IMPACT OF ICT INTEGRATION ON MATHEMATICS PERFORMANCE IN KENYA: A CASE STUDY OF PUBLIC SECONDARY SCHOOLS IN WEST POKOT COUNTY

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DECLARATION

This research project is my original work and has never been submitted for degree award in any other University.

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This research project has been submitted with my approval as the University of Nairobi supervisor.

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DEDICATION

To my children Victor, Collins, Melvin and my beloved wife Salome

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I sincerely thank The University of Nairobi for giving me the opportunity to study and pursue knowledge in the field of measurement and evaluation. I wish to acknowledge my employer, the Teachers' Service Commission (TSC) for permission to be out of school in pursuit of this study, the County Director of Education of West Pokot for consent to carry out the research study in the County, the principals, teachers of mathematics and students of the various public secondary schools where data was collected.

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LIST OF ACRONYMS

CEMASTEA: Centre of mathematics, science and technology education in Africa.

CAI: Computer Assisted Instruction

CAL: Computer Assisted Learning

CSLR: Computer Support Learning Resource

EFA: Education for All

ESP: Economic stimulus program.

ICT: Information Communication Technology

KCSE: Kenya certificate of secondary education

KESSP: Kenya Education Sector Support Project

KICD: Kenya institute of curriculum development.

KNEC: Kenya national examination council.

MDGs: Millennium Development Goals

MOEST: Ministry of education science and technology.

NEPAD: New partnership for African development.

PDSI-ASEI: Plan-Do-See-Improve; Activity-Student-Experiment-Improvize

SDGs: Sustained Development Goals

SMASSE: Strengthening Mathematics and Sciences for Secondary Education

TPACK: Technological Pedagogical Content Knowledge

UPE: Universal Primary Education

ABSTRACT

This research addressed the issue of influence of ICT integration as a pedagogical tool on performance in mathematics in public secondary schools particularly in West Pokot County. Mathematics performance in Kenya has generally been poor and the reason attributed to this scenario is mainly the teaching methods employed by tutors and/ or the learners' attitude towards the subject. ICT integration and the factors hindering its integration has been investigated by researchers elsewhere but not in west pokot. This study sought to investigate whether ICT integration has an influence on performance in mathematics by looking at the use of computers as a means of instruction (CAI), a means of learning (CAL) and as a learning support resource (CLSR). The study objective was to determine the impact of ICT integration in teaching and learning on mathematics performance in public secondary schools in Kenya. The hypothesis tested in the study was that there is no difference in mathematics performance between students in classes taught by traditional methods and the ICT integrated in public secondary schools in west Pokot County.

This research used purposive experimental research design to investigate the extent to which ICT integration would influence mathematics performance. Five public secondary schools were identified on the basis of availability of computer laboratory, one mixed day school, two girls' and two boys' schools therefore participated. Apart from the mixed day school, the other four were large schools comprising of 5 streams per class with population of over 1000 students. A total of 435 form three students from the 5 schools participated in this study. Two streams were selected randomly out of the 5 in each of the 4 large schools whereas for the single stream, the class was divided in two groups, so that one is taught the mathematical concept with the aid of computers (experimental) and the other is taught the same concept using traditional methods. At the end of the sub-topic which took one double lesson of 80 minutes, the two groups were subjected to a standardized assessment test whose pass mark was 47.5%, that is, 19 out of 40. All scripts were marked by the researcher using the same marking scheme. Results were analyzed, a two sample paired t-test was used to measure differences in performance at a significance tests difference of $\alpha=0.05$.

The key findings were that the experimental group performed better than the control group in all the 5 schools. These results indicated significance differences due to flexibility and focused interest in classes where ICT was integrated. From the research, it was concluded that ICT integration in mathematics teaching brings about better understanding of concepts and skill transfer from abstract to concrete. Integration of ICT in teaching and learning mathematics especially so for abstract concepts such as waves, helped to overcome such limitations, hence impacted positively on the performance in the test scores. The study recommended technology skills to be integrated into the total curriculum during the entire education processes through

holistic approach and that ICT should be exploited to support the complete mathematics content and learning experience. Teachers of mathematics need frequent in-service courses on the new innovations in-terms of instructional skills and approaches. It was recommended that MOEST to fast track their strategies in-terms of mobilizing of resources and digitalization of curriculum and content.

CHAPTER ONE

1.0 I N T R O D U C T I O N

1.1 Background of the study

Vision 2030, an economic blueprint in Kenya, is anchored on knowledge based economy with ICT, which in this study refers to the Computer, as the main driver in all the sectors including education. A number of initiatives have been taken in education to realize the vision which include; teacher inset programs like SMASSE, NEPAD model schools project and the laptop project in primary schools. It is believed that ICTs are potentially powerful and enabling tools to bring about the much needed educational change and reform in Kenya as it makes learning more interesting thereby reducing the dropout rate which is prevalent in developing countries.

It is believed that the use of digital technologies in pedagogy and information sourcing gives learners the advantage in academic performance and in the job market (Delen and Bulut 2011), and probably for this reason, there is a driving demand for ICT by students out of career perception and peer pressure. The world has become a 'global village', the advance in technology has led to rapid generation of information which has drastically reduced the shelf life of information, as new knowledge is created, old is shelved. Teachers should, therefore endeavor to help learners to be part of this global village. Employers want to hire skilled personnel who can use contemporary technologies and are ready to continue learning, creating and innovating. Is the teaching and learning in the classroom responding to this dynamism in society? Are learners equipped with the skills that are necessary in the technology-infused workplace? The answer is 'No! Therefore, the need to embrace change to reflect the changing social, political and economic landscape. The classroom in this case becomes the first port of call to realize this dynamism. The appropriate infusion of technology in teaching and learning is critical for this change. ICTs are a range of technological tools and resources that are used to communicate, create, disseminate, store and manage information (MOE 2010).

