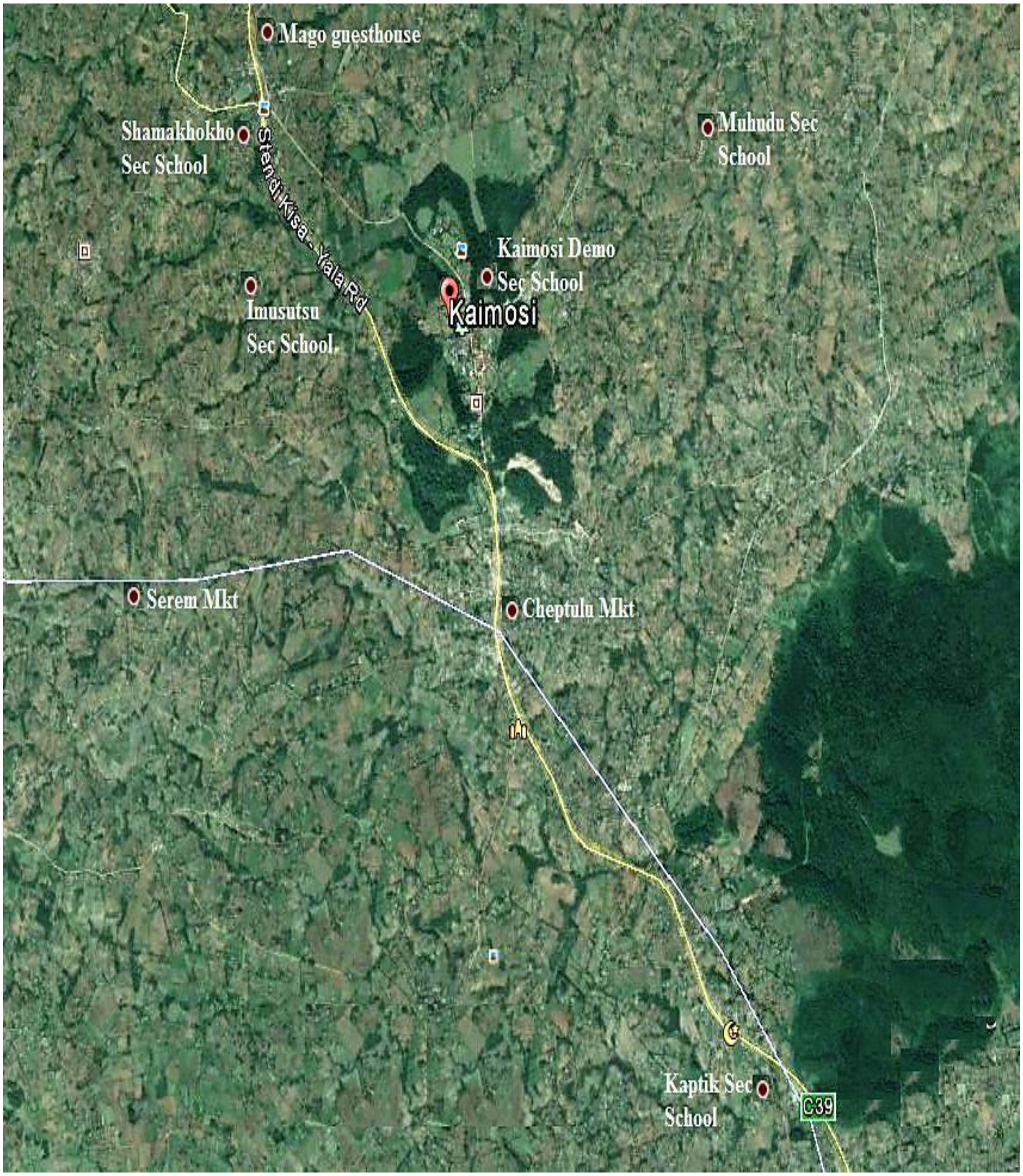
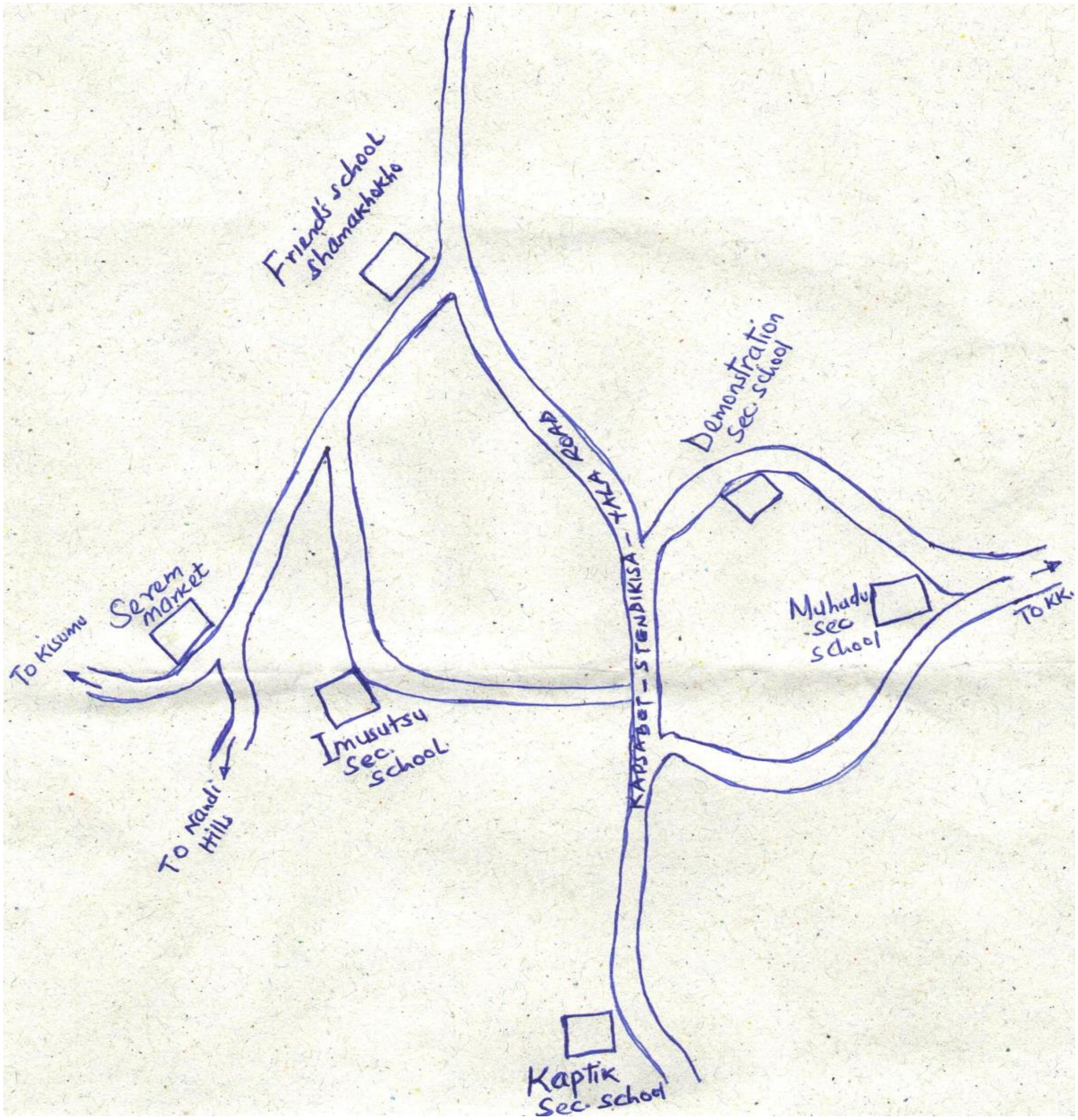
APPENDICES

Appendix I (a): Map of the Study Area



Source: Google

Appendix I (b): Map of the Study Area



Source: Researcher

Appendix II: Students' Questionnaire (Pre-test)

General Instructions

The purpose of this questionnaire is to study how to enhance students' achievement and attitude through Information and Communication Technology (ICT) in Day secondary schools in Tiriki East Division, Hamisi District, Vihiga County.

The questionnaire consists of two sections.

Please read the questions in each section carefully and indicate your responses candidly.

For questions with boxes please tick the appropriate box with the correct answer .All your responses and information will be treated with strict confidentiality and will only be used for analytic purposes of this research.

Section A: (Demographic Information)

What is your name? (Optional)……………………………………………………

School………………………………………………………………………………

What is your gender?

Male ☐

Female ☐

Section B: (Attitude towards Mathematics learning)

How do you feel about learning mathematics in school?