Mathematics plays a key role in the academic world and in any educational system in assisting students think and reason precisely, logically and critically in given situations that may be familiar and unfamiliar (KIE, 2002). The need to integrate ICT in mathematics is prompted by the general low performance in the subject (KNEC, 1996; Kanja et al, 2001; Odhiambo, 2006; Yara and Otieno, 2010; Mbugua et al, 2012 and Githua, 2013). Poor mathematics results posted in KCSE examinations is of serious concern to parents, teachers and all stakeholders. Northern Frontier Districts in Kenya have always been disadvantaged in terms of access and quality. Various attempts have been made to address quality concerns through SMASSE via ASEI-PDSI approach in public secondary schools since 2004 but more is needed to be done. The integration of ICT in mathematics teaching is expected to promote understanding of abstract concepts like algebra, geometry, linear programming, Trigonometry and waves. The use of graphic calculators and computerized graphing in mathematics speeds up the graphing process, freeing people to analyze and reflect on the relationships between data (Hannessy, 2000; Clements, 2000).

It is on this background that this research attempted to determine the impact of ICT in the teaching and learning of mathematics in Kenyan public secondary schools on academic performance. Merely integrating technology into the curriculum will not improve students' performance on its own, but thoughtful and appropriate selection of how and where technology should be integrated is essential (Charp, 2000). A good teacher is more important than technology in the classroom thus, teachers must master their subject both theoretically and practically. In teaching therefore one needs to have content knowledge, how to structure and present it. Digital technology allows for the creation of new tasks previously inconceivable as well as allowing for significant task redesign. Gakuu and Kidombo (2010) points out that there is a difference between having computers in school and using them to teach. The aim of this study was to look at the influence of ICT integration on mathematics performance in West Pokot County.

1.2 Statement of the Problem

The purpose of this research was to address the problem of general poor performance in mathematics in the national examinations in the public secondary schools in Kenya by considering the possible role of ICT integration through a case study in West Pokot County. The quality of education offered in any country can be seen through increase in literacy, cognitive abilities and better student performance in examinations (Deolalika, 1999). In this study, the focus was on performance based on the use of ICT and non-ICT within the limits of experimentally designed activities in 5 public secondary schools equipped with computer laboratories that suits the teaching and learning purposes. Two groups in each school were selected randomly; the control group, in which teachers used traditional teaching methods and the experimental group, where ICT was integrated to teach and learn the mathematics concept.

The specific question to be addressed in this research was:

> '*Is there significance difference in mathematics performance between the traditional teaching method classes and the ICT* integration *classes*?'

1.3 Research Objective

The specific Objective of this research was to determine the role of ICT integration in teaching and learning on mathematics performance in public secondary schools in Kenya. KNEC (1996) reported that lack of mastery of basic concepts and understanding the language used in mathematics could be the cause of poor performance. This study therefore, sought to bridge this gap.

1.4 Research Hypothesis

In an attempt to answer the research question, the following hypothesis was tested:

- There is no significant difference in mathematics performance between students in classes taught by traditional methods and the ICT integration classes of public secondary schools in West Pokot County.

1.5 Justification of the Study

Solving the problem of poor performance in public secondary schools especially in mathematics in West Pokot and indeed in Kenya, would be of great benefit to policy makers as science, technology, engineering and mathematics (STEM), are key to any meaningful economic development in this country and would help greatly in realizing vision 2030 objectives.

As an evaluation study, the findings could serve as a feedback to assist policy makers in strategic planning in line with government educational policies. KICD may use the findings of this study as a basis for curriculum revision in its e-learning content. Teachers' employer (TSC), may utilize the report to advice teachers' training institutions on practical skills needed in the classroom by tutors in regard to ICT.

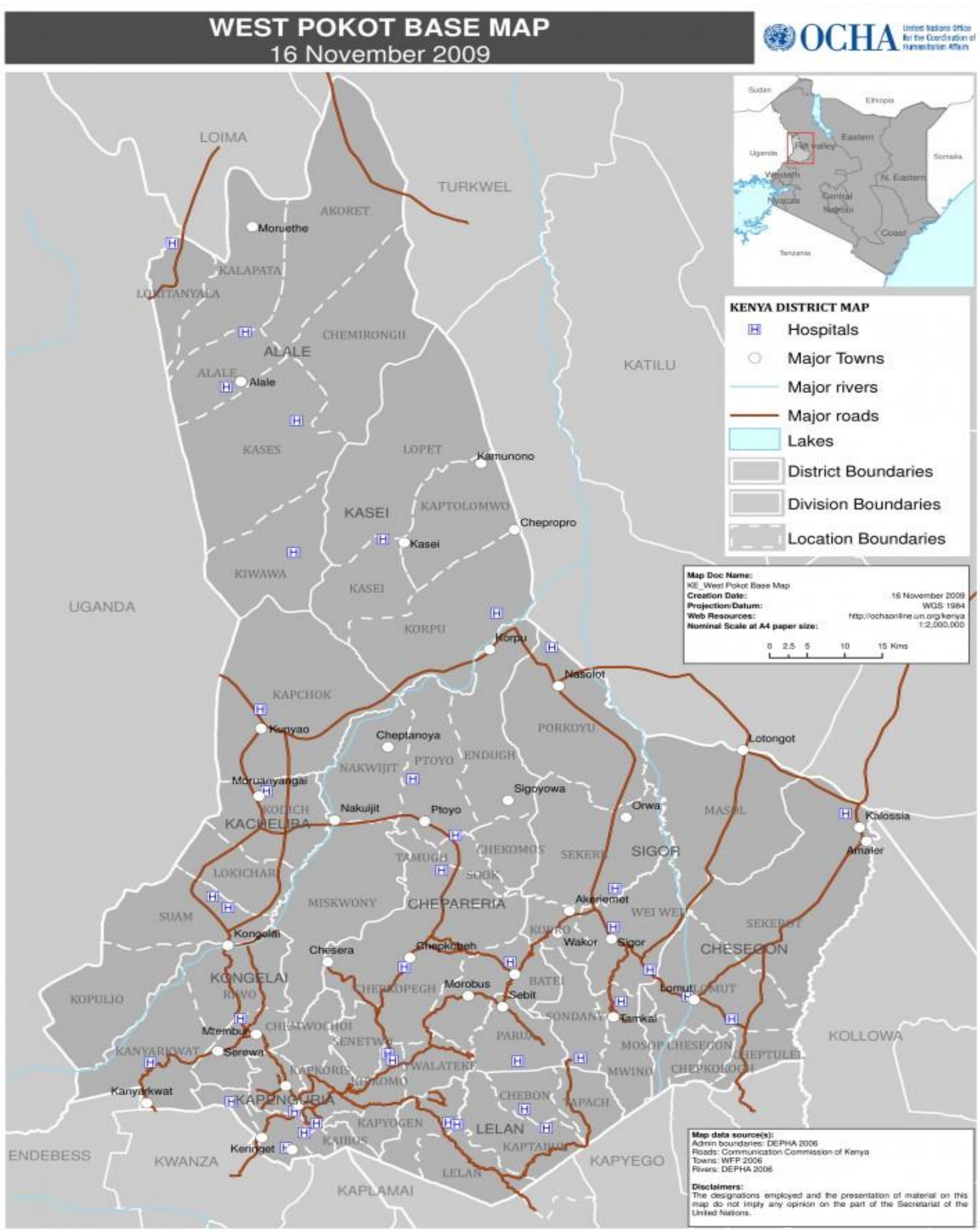
Research findings in this direction is greatly beneficial to school education and it must be understood that there is a spectrum of technology use in education. This study intended to offer educators an opportunity to further understand the concept of ICT integration in teaching and learning mathematics and hopefully get motivated enough to start practicing in their teaching.

1.6 Study matrix

West Pokot County is located in the northern Rift Valley of Kenya between latitudes 1^0 N and 2^0 N and longitudes 35^0 E and 36^0 E. The County borders Trans-nzoia County to the south, Elgeiyo-Marakwet to the south east, Baringo to the east, Turkana County to the north and the republic of Uganda to the west. It covers an area of 9,169.4 square km. Rainfall varies from 400mm to 1,500mm p.a. while temperatures ranges from 10 °C to 30 °C. The communities are generally pastoralists, as a bigger portion of the county is dry, hence, frequent food shortages and water point conflicts with other communities in the neighbouring Counties resulting to cattle rustling which to some extent has had an effect on education alongside other factors. Other members of the community in the County, especially those in the higher altitude zones practice agro-pastoralism, combining mixed farming with nomadic-pastoralism all of which has had a net effect on education.

The county has 4 sub-counties, namely: Pokot north, Pokot south, Pokot central and West pokot. There are 4 constituencies in the county; Kapenguria, Kacheliba, Pokot south and Sigor, through which educational bursaries for the needy children has been distributed. Kapenguria Town is the administrative headquarters where development and other social amenities seem to be concentrated. Tourist attractions include Nasolot National Park, the Turkwel Hydro Power Plant and the kapenguria-6 Prison's museum which may not have much impact on education.

Figure 1.1 Map of West pokot County



(Source; Krakow cultural and dev. Org.2009)

1.7 Operational Definitions

Computer: Digital machine that accepts data, process it and provides feedback

Digital technology: Use of computers, digital cameras, and networking software.

Integration: Effective and meaningful incorporation of selected media technology into the topic or content being taught.

ICT: use of Computers

ICT Integration: Effective and meaningful use of computer in teaching and learning given content

Performance: Students being able to score high marks on a standardized test.

Skills: Certain core competencies to help learners thrive in today's world and cope with the demands of modern life.

Teaching: Process through which Knowledge is transferred from the teacher to learners

Learning: Process by which knowledge, skills and attitudes are acquired by students

Impact: The influence and role played by a treatment on a variable

Traditional Teaching Method: Methods of teaching that include drilling, lecture, notes taking and exposition

Computer laboratory: An educational facility within the school environment that is equipped with Computers

Challenges: Difficulties experienced in the process of using media instructional equipment.

Public School: This is a government aided or sponsored institution in terms of provision of infrastructure, personnel and administration.

CHAPTER TWO

2.0 LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Introduction

The literature was reviewed in order to have a better understanding of the study problem in terms of trends and methods in ICT integration in pedagogy and assist to identify gaps in this field of study. The review was conducted topically in terms of approaches and techniques undertaken by other scholars on this topic. A range of scholars have argued that knowledge about technology cannot be treated as context-free, and that good teaching requires an understanding of how technology relates to the pedagogy and content (TPACK). From a systems approach, teaching with technology involves four major components: the students, the instructor, course content, and technology tools. The TPACK framework argues that effective technology integration for teaching mathematics content requires understanding and negotiating the relationships between Technology, Pedagogy and Content. Success in applying TPACK is being flexible and sensitive to context.

In the current study, teachers learnt technology not by learning specific computer programs, but rather by designing technological solutions to pedagogical problems. By participating in these design activities, teachers developed knowledge of technology that is sensitive to the subject matter to be taught and the specific instructional goals. Shulman (1998), postulated that in teaching one needs to have content knowledge and how to structure and present it to learners.

Starting from the general literature on ICT in education, ICT and pedagogy, ICT integration in mathematics pedagogy, mathematics teaching and performance, and approaches undertaken to learn mathematics were looked into and the summary of the key findings were made which assisted in conceptualizing this study.

2.2 The Review of the Literature

According to Partnership for 21st century skills, 2002, pedagogical and technical skills are the enablers to facilitate the process of educational exploration. Teacher's ability to use a variety of pedagogical strategies is the key to ICT integration. In a non-threatening atmosphere, students have used calculators to study iteration of many algebraic functions and therefore computers for mathematical exploration have far much higher possibilities and because they are expensive, governmental action, to provide appropriate alternative low-cost technology becomes appropriate. The year 2015 was the target specified by MDGs and EFA initiatives to achieve the universal primary education access. Many countries, including Kenya, did not attain these targets due to shortages of teachers and infrastructure among other impediments. Today, as developing economies think of Sustainable Development Goals, here referred to as SDGs, ICT can be an alternative avenue to improve, expand and increase quality of education as it drives students' needs, interest, strength and weaknesses in learning where the teacher is only a facilitator (Rodgers, 1995). Such innovations in the design and use of such material should be encouraged so that their use makes school enjoyable and meaningful.