SA = Strongly Agree, **A** = Agree, **N** = Neutral, **D** = Disagree, **SD** = Strongly Disagree

Item No.	Questionnaire Indicator	SA	A	N	D	SD
1	I am not naturally good at math					
2	I have a lot of confidence when it comes to math					
3	I find math confusing					
4	When I have difficulties in math, I know I can handle them					
5	I can get good results in math					
6	I have never felt myself able to learn math					

7	I have less trouble learning math than any other subject					
8	No matter how much I study, math is always difficult for me					
9	I am able to solve math problems without much difficulty					
10	I find many math problems interesting and challenging					
11	I can become completely absorbed doing math problems					
12	I am interested to learn new things in math					
13	I don't understand how some people seem to enjoy spending so much time on math problems					
14	I enjoy trying to solve new math problems					
15	I have never been very excited about math					
16	Math is a subject I enjoy doing					
17	I like to stick at a math problem until I get it right					
18	Having to spend a lot of time on a math problem frustrates me					
19	If something about math puzzles me, I would rather be given the answer than have to work it out myself					
20	If I make mistakes, I work until I have corrected them					
21	I try to answer the questions the teacher asks in class					
22	I don't usually find time to check my own working to find and correct errors					
23	I find it helpful to test understanding by attempting exercises & problems					
24	Mathematics is important in everyday life					
25	High school math courses will be very helpful no matter what I decide to study					
26	I prefer to work on my own than in a group					
27	I prefer to work with symbols(Algebra) than with pictures (Diagrams & Graphs)					
28	I find working through examples less effective than memorizing given material					

Appendix III: Students' Questionnaire (Post-test)

General Instructions

The purpose of this questionnaire is to study how to enhance students' achievement and attitude through Information and Communication Technology (ICT) in Day secondary schools in Tiriki East Division, Hamisi District, Vihiga County.

The questionnaire consists of two sections.

Please read the questions in each section carefully and indicate your responses candidly.

For questions with boxes please tick the appropriate box with the correct answer .All your responses and information will be treated with strict confidentiality and will only be used for analytic purposes of this research.

Section A: (Demographic Information)

What is your name? (Optional)……………………………………………………

School………………………………………………………………………………

What is your gender?

Male ☐

Female ☐

Section B: (Attitude towards Mathematics learning)

How do you feel about learning mathematics in school?

SA = Strongly Agree, **A** = Agree, **N** = Neutral, **D** = Disagree, **SD** = Strongly Disagree

Item No.	Questionnaire Indicator	SA	A	N	D	SD
1	I can get good results in math					
2	I have trouble learning math than any other subject					
3	I find math confusing					
4	When I have difficulties in math, I know I can handle them					
5	I am not naturally good at math					
6	I have never felt myself able to learn math					

7	I have a lot of confidence when it comes to math					
8	I like to stick at a math problem until I get it right					
9	I am interested to learn new things in math					
10	I find many math problems interesting and challenging					
11	I can become completely absorbed doing math problems					
12	I am able to solve math problems without much difficulty					
13	I don't understand how some people seem to enjoy spending so much time on math problems					
14	If something about math puzzles me, I would rather be given the answer than have to work it out myself					
15	I have never been very excited about math					
16	Math is a subject I enjoy doing					
17	No matter how much I study, math is always difficult for me					
18	I try to answer the questions the teacher asks in class					
19	I enjoy trying to solve new math problems					
20	If I make mistakes, I work until I have corrected them					
21	I find working through examples less effective than memorizing given material					
22	I don't usually find time to check my own working to find and correct errors					
23	High school math courses will be very helpful no matter what I decide to study					
24	Having to spend a lot of time on a math problem frustrates me					
25	I find it helpful to test understanding by attempting exercises & problems					
26	Mathematics is important in everyday life					
27	I prefer to work with symbols(Algebra) than with pictures (Diagrams & Graphs)					
28	I prefer to work on my own than in a group					

Appendix IV: Quantitative Mathematics Assessment Test (QMAT)

Name……………………………………..School………………………………………

Gender…………………………

Marks: 25 Time: 30 minutes

Instructions: Answer **all** the questions in the spaces provided

1. Determine the median of the following data (3mks)

56, 34,29,40,50,21,26,16

2. The table below shows the marks of 100 candidates in a math test

Marks (x)	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Frequency(f)	4	9	16	24	18	12	8	5	3	1

a) Draw a cumulative frequency table (3mks)

b) Draw a cumulative frequency curve in the grid below (5mks)

c) On the curve in (b) above, show the lower quartile (Q_1) and upper quartile (Q_3)

(2mks)

d) Calculate the interquartile range (2mks)

3. The table below shows the distribution of height to the nearest centimeter of 40 students

Height (cm)	145-149	150-154	155-159	160-164	165-169	170-174	175-179
Frequency (f)	2	5	16	9	5	2	1

a) Draw a cumulative frequency table based on the data in the table (4mks)

b) Determine the median class (2mks)

c) Using the formula $m = L + \frac{(^n/_2 - C)\, i}{f}$, determine the median height (4mks)

Appendix V: Lesson Plans for Control Groups

Lesson Plan 1

School: ………………………………………………………………………….

Date : ………………………Class : ………...Time: ………………………

Subject: ……………………………………….No. of students: ……………

Topic: Statistics II

Sub-topic: Determination of median of a given set of data

Objectives: By the end of the lesson, the learner should be able to:

-Define median of a simple ungrouped data

-Determine median of grouped data

Time/Activity	Content	Learning activities	Resources/ Materials
5 Minutes **Introduction**	Review on determination of mean of simple ungrouped data	Example on determination of mean	Chart
30 Minutes **Lesson Development**	i. Definition of median and using simple ungrouped data. ii. Determination of median of grouped data.	Chalkboard illustrations and discussions.	Chart
5 Minutes **a. Conclusion** **b. Evaluation**	• Review of worked example on median. • Assignment written on the chalkboard	• Discussion • Writing of assignment on the board	N/a
Remarks			

Lesson Plan 2

School: ………………………………………………………

Date: …………………………Class : ……Time: …………

Subject: ……………………………………No. of students: …………………

Topic: Statistics II

Sub-topic: Estimation of quartiles of a given set of data

Objectives: By the end of the lesson, the learner should be able to:

-Define upper and lower quartiles using simple ungrouped data

-Determine the quartiles of grouped data

Time/Activity	**Content**	**Learning activities**	**Resources/ Materials**
5 Minutes **Introduction**	Review on determination of median of simple grouped data	Review of the assignment on median	Chart
30 Minutes **Lesson Development**	i. Definition of upper and lower quartiles using simple ungrouped data. ii. Determination of quartiles of grouped data.	Chalkboard illustrations and discussions.	Chart
5 Minutes a) **Conclusion** **b) Evaluation**	• Review of worked example on upper and lower quartiles • Assignment written on the chalkboard	• Discussion • Writing of assignment on the board	N/a
Remarks			

Appendix VI: Lesson Plans for Experimental Groups

Lesson Plan 1

School: ……………………………………………………………………………

Date : ……………………..Class: ………………Time: …………………….

Subject: ……………………………………………No. of students: ……………..

Topic: Statistics II

Sub-topic: Determination of median of a given set of data

Objectives: By the end of the lesson, the learner should be able to:

-Define median using simple ungrouped data

-Determine median of grouped data

Time/Activity	Content	Learning activities	Resources/ Materials
5 Minutes **Introduction**	Review on determination of mean of simple ungrouped data	Class collects data on the number of electronic devices in their homes and work out mean using MS-Excel	Chart, a laptop and a projector
30 Minutes **Lesson Development**	i. Definition of median using simple ungrouped data. ii. Determination of median of grouped data.	i) Weights of all students in class are taken and tabulated. ii) A computer program is used to draw the cumulative frequency curve and determine the median	Computers, Laptop and a projector
5 Minutes c) **Conclusion** d) **Evaluation**	• Class activity • Assignment	Counting number of words in a one page essay, tabulating and working out the median. Students tabulate ages of all the students in class.	Computers, Laptop and a projector
Remarks			

Lesson Plan 2

School: ………………………………………………………….……………..

Date : ……………Class : …………Time : ……………………………..

Subject: ………………………………..No. of students: …………………….