Findings in USA revealed that ICT has the power to remake American schooling, raising performance standards while cutting costs. Kozma (1992), postulates that ICT makes a departure from the current teaching methods where all learners are treated more or less alike en-mass and that while ICT continues to advance in the western world, Africa and the developing economies are still lagging behind. According to Morrison, (1998), ICT can personalize learning that produce stronger results, enable and empower students to pursue their own knowledge, enhance content and information rich resources that are not limited hard copy, given the role ICT plays in the global economy.

Kenya is not exceptional, like the rest of the world, it has made strides through MOEST by recognizing the role of ICT in education. National ICT policy in Kenya emphasizes its integration to improve access, learning and administration, to establish a policy framework, install digital equipment, connectivity and networking. The ministry admits that ICT in education is the natural platform for equipping its citizens with skills for dynamic and sustainable economic growth and failure to integrate ICT, the country risks serious global marginalization (MoEST, 2006). For this reason, sessional paper no. 1 of 2005, articulates strategies to address the challenges of ICT in education. Mobilization of resources, digitalization of curriculum by KESSP and identifying of pilot schools and equipping teachers with the necessary skills. Sessional paper on ICT for Education (2012), points out that ICT strategies were put in place in 2006, with the aim to modernize Kenya's education system and expand access, training and research by working towards developing new models, develop ICT curriculum and incorporate necessary standards, practices and regulations. Institutions working in ICT for education at the ministry of education in Kenya include; ICT for education department, ICT integration committee, National ICT integration and innovation center, KICD and CEMASTEA. KICD launched the e-learning content which the CD ROMs and DVDs are produced for schools (KICD, 2010). Despite all these initiatives, Gakuu (2010), posits that ICT integration is commonly embedded in private schools unlike in the public schools with a view to attract students in these schools to improve performance.

ICT pedagogy is about teaching methodologies that calls for software application to solve educational problems, to provide student capabilities, to create products and/or communicate and share their perspectives with each other (Janassen et al. 2008). According to Gaible and Burns, 2005, many policies seem to place great deal of emphasis on providing ICT infrastructure in schools rather than their use in pedagogy. Studies indicate that investment in new ways of teaching and learning is not the same as investment in technology and infrastructure, the balance seems to tip towards to the later. As pointed out by OFSTED (2001, 2002), there is need for motivation to develop teachers' pedagogy and practice; confirmation of what pupils should learn using ICT and how teachers should facilitate this. Ottevanger et al (2007), recommends that effective use of ICT needs to be optimized through extensive programs of teacher support. According to Mselle (2012), teachers are not doing enough to improve academic performance and may not be aware of the potentials that technology offers in pedagogy. Knight et al. (2006), observed that despite the dramatic impact and growth of ICT in society, students in many schools are still being taught using methods of 1950's because of ineffective use of ICT as a pedagogical tool. Kelleher, (2000), observed that ICT cannot replace the normal classroom teaching but is a positive force to enhance deeper understanding of principles and concepts that provides new, authentic, interesting, motivating and successful learning experiences.

A study by Condie and Livingston (2007), found that while some teachers continue to display a reluctance to engage with new technology, others remain fearful of trying new approaches which they perceive may have negative impact on examination results, that using more constructivist approaches is a risky strategy and therefore prefer tried and tested methods that enable them predict and control outcomes more easily. Rahman et al (2003) identified factors that compelled teachers to opt for drilling learners for answers instead of solving and understanding. A study by

Kamau (2014) on factors related to technology adoption, the findings revealed that secondary mathematics teachers in Kenya lacked technology skills and technology training was low and that time to complete the syllabus and to prepare technology-enhanced lessons inhibited teachers' decisions to adopt technology in teaching. This study shows that despite many years now since the introduction of ICT policy, it seems that what is stated is only paper work and has not been achieved since the level of competence of teachers on the use of ICT as a pedagogical tool is still low and . It is on this premise that one may say that ICT use in teaching in Kenya is not a common practice in many secondary schools. Ang'ondi, 2013, in a paper presented at a world conference, points out the same as Kamau, 2014, and recommends that schools should be equipped with technology and teachers should have Technological Pedagogical Content Knowledge (TPACK); this component is missing. Lack of training in digital material, pedagogic and didactic training in how to use technology in the classroom in specific mathematics content areas was truly impediment in the integration of ICT. Teachers in schools endowed with ICT tools are yet to effectively use them for lesson delivery. According to a study by Wakhaya, 2010, on training in ICT tools for teaching and learning in schools, only 32.1% of teachers were trained to use computers whereas 67.9% were not. A survey by Lusike (2006) revealed that teachers see the use of computers in classroom as worthwhile and those who use them were enthusiastic and spoke positively whereas non-users felt left behind technologically and revealed that teachers' attitude play a significant role in the use of ICT and therefore, argued for the need for a more balanced approach.

National Centre for Excellence in Teaching Mathematics (NCETM) in England makes use of computers in a number of ways; interactive tutorials, hypermedia, simulations and educational games (NCETM, 1996). This study found computer assisted learning (CAL), computer assisted instruction (CAI) and computer support learning resource (CSLR) of great input as a form of ICT integration in learning of mathematics especially in regard to interactive benefit given that many of the learners are operating computer for the first time.

According to Polya (1969), one can think of two kinds of aims for school education; a good but narrow aim of turning out employable adults who eventually contribute to social and economic development, and a higher aim of developing the inner resources of the growing child. In developing a child's inner resources, the role that mathematics plays is mostly about thinking where clarity of thought and pursuing assumptions to logical conclusions is central and an important consequence of such requirements is that school mathematics must be activity-oriented. Specialized software such as Computer Algebra Systems (CAS); Dynamic Geometry Systems (DGS) and mathematics curriculum software improve pupils' skills and understanding in algebra, allow them manipulate and measure shapes leading to a higher level of learning among them (Hannessy et al 2001). Programmable toys and floor robots controlled by instructions, where used, caused significant changes in mathematics teaching and academic improvement (Becta, 2003). Logo encourages students to develop problem solving skills, leads them to develop higher order mathematical thinking as well as learn geometric concepts (Clements, 2000). According to Ittigson and Zewe (2003), ICT supports constructivist pedagogy, which allows students explore and reach an understanding of mathematical concepts which therefore promotes higher order thinking and better problem solving strategies.