Topic: Statistics II

Sub-topic: Determination of quartiles a given set of data

Objectives: By the end of the lesson, the learner should be able to:

-Define quartiles using simple ungrouped data

-Determine the upper and lower quartiles of grouped data

Time/Activity	Content	Learning activities	Resources/ Materials
5 Minutes **Introduction**	Review on determination of median of simple grouped data	Using computer program to determine median mass of students in class	Computer, Laptop and projector
30 Minutes **Lesson Development**	i.Definition of quartiles using a simple ungrouped data. ii.Determination of quartiles of grouped data.	i) Data of ages of 10 students in class is collected. ii) Students draw on workspaces a line of 20cm using free hand. iii) Students measure the length between the start and the end of the line and tabulate the results.	Computers and projector
5 Minutes e) **Conclusion** **f) Evaluation**	• Quartiles and Interquartile range marks of the latest English test. • Homework assignment	Data collection on the latest English test. Students prepare frequency table on the English test	
Remarks			

Appendix VII: One-way ANOVA results

a. : Score versus school

```
Level             N    Mean  StDev  ---+---------+---------+---------+------
F.S. Muhudu post  64  17.250  6.419                           (-*--)
F.S. Muhudu pre   68  11.662  5.006                (-*--)
Imusutsu post     79  13.639  5.643                    (-*--)
Imusutsu pre      98   4.755  5.286  (--*-)
Kaimosi post      30  18.767  2.921                             (---*--)
Kaimosi pre       31  17.484  3.741                          (---*---)
Kaptik post       67  19.985  5.321                                (--*-)
Kaptik pre        59  16.814  5.050                          (--*-)
---+---------+---------+---------+------
5.0      10.0      15.0      20.0
Pooled StDev = 5.257
```

b. Score versus Test

```
Level    N    Mean  StDev     +---------+---------+---------+---------
Post   240  17.015  6.062                                     (---*---)
Pre    256  10.910  7.259     (----*---)
+---------+---------+---------+---------
10.0      12.0      14.0      16.0
Pooled StDev = 6.706
```

c. Score versus Treatment

```
Level           N    Mean  StDev  ---------+---------+---------+---------+
Control       238  11.128  7.503   (----*---)
Experimental  258  16.388  6.259                              (---*---)
---------+---------+---------+---------+
12.0      14.0      16.0      18.0
Pooled StDev = 6.884
```

Appendix VIII: Students' attitude towards mathematics in pre-test examination in control and experimental group

		Pre-test Control										Pre-test Experimental									
		SA		**A**		**N**		**D**		**SD**		**SA**		**A**		**N**		**D**		**SD**	
		F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Q1	Mean	11	7	12	13	3	3	0	2	0	1	10	20	12	16	2	2	0	1	0	1
	StDev	7	4	5	13	3	4	*	*	0	0	3	4	8	2	2	2	0	1	0	1
	Sum	22	14	23	25	6	5	0	2	0	2	20	39	23	31	3	3	0	2	0	1
Q2	Mean	5	5	10	4	7	4	3	6	2	6	1	8	5	7	7	5	5	8	6	11
	StDev	1	4	6	4	5	6	1	6	3	4	1	3	1	0	0	1	4	1	1	1
	Sum	10	10	19	7	13	8	5	12	4	11	2	16	9	14	14	10	9	15	11	21
Q3	Mean	5	4	10	7	5	3	5	6	3	5	2	3	7	7	4	11	7	8	4	10
	StDev	2	4	5	8	5	3	2	6	1	3	1	1	3	1	4	1	3	6	1	2
	Sum	9	7	19	13	9	6	9	12	5	10	3	6	14	13	7	22	14	16	8	19
Q4	Mean	8	6	10	6	4	8	6	6	1	2	6	12	8	18	6	5	4	3	1	2
	StDev	6	4	8	6	1	6	*	*	1	3	1	5	1	4	1	1	2	2	0	1
	Sum	16	11	19	12	8	15	6	6	2	4	11	23	15	35	11	9	7	5	2	4
Q5	Mean	2	6	9	7	5	4	6	4	5	7	2	4	8	8	4	9	4	6	7	11
	StDev	*	*	7	8	1	2	1	3	4	5	1	1	6	3	1	3	1	0	1	0
	Sum	2	6	18	14	10	7	11	8	10	13	3	8	15	16	7	18	7	12	14	22
Q6	Mean	3	2	5	4	2	4	7	5	10	9	1	2	2	4	2	6	6	11	13	17
	StDev	1	3	6	6	2	4	4	4	2	8	0	2	3	1	3	1	4	3	1	1
	Sum	5	4	10	8	3	8	14	9	19	17	2	3	4	7	4	11	11	22	25	33
Q7	Mean	6	7	7	9	6	5	5	2	2	2	6	12	7	14	7	8	4	3	1	2
	StDev	4	4	4	6	1	6	4	3	1	3	0	8	2	1	1	4	1	3	1	1
	Sum	11	14	14	17	12	9	10	4	4	4	12	23	13	27	13	16	7	6	1	4
Q8	Mean	7	7	10	8	4	6	4	2	1	2	5	11	12	13	4	9	3	5	1	2
	StDev	8	3	6	10	0	6	3	1	1	2	2	1	3	2	1	4	2	4	1	1
	Sum	13	14	20	16	8	11	8	4	1	3	9	22	24	25	7	17	5	9	1	3
Q9	Mean	14	8	10	10	2	4	1	2	0	2	10	18	9	15	3	4	1	1	1	1
	StDev	6	6	5	10	3	4	*	*	*	*	4	7	2	1	3	3	1	0	0	1
	Sum	27	16	19	20	4	8	1	2	0	2	20	36	17	29	6	8	1	2	2	1
Q10	Mean	7	7	12	8	2	4	4	4	2	2	3	15	14	17	4	6	1	1	2	0
	StDev	1	4	7	7	2	4	4	6	1	2	2	8	0	1	1	2	0	1	0	0
	Sum	14	14	24	16	3	7	7	8	3	3	5	30	28	33	7	11	2	2	4	0
Q11	Mean	4	6	8	10	8	5	3	4	2	1	2	7	10	14	8	11	4	4	0	3
	StDev	3	4	6	8	6	6	1	4	0	1	0	3	6	6	1	8	2	1	0	3
	Sum	8	11	15	19	16	9	6	8	4	1	4	14	20	27	15	22	7	7	0	6
Q12	Mean	1	3	6	7	6	6	10	7	4	2	2	2	3	11	5	14	13	8	1	5
	StDev	0	1	6	4	6	8	2	8	1	2	0	1	0	1	2	2	1	1	0	4
	Sum	2	5	11	14	12	12	19	13	7	3	4	4	6	21	9	27	25	15	2	9
Q13	Mean	5	2	7	7	5	5	6	5	4	6	2	4	6	10	5	8	7	8	4	10
	StDev	2	3	4	5	4	5	2	7	3	3	3	1	2	2	1	2	4	1	1	1
	Sum	9	4	14	13	9	9	11	10	8	12	4	8	11	19	10	15	14	15	7	19