Gachenga (2007) observed that assignments, demonstrations, drill and practice were the common methods of teaching, hence no creativity and problem solving cues which failed student to discover knowledge on their own. Cubukcouglu (2013) found that in order to create an environment where technology is used frequently and effectively, it is important to support the need of teachers in using technology in teaching and learning. A number of international studies show that secondary school teachers lack competency on the use of ICT as a pedagogical tool for teaching and learning process (Nihuka & Voogt, 2011; Bingmlas, 2009). Studies show that teachers' reluctance to abandon their existing methodologies which Rodgers (2002) views as an obstacle to teacher development in classroom use of ICT than even limited resources. Literature further points out that teacher's beliefs about their own efficacy play an important role in integrating technology into instruction (Ertmer & Ottenbreit-Leftwich, 2010). Indeed these studies proofs that unless teachers see the connection between technology and mathematics subject content, they are unlikely to develop technology–supported pedagogy. To this end and as purported by Bingimlas (2009), the importance of ICTs in the future of education cannot be underrated. Teachers do not only need to have competent knowledge of teaching mathematics but also need to be competent in the pedagogical use of ICT (AACTE, 2008; Voogt, 2008).

In terms of mathematics teaching and performance, as widely understood, mathematics plays a key role in shaping how individuals deal with the various spheres of private, social, and civil life, yet today as in the past, many students struggle with it and become disaffected as they continually confront obstacles to engagement (Anthony, 2009). In order to break this pattern it is imperative that there is an understanding of what effective mathematics teaching looks like. Hiebert and Grouws (2007), argues for a more detailed, richer, and coherent knowledge base to inform policy and practice and their views are closely aligned with recent mathematics initiatives within western education systems that shift teaching and learning away from a traditional emphasis on learning rules for manipulating symbols. Initiatives by Principles and Standards for School Mathematics (PSSM) and National Council of Teachers of Mathematics (2000), focus on developing communities of practice in which students are actively engaged with mathematics. These are the academic outcomes that exemplify mathematical proficiency according to the National Research Council (2001);

- conceptual understanding: comprehension of mathematical concepts, operations, and relations;
- Procedural fluency: skill in carrying out procedures flexibly, accurately, efficiently, and appropriately;
- Strategic competence: the ability to formulate, represent, and solve mathematical problems;
- Adaptive reasoning: ability for logical thought, reflection, explanation, and justification;
- Productive disposition: habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy.

The gap identified here is that best practice descriptions and explanations which are tied to high-stakes assessment do not tell the whole story, pedagogy should be tied closely to interactions between people which cannot be separated from the axes of social and material advantage or deprivation that operate to define learners. According to Luke, 2005; these interactions should be productive to enhance not only skill and knowledge but also identity and disposition, they ought to add value to life and work, to the family and to the wider community of individuals. This was the concern of the current study.

According to the National Council of Educational Research and Training (NCERT) (2006), any analysis of mathematics education in schools will identify a range of issues as problematic and these issues are the core areas of concern:

- A sense of fear and failure regarding mathematics among a majority of children. Mathematics anxiety and 'math phobia' are terms that are used in popular literature. In the Indian context, there is a special dimension to such anxiety
- A curriculum that disappoints both a talented minority as well as the non-participating majority at the same time. Any mathematics curriculum that emphasizes procedure and knowledge of formulas over understanding is bound to enhance anxiety
- Crude methods of assessment that encourage perception of mathematics as mechanical

Computation. Tests are designed for assessing a student's knowledge of procedure and memory.

- Lack of teacher preparation and support in the teaching of mathematics. Textbook-centered pedagogy dulls the teacher's own mathematics activity.
- Other systemic problems; gender ideologies, curricular acceleration and compartmentalization. Yet in the twenty-first-century workplace, mathematical ability is a key determinant of productivity. According to the National Council of Educational Research and Training (2006), Central directions for action include;

- Shifting the focus of mathematics education from achieving 'narrow' to 'higher' goals,
- Engaging every student with a sense of success, while at the same time offering conceptual challenges to the emerging mathematician,
- Changing modes of assessment to examine students' mathematization abilities rather than procedural knowledge
- Enriching teachers with a variety of mathematical resources.

The current study intended to shift focus from mathematical content to mathematical learning environments, where a whole range of processes take precedence, such that formal problem solving, use of heuristics, estimation and approximation, optimization, use of patterns, visualization, representation, reasoning and proof, making connections, and mathematical communication was given importance. These processes also helped in removing fear of mathematics from student's minds, the implications being offering a multiplicity of approaches, procedures and solutions and therefore, liberating school mathematics from the tyranny of the one right answer, found by applying the one algorithm taught. This learning environment invited participation, engage learners, and offered a sense of success.

The big picture of U.S. performance on the 2012 Program for International Student Assessment (PISA), the fifteen-year-olds in the U.S. today are average in science and reading literacy, and below average in mathematics, compared to their counterparts in other industrialized countries and the ‘Tiger Economies’ in the far east. According to Duncan (2013), the educational challenge in America is not just about poor kids in poor neighborhoods, but it is about many kids in many neighborhoods. The test results underscore that educational shortcomings in the United States are not just the problems of other people’s children, (Duncan, 2013). A study by Hanushek (2013), revealed that the nation’s “educational shortcomings” are not just the problems of the other person’s child. When viewed from a global perspective, U.S. schools seem to do as badly at teaching those from better educated families as they do at teaching those from less-well-educated families. American performance on PISA has slipped over the past decade, notwithstanding the No Child Left Behind movement. America’s perpetual concern with youth mathematics performance has spawned numerous initiatives that has, cumulatively, exacerbated rather than solved the problem (Duncan, 2013).