Q14	Mean	2	2	4	3	2	3	9	6	9	11	1	1	3	4	3	4	6	13	11	17
	StDev	0	2	2	4	1	1	6	8	6	7	1	1	1	0	4	2	3	1	5	7
	Sum	4	3	7	6	4	6	18	11	18	22	2	1	5	8	6	7	12	26	21	34
Q15	Mean	1	3	4	4	4	4	7	4	11	11	1	3	4	6	4	5	5	7	10	19
	StDev	0	2	1	5	2	5	4	3	8	8	0	2	2	2	0	2	0	2	5	4
	Sum	2	5	8	7	7	7	13	8	21	21	2	5	7	11	8	9	10	13	19	38
Q16	Mean	7	7	6	6	6	6	6	4	2	2	7	11	7	15	6	7	3	5	1	1
	StDev	6	2	1	6	6	8	1	5	1	3	2	8	6	4	6	5	1	4	1	1
	Sum	13	13	12	12	12	11	11	7	3	4	13	22	14	30	12	13	6	9	1	2
Q17	Mean	5	3	6	5	2	5	7	4	7	11	1	4	4	3	5	5	5	7	8	20
	StDev	1	2	3	6	*	*	6	6	6	5	1	4	1	2	1	3	3	1	1	2
	Sum	9	5	12	9	2	5	14	8	14	21	2	8	7	5	10	10	10	14	15	39
Q18	Mean	4	5	14	13	5	7	4	2	1	2	4	12	12	14	5	8	2	4	1	2
	StDev	1	1	10	15	*	*	0	0	0	2	3	8	4	1	3	6	0	3	1	1
	Sum	8	9	28	25	5	7	8	4	2	3	8	23	23	27	10	15	4	8	1	3
Q19	Mean	7	5	10	10	5	6	4	2	1	2	6	10	11	17	5	7	1	3	1	2
	StDev	4	1	7	11	4	5	1	3	0	3	4	7	1	1	3	5	1	3	0	0
	Sum	13	9	20	20	9	11	7	4	2	4	11	20	22	33	10	13	1	6	2	4
Q20	Mean	7	4	9	11	6	4	4	8	2	2	5	11	7	12	6	8	4	4	2	4
	StDev	4	2	5	10	4	4	*	*	0	2	4	8	2	4	6	1	1	3	1	1
	Sum	14	7	17	22	11	7	4	8	4	3	10	21	13	24	12	16	7	8	4	7
Q21	Mean	5	5	13	8	3	4	2	5	2	4	4	8	7	10	4	9	5	5	4	7
	StDev	4	2	7	7	1	5	1	5	0	4	4	3	1	4	1	5	1	1	1	1
	Sum	9	9	26	16	6	7	3	9	4	7	8	16	14	19	7	17	9	10	8	14
Q22	Mean	4	4	6	6	3	5	8	5	7	5	2	5	8	7	4	7	4	11	6	10
	StDev	1	4	4	6	2	5	6	4	2	4	2	4	2	1	1	4	1	2	3	1
	Sum	7	7	11	12	5	9	15	10	13	10	3	9	15	13	8	13	8	21	12	20
Q23	Mean	13	13	9	10	2	1	2	2	1	0	15	20	4	13	3	3	2	1	0	2
	StDev	7	9	5	12	1	1	*	*	0	0	4	1	1	4	1	1	1	1	0	1
	Sum	26	25	17	19	4	1	2	2	2	0	30	39	7	26	6	6	3	1	0	4
Q24	Mean	4	2	7	11	4	4	6	4	7	5	3	5	6	7	4	5	7	10	4	12
	StDev	4	2	4	11	2	4	4	2	2	4	2	3	0	1	1	1	1	1	3	2
	Sum	7	3	13	21	7	7	11	7	13	10	5	10	12	14	8	10	13	19	8	23
Q25	Mean	14	8	9	11	2	8	2	1	2	0	4	6	8	17	2	3	0	1	9	12
	StDev	9	7	4	10	*	*	1	1	*	*	6	8	0	1	3	1	0	1	11	16
	Sum	27	16	17	22	2	8	3	1	2	0	8	12	16	34	4	6	0	1	18	23
Q26	Mean	15	16	7	8	1	1	1	0	4	1	17	25	5	10	2	2	0	1	0	1
	StDev	8	13	3	9	1	1	*	*	*	*	4	1	1	0	1	2	0	1	0	1
	Sum	30	31	14	15	1	1	1	0	4	1	33	50	9	20	3	3	0	1	0	1
Q27	Mean	5	3	7	7	5	8	5	3	5	4	5	5	5	7	8	12	4	10	2	6
	StDev	2	1	4	7	4	7	4	2	1	5	1	4	4	5	4	5	0	6	1	2
	Sum	9	6	14	14	10	16	9	5	9	7	10	9	9	13	15	23	8	20	4	11
Q28	Mean	4	2	5	4	2	4	8	6	7	8	1	4	3	5	3	6	8	6	9	19
	StDev	4	1	4	5	3	3	5	7	1	7	1	4	2	2	0	5	1	3	4	12
	Sum	8	4	10	7	4	8	15	12	14	16	1	7	5	9	6	11	16	12	18	37

Appendix IX: Students' attitude towards math in posttest control and experimental groups examination

		Posttest Control										Posttest experimental									
		SA		**A**		**N**		**D**		**SD**		**SA**		**A**		**N**		**D**		**SD**	
		F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Q1	Mean	3	3	6	8	6	4	4	9	5	9	4	5	3	5	2	6	4	6	8	12
	StDev	1	1	5	8	4	1	5	11	7	6	0	0	1	4	0	0	2	4	2	3
	Sum	5	5	11	15	12	7	7	17	10	17	8	10	6	10	4	12	7	12	15	24
Q2	Mean	4	7	9	10	8	9	2	4	0	1	6	11	6	11	5	8	4	3	0	2
	StDev	3	6	8	8	8	8	2	4	*	*	5	9	3	6	3	4	1	3	0	3
	Sum	8	14	18	20	16	17	3	8	0	1	11	21	12	22	10	15	7	6	0	4
Q3	Mean	2	3	8	9	6	7	5	8	2	5	1	2	5	5	5	6	6	10	4	12
	StDev	2	1	8	9	4	6	4	7	2	4	0	2	1	0	0	1	5	2	2	6
	Sum	3	5	16	17	11	14	10	16	3	9	2	3	10	10	10	12	11	19	7	24
Q4	Mean	4	9	13	11	5	7	2	3	0	3	3	9	9	13	5	6	3	5	1	2
	StDev	1	6	16	11	4	6	2	1	*	*	1	6	6	8	3	4	2	2	1	1
	Sum	7	17	26	21	9	13	3	6	0	3	6	17	18	26	10	12	5	9	1	4
Q5	Mean	5	13	15	12	2	4	0	4	2	2	11	19	6	10	3	14	0	1	0	1
	StDev	4	11	13	9	3	2	*	*	*	*	7	11	0	1	1	12	0	1	0	1
	Sum	10	25	29	23	4	7	0	4	2	2	22	38	12	20	6	27	0	2	0	1
Q6	Mean	2	1	2	6	4	6	7	9	9	9	2	4	2	6	2	3	7	6	8	16
	StDev	3	0	1	6	5	6	5	8	8	8	1	3	1	4	1	0	1	2	4	7
	Sum	4	2	3	11	7	12	13	17	18	17	3	8	4	11	4	6	13	11	16	32
Q7	Mean	3	4	3	7	5	5	8	7	5	9	2	5	3	7	3	3	7	8	6	12
	StDev	1	0	4	8	6	2	9	7	1	9	1	1	0	5	2	1	3	2	4	8
	Sum	6	8	6	13	9	9	15	14	9	17	3	10	6	13	5	6	14	15	12	24
Q8	Mean	2	2	5	6	5	3	8	8	4	12	1	4	3	2	2	3	8	8	8	19
	StDev	1	0	4	6	5	1	8	6	5	13	1	1	2	1	1	1	4	4	6	6
	Sum	3	4	10	11	9	6	16	15	7	24	1	7	5	3	4	5	15	16	15	37
Q9	Mean	2	2	7	8	7	10	5	8	3	3	2	4	5	9	6	9	7	9	1	5
	StDev	1	3	7	7	5	6	7	8	2	1	1	3	3	8	1	2	1	2	1	1
	Sum	3	4	14	16	13	19	10	16	5	6	4	8	10	17	11	17	13	17	2	9
Q10	Mean	4	7	14	14	2	5	4	9	1	2	6	10	9	19	4	5	2	0	0	1
	StDev	1	5	18	9	1	5	*	*	1	1	2	8	3	5	1	2	1	0	0	0
	Sum	8	13	27	27	4	9	4	9	2	3	11	20	18	37	8	9	3	0	0	2
Q11	Mean	3	6	10	12	7	6	3	6	1	1	4	8	7	11	5	10	2	4	2	2
	StDev	2	8	8	9	8	6	4	4	1	0	0	4	6	9	0	4	0	2	0	0
	Sum	5	11	19	23	13	12	5	12	2	2	8	16	14	21	10	20	4	7	4	4
Q12	Mean	9	10	11	15	3	7	2	2	0	1	3	8	4	5	3	2	5	7	7	13
	StDev	6	11	13	8	*	*	*	*	0	0	4	6	4	5	2	1	5	8	10	16
	Sum	17	20	22	30	3	7	2	2	0	2	5	15	7	9	5	4	9	14	14	26
Q13	Mean	5	4	3	7	5	9	6	8	5	4	3	7	5	8	4	7	3	4	6	9
	StDev	5	5	4	5	3	6	8	7	3	4	4	3	1	4	3	4	1	1	2	3
	Sum	9	7	5	13	10	17	11	16	10	7	6	14	9	15	8	13	6	8	11	18
Q14	Mean	4	8	10	11	5	6	2	6	1	1	9	12	6	13	3	5	3	3	1	2

	StDev	4	7	10	8	6	6	3	4	*	*	5	6	5	7	3	4	1	1	1	1
	Sum	8	16	20	22	10	11	4	11	1	1	17	23	11	26	6	10	5	5	1	4
Q15	Mean	2	4	2	7	4	6	7	7	9	9	0	3	2	4	3	5	5	10	10	14
	StDev	*	*	1	1	3	6	7	8	10	8	0	1	0	1	4	2	1	1	8	8
	Sum	2	4	3	14	8	11	14	14	18	17	0	5	4	7	6	9	10	19	20	28
Q16	Mean	4	8	6	8	9	9	2	5	2	2	5	12	8	9	5	9	3	3	1	2
	StDev	3	8	6	4	9	11	2	4	3	1	4	11	3	1	4	3	2	2	1	1
	Sum	8	15	12	15	17	17	3	10	4	3	9	24	16	18	9	18	5	5	1	3
Q17	Mean	6	7	8	12	5	5	4	4	1	4	5	10	6	10	3	7	6	4	1	4
	StDev	7	7	6	8	5	6	4	3	*	*	4	6	2	6	1	1	3	0	1	1
	Sum	12	14	16	24	9	10	7	8	1	4	9	19	11	20	6	13	12	8	2	8
Q18	Mean	5	5	5	10	4	3	6	7	3	7	3	3	5	10	1	5	6	7	7	10
	StDev	5	5	5	11	1	1	7	6	4	4	2	1	2	2	1	1	4	1	3	11
	Sum	9	9	9	19	8	5	12	13	6	14	5	6	9	19	1	10	11	14	14	19
Q19	Mean	3	2	3	6	3	6	6	7	8	11	3	1	2	5	2	5	6	10	8	14
	StDev	1	2	4	5	1	5	7	4	8	12	1	1	0	3	1	1	1	7	6	2
	Sum	6	3	6	11	5	11	12	13	16	21	6	1	4	10	3	10	11	20	16	27
Q20	Mean	4	6	9	12	7	7	4	9	1	2	5	8	6	15	6	6	2	5	3	2
	StDev	5	5	7	7	8	7	*	*	1	1	2	4	4	11	1	4	1	1	2	1
	Sum	7	11	18	24	13	14	4	9	1	3	9	16	11	29	12	11	3	9	5	3
Q21	Mean	6	7	10	14	5	4	2	4	1	2	4	9	12	15	3	7	1	2	1	2
	StDev	4	6	11	13	5	2	2	4	1	1	3	6	8	8	4	1	1	1	1	2
	Sum	12	14	20	27	9	7	3	8	1	4	8	18	23	29	6	14	2	4	1	3
Q22	Mean	4	5	4	10	4	4	7	9	6	6	1	3	6	9	4	4	5	11	5	8
	StDev	*	*	3	5	4	6	6	8	7	4	0	2	2	1	1	1	1	9	4	1
	Sum	4	5	8	19	7	8	14	17	12	12	2	5	11	18	8	8	10	21	9	16
Q23	Mean	10	15	9	12	2	1	2	2	1	1	12	14	5	17	3	2	1	2	0	1
	StDev	9	13	11	10	3	0	1	1	1	1	6	11	2	4	3	2	1	1	0	1
	Sum	19	29	18	24	4	2	3	4	1	2	24	28	9	33	6	3	1	3	0	1
Q24	Mean	7	7	8	7	4	5	3	7	2	4	6	5	6	7	2	9	4	9	5	3
	StDev	8	9	6	4	2	6	4	6	2	4	1	4	4	4	1	1	4	1	2	3
	Sum	13	13	15	14	7	10	6	14	3	7	12	10	11	14	3	18	7	18	9	6
Q25	Mean	13	18	7	11	1	1	1	1	2	1	15	21	5	9	1	3	1	1	0	1
	StDev	14	19	5	6	1	0	0	1	2	0	9	6	2	3	1	1	1	1	0	1
	Sum	26	35	13	21	1	2	2	1	3	2	29	42	9	18	1	6	1	1	0	1
Q26	Mean	2	3	5	6	4	7	8	6	5	9	1	3	2	3	3	7	4	8	11	14
	StDev	1	1	2	6	5	8	11	6	3	6	1	1	1	0	1	2	3	6	4	9
	Sum	4	6	9	12	7	13	15	12	10	17	2	6	4	6	5	13	8	16	21	27
Q27	Mean	4	4	4	9	7	9	7	4	2	4	5	6	2	6	7	13	4	6	4	5
	StDev	2	4	4	7	8	11	8	1	1	3	4	1	1	4	0	5	1	1	3	3
	Sum	7	8	8	18	14	18	13	8	3	8	9	11	3	11	14	25	7	11	8	10
Q28	Mean	16	22	6	8	2	3	0	0	0	0	18	27	2	6	1	1	0	0	0	0
	StDev	16	19	5	5	*	*	*	*	*	*	6	8	1	1	1	1	0	0	0	0
	Sum	31	43	11	15	2	3	0	0	0	0	36	54	3	12	1	1	0	0	0	0

Appendix X: Comparison of Pre-test and Post-test attitude examination for the control group

		Pre-test Control										Posttest Control									
		SA		A		N		D		SD		SA		A		N		D		SD	
		F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Q1	Mean	11	7	12	13	3	3	0	2	0	1	5	13	15	12	2	4	0	4	2	2
	StDev	7	4	5	13	3	4	*	*	0	0	4	11	13	9	3	2	*	*	*	*
	Sum	22	14	23	25	6	5	0	2	0	2	10	25	29	23	4	7	0	4	2	2
Q2	Mean	5	5	10	4	7	4	3	6	2	6	3	4	3	7	5	5	8	7	5	9
	StDev	1	4	6	4	5	6	1	6	3	4	1	0	4	8	6	2	9	7	1	9
	Sum	10	10	19	7	13	8	5	12	4	11	6	8	6	13	9	9	15	14	9	17
Q3	Mean	5	4	10	7	5	3	5	6	3	5	2	3	8	9	6	7	5	8	2	5
	StDev	2	4	5	8	5	3	2	6	1	3	2	1	8	9	4	6	4	7	2	4
	Sum	9	7	19	13	9	6	9	12	5	10	3	5	16	17	11	14	10	16	3	9
Q4	Mean	8	6	10	6	4	8	6	6	1	2	4	9	13	11	5	7	2	3	0	3
	StDev	6	4	8	6	1	6	*	*	1	3	1	6	16	11	4	6	2	1	*	*
	Sum	16	11	19	12	8	15	6	6	2	4	7	17	26	21	9	13	3	6	0	3
Q5	Mean	2	6	9	7	5	4	6	4	5	7	3	3	6	8	6	4	4	9	5	9
	StDev	*	*	7	8	1	2	1	3	4	5	1	1	5	8	4	1	5	11	7	6
	Sum	2	6	18	14	10	7	11	8	10	13	5	5	11	15	12	7	7	17	10	17
Q6	Mean	3	2	5	4	2	4	7	5	10	9	2	1	2	6	4	6	7	9	9	9
	StDev	1	3	6	6	2	4	4	4	2	8	3	0	1	6	5	6	5	8	8	8
	Sum	5	4	10	8	3	8	14	9	19	17	4	2	3	11	7	12	13	17	18	17
Q7	Mean	6	7	7	9	6	5	5	2	2	2	4	7	9	10	8	9	2	4	0	1
	StDev	4	4	4	6	1	6	4	3	1	3	3	6	8	8	8	8	2	4	*	*
	Sum	11	14	14	17	12	9	10	4	4	4	8	14	18	20	16	17	3	8	0	1
Q8	Mean	7	7	10	8	4	6	4	2	1	2	6	7	8	12	5	5	4	4	1	4
	StDev	8	3	6	10	0	6	3	1	1	2	7	7	6	8	5	6	4	3	*	*
	Sum	13	14	20	16	8	11	8	4	1	3	12	14	16	24	9	10	7	8	1	4
Q9	Mean	14	8	10	10	2	4	1	2	0	2	9	10	11	15	3	7	2	2	0	1
	StDev	6	6	5	10	3	4	*	*	*	*	6	11	13	8	*	*	*	*	0	0
	Sum	27	16	19	20	4	8	1	2	0	2	17	20	22	30	3	7	2	2	0	2
Q10	Mean	7	7	12	8	2	4	4	4	2	2	4	7	14	14	2	5	4	9	1	2
	StDev	1	4	7	7	2	4	4	6	1	2	1	5	18	9	1	5	*	*	1	1
	Sum	14	14	24	16	3	7	7	8	3	3	8	13	27	27	4	9	4	9	2	3
Q11	Mean	4	6	8	10	8	5	3	4	2	1	3	6	10	12	7	6	3	6	1	1
	StDev	3	4	6	8	6	6	1	4	0	1	2	8	8	9	8	6	4	4	1	0
	Sum	8	11	15	19	16	9	6	8	4	1	5	11	19	23	13	12	5	12	2	2
Q12	Mean	1	3	6	7	6	6	10	7	4	2	2	2	7	8	7	10	5	8	3	3
	StDev	0	1	6	4	6	8	2	8	1	2	1	3	7	7	5	6	7	8	2	1
	Sum	2	5	11	14	12	12	19	13	7	3	3	4	14	16	13	19	10	16	5	6
Q13	Mean	5	2	7	7	5	5	6	5	4	6	5	4	3	7	5	9	6	8	5	4
	StDev	2	3	4	5	4	5	2	7	3	3	5	5	4	5	3	6	8	7	3	4
	Sum	9	4	14	13	9	9	11	10	8	12	9	7	5	13	10	17	11	16	10	7
Q14	Mean	2	2	4	3	2	3	9	6	9	11	3	2	3	6	3	6	6	7	8	11
	StDev	0	2	2	4	1	1	6	8	6	7	1	2	4	5	1	5	7	4	8	12
	Sum	4	3	7	6	4	6	18	11	18	22	6	3	6	11	5	11	12	13	16	21
Q15	Mean	1	3	4	4	4	4	7	4	11	11	2	4	2	7	4	6	7	7	9	9
	StDev	0	2	1	5	2	5	4	3	8	8	*	*	1	1	3	6	7	8	10	8
	Sum	2	5	8	7	7	7	13	8	21	21	2	4	3	14	8	11	14	14	18	17