Mathematics performance in Kenya has been a concern for some time now. The continued poor performance in mathematics is worrying to the ministry of education and indeed the entire education sector as it has registered a decline in the last few years. There has been a great concern considering that mathematics is a key requirement in most scientific-related courses. The government has invested heavily in the subject with various initiatives being undertaken through CEMASTEA as well as increased capitation for teaching materials in the subject (MOEST, 2015).

Table 2.1: KCSE Mathematics performance over the last 8 years

Year/mean mark	2006	2007	2008	2009	2010	2011	2012	2013
P1	22.71	19.55	22.76	22.37	26.21	21.36	29.46	28.12
P2	15.36	19.91	19.82	19.87	19.92	28.22	27.86	27.03

(Source: KNEC Reports 2006-2013)

Literature exists on the possible causes of this poor performance, Kanja (2001), cites congested syllabus and perceived difficulty of content in some topic areas by learners and therefore, this study sought to investigate the impact of teaching methods on performance of mathematics.

Worldwide, policy makers are placing increasing demands on schools and their teachers to use effective research-informed practices. Quality and effective pedagogical approaches are those that achieve their purposes and are influenced by perspectives about how things should be at a given time (Krainer, 2005). Polya (1965), pressed for mathematics teachers to teach people to think and "Teaching to think'' means that teachers should not merely impart information, but should try also to develop the ability of the students to use the information imparted.

The study at hand intended to assist learners develop the skills, understandings and numerical literacy they need for dealing confidently with the mathematics of everyday life. Recent research study by Anthony and Walshaw (2009), identifies principles of effective pedagogical approaches that facilitate learning for diverse learners, which should not be taken in isolation but interpreted as part of a complex web of factors that can affect student learning. They incorporate elements of practice related to the classroom community, classroom discourse, the kinds of tasks that enhance student thinking, and the role of teacher knowledge. The current academic view in New Zealand is that the mathematics taught and learned in schools and early childhood centers provide a foundation for working, thinking and acting like mathematicians and statisticians, in this view, "effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well" (National Council of Teachers of Mathematics [NCTM], 2000, p. 16). According to the work of Anthony and Walshaw (2009), effective mathematics pedagogy:

- Acknowledges that all students, irrespective of age, can develop positive mathematical identities and become powerful mathematical learners.
- Is based on interpersonal respect and sensitivity and is responsive to the multiplicity of cultural heritages, thinking processes, and realities found in everyday classrooms.
- Is focused on optimizing a range of desirable academic outcomes that include conceptual understanding, procedural fluency, strategic competence, and adaptive reasoning.
- Is committed to enhancing a range of social outcomes within the mathematics classroom that will contribute to the holistic development of students for productive citizenship