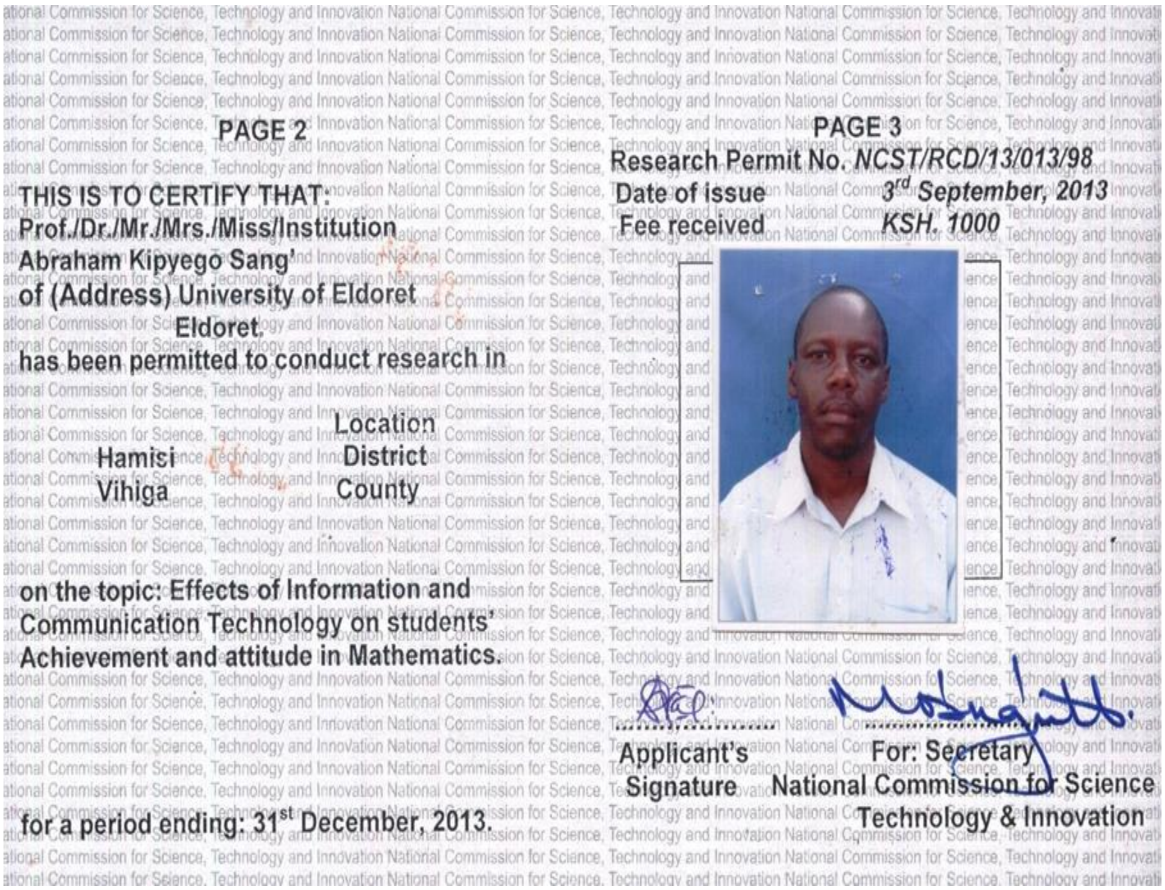
Q16	Mean	7	7	6	6	6	6	6	4	2	2	4	8	6	8	9	9	2	5	2	2
	StDev	6	2	1	6	6	8	1	5	1	3	3	8	6	4	9	11	2	4	3	1
	Sum	13	13	12	12	12	11	11	7	3	4	8	15	12	15	17	17	3	10	4	3
Q17	Mean	5	3	6	5	2	5	7	4	7	11	2	2	5	6	5	3	8	8	4	12
	StDev	1	2	3	6	*	*	6	6	6	5	1	0	4	6	5	1	8	6	5	13
	Sum	9	5	12	9	2	5	14	8	14	21	3	4	10	11	9	6	16	15	7	24
Q18	Mean	4	5	14	13	5	7	4	2	1	2	6	7	10	14	5	4	2	4	1	2
	StDev	1	1	10	15	*	*	0	0	0	2	4	6	11	13	5	2	2	4	1	1
	Sum	8	9	28	25	5	7	8	4	2	3	12	14	20	27	9	7	3	8	1	4
Q19	Mean	7	5	10	10	5	6	4	2	1	2	4	8	10	11	5	6	2	6	1	1
	StDev	4	1	7	11	4	5	1	3	0	3	4	7	10	8	6	6	3	4	*	*
	Sum	13	9	20	20	9	11	7	4	2	4	8	16	20	22	10	11	4	11	1	1
Q20	Mean	7	4	9	11	6	4	4	8	2	2	4	6	9	12	7	7	4	9	1	2
	StDev	4	2	5	10	4	4	*	*	0	2	5	5	7	7	8	7	*	*	1	1
	Sum	14	7	17	22	11	7	4	8	4	3	7	11	18	24	13	14	4	9	1	3
Q21	Mean	5	5	13	8	3	4	2	5	2	4	16	22	6	8	2	3	0	0	0	0
	StDev	4	2	7	7	1	5	1	5	0	4	16	19	5	5	*	*	*	*	*	*
	Sum	9	9	26	16	6	7	3	9	4	7	31	43	11	15	2	3	0	0	0	0
Q22	Mean	4	4	6	6	3	5	8	5	7	5	4	5	4	10	4	4	7	9	6	6
	StDev	1	4	4	6	2	5	6	4	2	4	*	*	3	5	4	6	6	8	7	4
	Sum	7	7	11	12	5	9	15	10	13	10	4	5	8	19	7	8	14	17	12	12
Q23	Mean	13	13	9	10	2	1	2	2	1	0	13	18	7	11	1	1	1	1	2	1
	StDev	7	9	5	12	1	1	*	*	0	0	14	19	5	6	1	0	0	1	2	0
	Sum	26	25	17	19	4	1	2	2	2	0	26	35	13	21	1	2	2	1	3	2
Q24	Mean	4	2	7	11	4	4	6	4	7	5	5	5	5	10	4	3	6	7	3	7
	StDev	4	2	4	11	2	4	4	2	2	4	5	5	5	11	1	1	7	6	4	4
	Sum	7	3	13	21	7	7	11	7	13	10	9	9	9	19	8	5	12	13	6	14
Q25	Mean	14	8	9	11	2	8	2	1	2	0	10	15	9	12	2	1	2	2	1	1
	StDev	9	7	4	10	*	*	1	1	*	*	9	13	11	10	3	0	1	1	1	1
	Sum	27	16	17	22	2	8	3	1	2	0	19	29	18	24	4	2	3	4	1	2
Q26	Mean	15	16	7	8	1	1	1	0	4	1	7	7	8	7	4	5	3	7	2	4
	StDev	8	13	3	9	1	1	*	*	*	*	8	9	6	4	2	6	4	6	2	4
	Sum	30	31	14	15	1	1	1	0	4	1	13	13	15	14	7	10	6	14	3	7
Q27	Mean	5	3	7	7	5	8	5	3	5	4	4	4	4	9	7	9	7	4	2	4
	StDev	2	1	4	7	4	7	4	2	1	5	2	4	4	7	8	11	8	1	1	3
	Sum	9	6	14	14	10	16	9	5	9	7	7	8	8	18	14	18	13	8	3	8
Q28	Mean	4	2	5	4	2	4	8	6	7	8	2	3	5	6	4	7	8	6	5	9
	StDev	4	1	4	5	3	3	5	7	1	7	1	1	2	6	5	8	11	6	3	6
	Sum	8	4	10	7	4	8	15	12	14	16	4	6	9	12	7	13	15	12	10	17

Appendix XI: Comparison of Pre-test and Posttest attitude examination for the experimental group

		Pre-test Experimental										Posttest Experimental									
		SA		A		N		D		SD		SA		A		N		D		SD	
		F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Q1	Mean	10	20	12	16	2	2	0	1	0	1	11	19	6	10	3	14	0	1	0	1
	StDev	3	4	8	2	2	2	0	1	0	1	7	11	0	1	1	12	0	1	0	1
	Sum	20	39	23	31	3	3	0	2	0	1	22	38	12	20	6	27	0	2	0	1
Q2	Mean	1	8	5	7	7	5	5	8	6	11	2	5	3	7	3	3	7	8	6	12
	StDev	1	3	1	0	0	1	4	1	1	1	1	1	0	5	2	1	3	2	4	8
	Sum	2	16	9	14	14	10	9	15	11	21	3	10	6	13	5	6	14	15	12	24
Q3	Mean	2	3	7	7	4	11	7	8	4	10	1	2	5	5	5	6	6	10	4	12
	StDev	1	1	3	1	4	1	3	6	1	2	0	2	1	0	0	1	5	2	2	6
	Sum	3	6	14	13	7	22	14	16	8	19	2	3	10	10	10	12	11	19	7	24
Q4	Mean	6	12	8	18	6	5	4	3	1	2	3	9	9	13	5	6	3	5	1	2
	StDev	1	5	1	4	1	1	2	2	0	1	1	6	6	8	3	4	2	2	1	1
	Sum	11	23	15	35	11	9	7	5	2	4	6	17	18	26	10	12	5	9	1	4
Q5	Mean	2	4	8	8	4	9	4	6	7	11	4	5	3	5	2	6	4	6	8	12
	StDev	1	1	6	3	1	3	1	0	1	0	0	0	1	4	0	0	2	4	2	3
	Sum	3	8	15	16	7	18	7	12	14	22	8	10	6	10	4	12	7	12	15	24
Q6	Mean	1	2	2	4	2	6	6	11	13	17	2	4	2	6	2	3	7	6	8	16
	StDev	0	2	3	1	3	1	4	3	1	1	1	3	1	4	1	0	1	2	4	7
	Sum	2	3	4	7	4	11	11	22	25	33	3	8	4	11	4	6	13	11	16	32
Q7	Mean	6	12	7	14	7	8	4	3	1	2	6	11	6	11	5	8	4	3	0	2
	StDev	0	8	2	1	1	4	1	3	1	1	5	9	3	6	3	4	1	3	0	3
	Sum	12	23	13	27	13	16	7	6	1	4	11	21	12	22	10	15	7	6	0	4
Q8	Mean	5	11	12	13	4	9	3	5	1	2	5	10	6	10	3	7	6	4	1	4
	StDev	2	1	3	2	1	4	2	4	1	1	4	6	2	6	1	1	3	0	1	1
	Sum	9	22	24	25	7	17	5	9	1	3	9	19	11	20	6	13	12	8	2	8
Q9	Mean	10	18	9	15	3	4	1	1	1	1	3	8	4	5	3	2	5	7	7	13
	StDev	4	7	2	1	3	3	1	0	0	1	4	6	4	5	2	1	5	8	10	16
	Sum	20	36	17	29	6	8	1	2	2	1	5	15	7	9	5	4	9	14	14	26
Q10	Mean	3	15	14	17	4	6	1	1	2	0	6	10	9	19	4	5	2	0	0	1
	StDev	2	8	0	1	1	2	0	1	0	0	2	8	3	5	1	2	1	0	0	0
	Sum	5	30	28	33	7	11	2	2	4	0	11	20	18	37	8	9	3	0	0	2
Q11	Mean	2	7	10	14	8	11	4	4	0	3	4	8	7	11	5	10	2	4	2	2
	StDev	0	3	6	6	1	8	2	1	0	3	0	4	6	9	0	4	0	2	0	0
	Sum	4	14	20	27	15	22	7	7	0	6	8	16	14	21	10	20	4	7	4	4
Q12	Mean	2	2	3	11	5	14	13	8	1	5	2	4	5	9	6	9	7	9	1	5
	StDev	0	1	0	1	2	2	1	1	0	4	1	3	3	8	1	2	1	2	1	1
	Sum	4	4	6	21	9	27	25	15	2	9	4	8	10	17	11	17	13	17	2	9
Q13	Mean	2	4	6	10	5	8	7	8	4	10	3	7	5	8	4	7	3	4	6	9
	StDev	3	1	2	2	1	2	4	1	1	1	4	3	1	4	3	4	1	1	2	3
	Sum	4	8	11	19	10	15	14	15	7	19	6	14	9	15	8	13	6	8	11	18
Q14	Mean	1	1	3	4	3	4	6	13	11	17	3	1	2	5	2	5	6	10	8	14
	StDev	1	1	1	0	4	2	3	1	5	7	1	1	0	3	1	1	1	7	6	2
	Sum	2	1	5	8	6	7	12	26	21	34	6	1	4	10	3	10	11	20	16	27

Q15	Mean	1	3	4	6	4	5	5	7	10	19	0	3	2	4	3	5	5	10	10	14
	StDev	0	2	2	2	0	2	0	2	5	4	0	1	0	1	4	2	1	1	8	8
	Sum	2	5	7	11	8	9	10	13	19	38	0	5	4	7	6	9	10	19	20	28
Q16	Mean	7	11	7	15	6	7	3	5	1	1	5	12	8	9	5	9	3	3	1	2
	StDev	2	8	6	4	6	5	1	4	1	1	4	11	3	1	4	3	2	2	1	1
	Sum	13	22	14	30	12	13	6	9	1	2	9	24	16	18	9	18	5	5	1	3
Q17	Mean	1	4	4	3	5	5	5	7	8	20	1	4	3	2	2	3	8	8	8	19
	StDev	1	4	1	2	1	3	3	1	1	2	1	1	2	1	1	1	4	4	6	6
	Sum	2	8	7	5	10	10	10	14	15	39	1	7	5	3	4	5	15	16	15	37
Q18	Mean	4	12	12	14	5	8	2	4	1	2	4	9	12	15	3	7	1	2	1	2
	StDev	3	8	4	1	3	6	0	3	1	1	3	6	8	8	4	1	1	1	1	2
	Sum	8	23	23	27	10	15	4	8	1	3	8	18	23	29	6	14	2	4	1	3
Q19	Mean	6	10	11	17	5	7	1	3	1	2	9	12	6	13	3	5	3	3	1	2
	StDev	4	7	1	1	3	5	1	3	0	0	5	6	5	7	3	4	1	1	1	1
	Sum	11	20	22	33	10	13	1	6	2	4	17	23	11	26	6	10	5	5	1	4
Q20	Mean	5	11	7	12	6	8	4	4	2	4	5	8	6	15	6	6	2	5	3	2
	StDev	4	8	2	4	6	1	1	3	1	1	2	4	4	11	1	4	1	1	2	1
	Sum	10	21	13	24	12	16	7	8	4	7	9	16	11	29	12	11	3	9	5	3
Q21	Mean	4	8	7	10	4	9	5	5	4	7	18	27	2	6	1	1	0	0	0	0
	StDev	4	3	1	4	1	5	1	1	1	1	6	8	1	1	1	1	0	0	0	0
	Sum	8	16	14	19	7	17	9	10	8	14	36	54	3	12	1	1	0	0	0	0
Q22	Mean	2	5	8	7	4	7	4	11	6	10	1	3	6	9	4	4	5	11	5	8
	StDev	2	4	2	1	1	4	1	2	3	1	0	2	2	1	1	1	1	9	4	1
	Sum	3	9	15	13	8	13	8	21	12	20	2	5	11	18	8	8	10	21	9	16
Q23	Mean	15	20	4	13	3	3	2	1	0	2	15	21	5	9	1	3	1	1	0	1
	StDev	4	1	1	4	1	1	1	1	0	1	9	6	2	3	1	1	1	1	0	1
	Sum	30	39	7	26	6	6	3	1	0	4	29	42	9	18	1	6	1	1	0	1
Q24	Mean	3	5	6	7	4	5	7	10	4	12	3	3	5	10	1	5	6	7	7	10
	StDev	2	3	0	1	1	1	1	1	3	2	2	1	2	2	1	1	4	1	3	11
	Sum	5	10	12	14	8	10	13	19	8	23	5	6	9	19	1	10	11	14	14	19
Q25	Mean	4	6	8	17	2	3	0	1	9	12	12	14	5	17	3	2	1	2	0	1
	StDev	6	8	0	1	3	1	0	1	11	16	6	11	2	4	3	2	1	1	0	1
	Sum	8	12	16	34	4	6	0	1	18	23	24	28	9	33	6	3	1	3	0	1
Q26	Mean	17	25	5	10	2	2	0	1	0	1	6	5	6	7	2	9	4	9	5	3
	StDev	4	1	1	0	1	2	0	1	0	1	1	4	4	4	1	1	4	1	2	3
	Sum	33	50	9	20	3	3	0	1	0	1	12	10	11	14	3	18	7	18	9	6
Q27	Mean	5	5	5	7	8	12	4	10	2	6	5	6	2	6	7	13	4	6	4	5
	StDev	1	4	4	5	4	5	0	6	1	2	4	1	1	4	0	5	1	1	3	3
	Sum	10	9	9	13	15	23	8	20	4	11	9	11	3	11	14	25	7	11	8	10
Q28	Mean	1	4	3	5	3	6	8	6	9	19	1	3	2	3	3	7	4	8	11	14
	StDev	1	4	2	2	0	5	1	3	4	12	1	1	1	0	1	2	3	6	4	9
	Sum	1	7	5	9	6	11	16	12	18	37	2	6	4	6	5	13	8	16	21	27