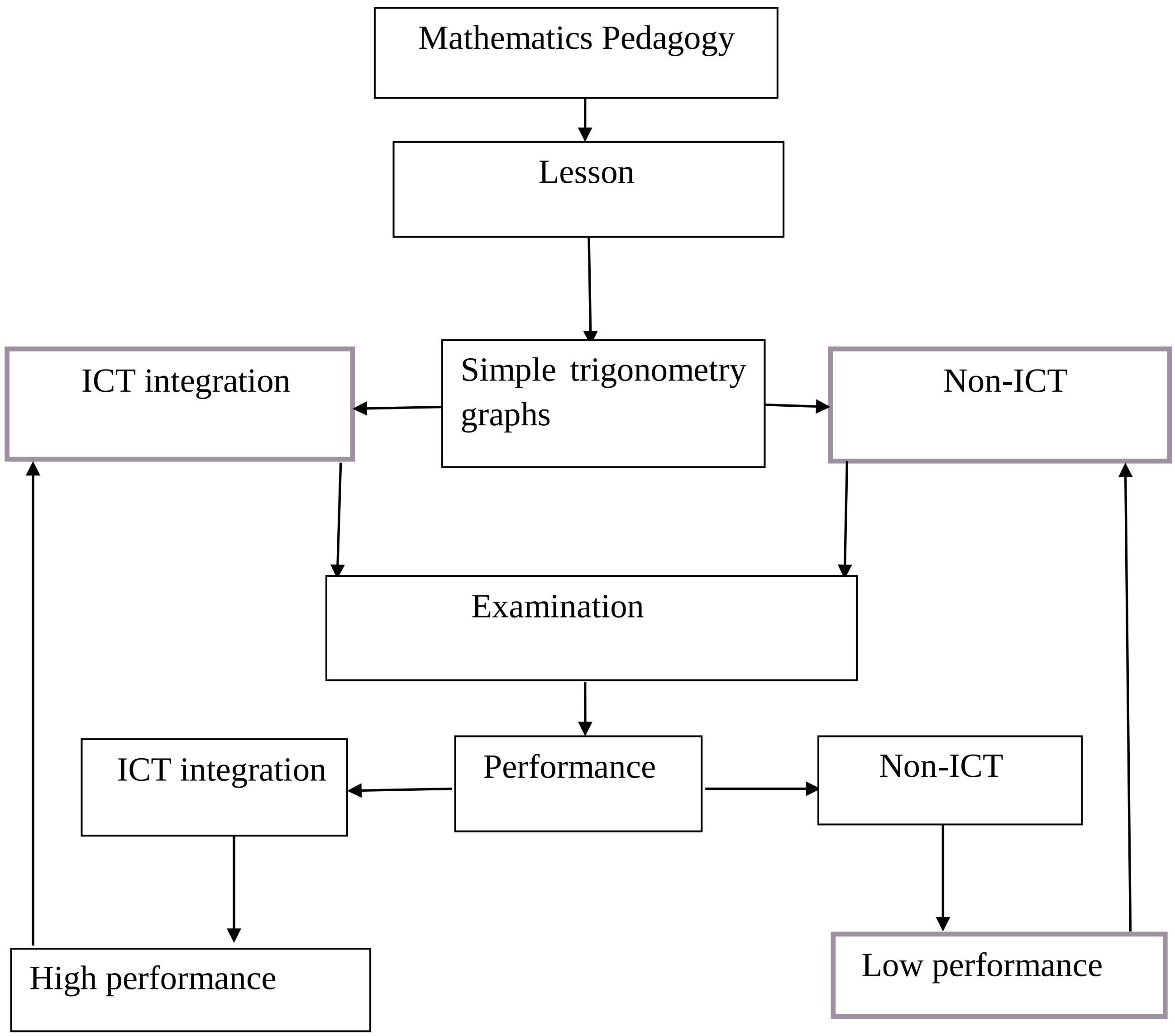
2.3 Summary of the Literature

Literature revealed that ICT can greatly aid the process of educational exploration and initiatives have been undertaken to promote it. It also showed that ICT pedagogy calls for software application to solve educational problems, to provide student capabilities, to create products and/or communicate and share their perspectives with each other. Literature revealed that use of ICT in pedagogy help learners to concretize content which would otherwise be abstract. It was shown that many students struggle with mathematics and become disaffected as they continually confront obstacles to engagement. Empirical data on benefits of ICT integration in mathematics teaching and its impact on performance have not fully been realized and utilized. It was seen that the use of digital technologies in teaching is still in its infancy stages in most developing countries including Kenya as there are many factors that determine the effectiveness of ICT to enhance mathematics performance. It was revealed that it is important to remove the possible barriers that hinder the frequent technology use and identify the enablers that promote it and that the enabling factors would help teachers to be motivated and enthusiastic users of ICT as a pedagogical tool. Even though many countries are struggling to embrace ICT in teaching in the developing countries, there is no enough evidence of how successful this integration is; the available studies show poor applications and their impacts are found to be insignificant as teachers are limited by what they are able to do in their own environment. It was also seen that policy makers are placing increasing demands on schools and their teachers to use effective research-informed practices, quality and effective pedagogical approaches that achieve their purposes and are influenced by perspectives about how things should be at a given time,

2.4 Conceptual Framework

According to Wang and Woo (2007), ICT integration can happen in three areas; namely, curriculum/macro, topic/meso and lesson/micro. At macro-level, ICT is exploited to support the complete content and learning experience of a whole course in a specific discipline whereas at meso-level, it is used in certain topics to supplement student learning. At micro-level, ICT is applied onto one lesson to help learners better understand certain concepts and to help explain specific knowledge units within a topic. In this study, ICT integration is at lesson level.

Figure 2.1 ICT Influence on performance

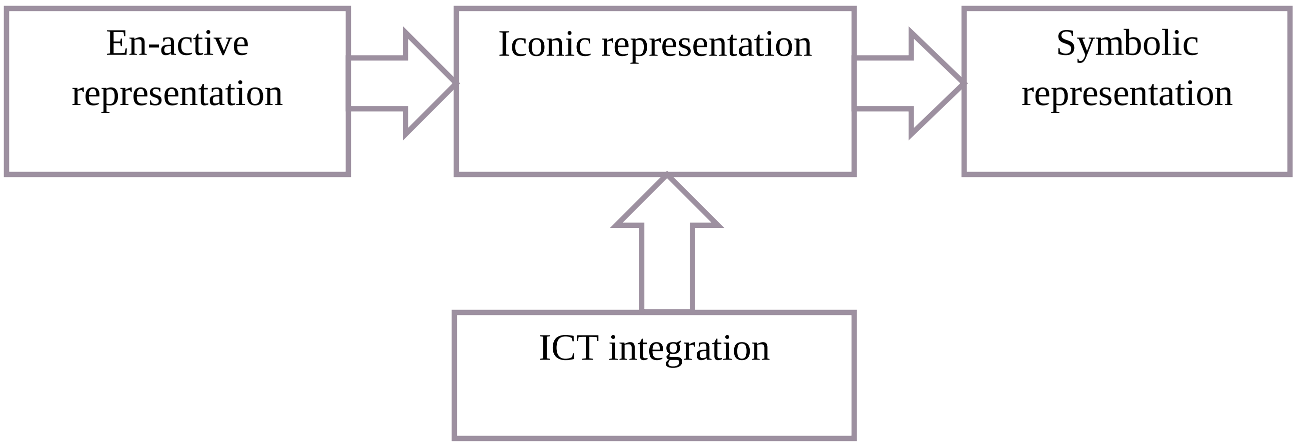


Traditional Transmission Instruction is based on learning theory which suggests that students will learn facts, concepts and understanding by absorbing the content of teacher's explanations. Skills are mastered through guided and repetitive practice in sequence, systematic and highly prescribed fashion. Constructivist-Compatible Instruction is based on the theory of learning which suggest that understanding arises only through prolonged engagement of the learner in relating new ideas and explanation to the learner's own prior beliefs. Capacity to employ skills only come from experience in working with concrete problems that provide experience in deciding how and when to call upon each of a diverse set of skills. Modern learning theories emphasizes that learners learn better if they are accorded autonomy in the classroom, time and facilities to construction knowledge for themselves and others. The current study is intended that through interactions with the computer, learners are able to construct knowledge involving trigonometric graphs by manipulations and discussions as many time as they wish.

Theoretical framework of Jerome Bruner is that learning is an active process in which learners construct new ideas and concepts based upon their current and/or past knowledge. The learner selects and transforms information, construct hypotheses, and make decisions relying on cognitive structures to do so. Cognitive structures, that is, schema and mental models, provide meaning and organization to experiences and allows individuals to ‘go beyond the information given’. Constructivism epistemology holds that there is no objective truth waiting to be discovered, truth and meaning comes into existence in and out of engagement with the realities of the world and that there is no meaning without a mind. Different people may construct meaning differently even in relation to the same phenomena (Crotty, 1998). According to Bruner (1974), three stages of representation, none of which is age specific to learners, exist

- The en-active representation: where learning is through action and knowledge is largely in the form of motor responses. Students may be able to perform a physical task better than describing the exact same task that has just been accomplished.
- The iconic representation: Where knowledge is stored in the form of visual or other sensory organization upon use of summarizing images and governed by the principles of perceptual organization.
- The symbolic representation: Knowledge is stored primarily in words and mathematical symbols which are arbitrary.