Appendix XII: Research Permit



PAGE 2

THIS IS TO CERTIFY THAT:
Prof./Dr./Mr./Mrs./Miss/Institution
Abraham Kipyego Sang'
of (Address) University of Eldoret
Eldoret.
has been permitted to conduct research in

Location
Hamisi District
Vihiga County

on the topic: Effects of Information and Communication Technology on students' Achievement and attitude in Mathematics.

for a period ending: 31st December, 2013.

PAGE 3

Research Permit No. *NCST/RCD/13/013/98*
Date of issue *3rd September, 2013*
Fee received *KSH. 1000*

Applicant's Signature

For: Secretary
National Commission for Science Technology & Innovation

Appendix XIII: Letter of research authorization from the National Council of Science and Technology

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telephone: 254-020-2213471, 2241349, 254-020-2673550
Mobile: 0713 788 787 , 0735 404 245
Fax: 254-020-2213215
When replying please quote
secretary@ncst.go.ke

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref: **NCST/RCD/13/013/98**

Date: **3rd September, 2013**

Abraham Kipyego Sang'
University of Eldoret
Eldoret.

RE: RESEARCH AUTHORIZATION

Following your application dated ***15th August, 2013*** for authority to carry out research on "***Effects of Information and Communication Technology on students' achievement and attitude in Mathematics,***" I am pleased to inform you that you have been authorized to undertake research in **Vihiga County** for a period ending **31st December, 2013.**

You are advised to report to **the County Commissioner and the County Director of Education, Vihiga County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. M. K. RUGUTT, ~~PhD~~, HSC.
DEPUTY COMMISSION SECRETARY
NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Copy to:

The County Commissioner
The County Director of Education
Vihiga County.

"The National Council for Science and Technology is Committed to the Promotion of Science and Technology for National Development".

Appendix XIV: Letter of Research Authorization from the County Director of Education

MINISTRY OF EDUCATION, SCIENCE & TECHNOLOGY
STATE DEPARTMENT OF EDUCATION

Telegrams: ………………
Telephone: (056) 51450
Email:vieducounty@gmail.com
When replying please quote

COUNTY EDUCATION OFFICE,
VIHIGA COUNTY,
P.O. BOX 645,
MARAGOLI.

Our ref MOE/VC/ADM/ 1/1

16th September, 2013

All Headteachers
Titiki East Division
Hamisi District

REF: **RESEARCH AUTORIZATION**
ABRAHAM KIPYEGO SANG'

The above named is a student of University of Eldoret and is hereby authorized to carryout research in Tiriki, East Division, Hamisi District in Vihiga County.

Kindly give him the necessary assistance and co operation to enable him collect data for his thesis.

Pamela Akello (Mrs)
County Director of Education
VIHIGA COUNTY

THE COUNTY DIRECTOR OF EDUCATION
17 SEP 2013
VIHIGA COUNTY

c.c.
District Education officer
HAMISI.

The County Commissioner
VIHIGA COUNTY

Appendix XV: Letter of Research Authorization from the County Commissioner

MINISTRY OF EDUCATION, SCIENCE & TECHNOLOGY
STATE DEPARTMENT OF EDUCATION

Telegrams: ………………
Telephone: (056) 51450
Email:vieducounty@gmail.com
When replying please quote

COUNTY EDUCATION OFFICE,
VIHIGA COUNTY,
P.O. BOX 645,
MARAGOLI.

Our ref MOE/VC/ADM/ 1/1

16th September, 2013

All Headteachers
Titiki East Division
Hamisi District

REF: **RESEARCH AUTORIZATION**
ABRAHAM KIPYEGO SANG'

The above named is a student of University of Eldoret and is hereby authorized to carryout research in Tiriki, East Division, Hamisi District in Vihiga County.

Kindly give him the necessary assistance and co operation to enable him collect data for his thesis.

THE COUNTY DIRECTOR OF EDUCATION
17 SEP 2013
VIHIGA COUNTY

Pamela Akello (Mrs)
County Director of Education
VIHIGA COUNTY

c.c.
District Education officer
HAMISI.

The County Commissioner
VIHIGA COUNTY

Appendix XVI: Letter of Information to the Head Teacher/Principal

University of Eldoret.

P.O Box 1125, Eldoret.

26/7/2013

Dear Sir/Madam

RE: RESEARCH DATA COLLECTION

I am **Master of Science in Education** student from University of Eldoret, and will be collecting data on**: Effects of Information and Communication Technology (ICT) on students' achievement and attitude in Mathematics.**

This is an area of great concern to students, teachers, parents and other Education stake holders in the county. Data will be collected through experimental design and questionnaire.

Form four students will be required to write a short test before the start of the research and another after the research. They will also be required to answer questions in the questionnaire candidly and to the best of their knowledge and ability. The information so obtained shall be exclusively confidential and shall only be used for the research purpose of this study.

I wish to kindly notify you of my visit to your school between **September 2013** and **October 2013.** Herein find my research abstract and letter of introduction from the County commissioner and the County Director of Education in Vihiga.

Thank you in advance.

SANG' KIPYEGO ABRAHAM

Appendix XVII: Tiriki East Day Secondary Schools KCSE results analysis (2009 – 2012) mean scores

S/No.	School	2009	2010	2011	2012
1	Friends' School – Muhudu	4.424	4.371	4.613	4.7879
2	Ishiru	3.853	3.823	4.054	3.3450
3	Imusutsu Mixed	4.831	4.739	4.846	4.4922
4	George Khaniri	2.984	3.750	3.631	3.4691
5	Friends' School – Shamakhokho	3.727	3.894	3.693	4.2880
6	Kaptik	5.247	5.619	5.693	5.2700
7	Kaimosi Demonstration	2.982	3.440	3.420	3.7950
8	Makuchi	2.910	3.520	3.215	3.2630
9	St.John'sCheptech	1 st Attempt	3.066	3.050	3.3690
	Overall Mean	3.872	4.025	4.024	5.3000

Source: D.E.O's Examination Office – Hamisi District- Vihiga County

Appendix XVIII: Tiriki East Day Secondary Schools KCSE Mathematics Mean score results analysis (2010 and 2012)

S/No.	School	2010	2011	2012
1	Friends' School -Muhudu	3.067	2.532	3.1212
2	Ishiru	1.765	1.946	1.6290
3	Imusutsu Mixed	2.460	2.720	2.6094
4	George Khaniri	1.875	2.024	1.8900
5	Friends' School - Shamakhokho	2.079	2.016	2.5770
6	Kaptik	2.976	3.444	3.5200
7	Kaimosi Demonstration	1.529	1.696	3.1388
8	Makuchi	2.920	1.646	1.7540
9	St.John'sCheptech	1.533	1.300	2.1250
	Overall Mean	2.245	2.147	2.5960

Source: A.E.O's Office – Tiriki East Division-Hamisi Sub-county