Figure 2.2 ICT integration and intellectual development process



(Source; adapted from CEMASTEA manual, 2012)

In this study, learners in the experimental group were accorded the autonomy, time and computers to construct knowledge for themselves through manipulation of information, whereas the duty of the teacher was that of facilitation and encouragement for them to discover principles by themselves through active dialogue. The integration of ICT in the teaching and learning process is a paradigm shift which is grounded in the constructivist theory of learning. In the current study teachers' focus was on the development of suitable environment for constructing knowledge rather than for its transfer. More often teachers jump from en-active to symbolic thereby overlooking the iconic stage. This study intended to bridge this gap.

According to the triarchic theory of intellectual abilities (Sternberg, 1985; 1986), three kinds of intellectual abilities exist; practical, analytical and creative abilities. Research done by Sternberg (1997) showed that the more teaching and assessment of students based on a broader set of abilities, the more racially, ethnically, and socio-economically diverse achievers will be.
Shortcomings of conventional measures of abilities and achievement is that they are orientated primarily toward assessing memory skills, and partially, analytical skills but rarely tap creative and practical skills in any meaningful way (Sternberg, 1998). It was the intention of the current study to fill this gap by measuring all the three kinds of abilities through the achievement test.
Research by Sternberg emphasises that students' learning and thinking styles (Sternberg, 1997) which are usually ignored, together with their ability levels, play an important role in their performance (Sternberg, 1994; Sternberg and Grigorenko, 1997). Theory of Mental Self-

Government (Sternberg, 1997) refers to an inventory of different thinking styles that gives an indication of people's preference of thinking patterns. Whereas the triarchic theory focuses on the ability itself, the theory of Mental Self-Government refers to different thinking styles which constitutes preference in the use of abilities (Sternberg, 1990). Within a class, learners are likely to show different thinking styles in the use of their abilities all of which are important. In this study, each learner's thinking style was given due consideration. Theory of performance develops and relates six foundational concepts that assist to form a framework that can be used to explain performance as well as performance improvements. To perform is to produce valued results. Current level of performance depends holistically on 6 components: context, level of knowledge, levels of skills, level of identity, personal factors, and fixed factors. Theory of performance which includes the parallel curriculum, advocated by Tomlinson et al. (2002), outlines parallel curriculums that reinforce the adjustable components; the core curriculum and the curriculum of connections which focuses on knowledge construction, the curriculum of practices which emphasizes context and promotion of skill. For effective performance improvements, three axioms are proposed which involves a performer's mindset, immersion in an enriching environment, and engagement in reflective practice. Performer's mindset includes actions that engage positive emotions like setting challenging goals, allowing failure as a natural part of attaining high performance, and providing conditions in which the performer feels an appropriate degree of safety. Immersion, a physical, social, and intellectual environment that elevates performance and stimulate personal development; that includes social interactions, disciplinary knowledge, active learning, emotions, and spiritual alignment. Reflective practice involves actions that help learners pay attention to and learn from experiences which includes observing the present level of performance, noting accomplishments, analyzing strengths and areas for improvements. Support for the three axioms can also be found in writings by Caine et al; relaxed alertness aligns with the performer's mindset, orchestrated involvement in complex challenges and supportive experiences aligns with immersion and active processing of experiences aligns with reflective practice. In the current study, the conditions for optimal performance and improvements in performance were synthesized in the three axioms: engaging the learner in an optimal emotional state (performer's mindset), immersing the student in an enriching environment through manipulation of computer, and engaging the learner in reflective practice in the form of testing and assessment.

CHAPTER THREE

3.0 METHODOLOGY

3.1 The Study Design

The research project used two independent samples, experimental and control groups of form three students in 5 public secondary schools which were randomly selected from the population of all the form 3's. The 5 public secondary schools were arrived at through a non-probability sampling procedure as these were the only public secondary schools in west pokot County with ICT facilities suitable for teaching and learning. It was purposive sampling in that only schools with ICT facilities suitable for learning were included. To identify class streams and students to take part in the study, simple random sampling technique was applied where the name for each stream was written on different small paper which was folded and all placed in a bag and mixed thoroughly, 2 were drawn one after the other without replacement. The first draw represented the experimental group of which all learners in the entire class participated while the second the control group. For the single stream school, the class was divided into two categories of almost equal size to form the experimental and control groups. It was necessary to use the 2 groups in each school for the purpose of uniform conditions and entry behavior of learners.

The two groups learnt a mathematics concept involving simple trigonometric graphs, in the topic Trigonometry (II) in a double lesson of 80 minutes. The double lesson was necessary due to the practical nature of the concept content under the study. The experimental class learnt the concept by integrating ICT, through CAI, CAL and CSLR in the presence of the researcher for purposes of quality assurance and control while the control group received the teaching in the normal traditional way of exposition and drilling thereafter the two groups were subjected to the same written mathematics standardized test. 1 week period was allowed to enable all participating schools and students to cover the said content and do the necessary practice. The test lasted for 40 minutes, which was enough in relation to the content cored. The test paper contained 4 extended test items, testing all the 6 levels of Blooms Taxonomy as well as factual, procedural, analytical and meta-cognition dimensions. Learners used the paper containing the test items to work. The subject teacher supervised and invigilated this exercise closely, the aim was to increase the validity. The entire test was carefully marked and scored by the researcher using a common marking scheme as the protocol. Pass mark was set at 19 marks out of the maximum possible score of 40, for the reason that it constitutes 47.5% given that pass at under graduate in Kenya is pegged at 40%, whereas at KCSE level, minimum qualification for under graduate in Kenya is C+ which ranges between 45% and 55%. The results for each individual school and student in each category were tabulated. Marked scripts were returned to students no-sooner marking was done

3.2 Data Types and Sources

Primary data sets comprised the test marks from the two groups, schools equipped with ICT facilities, number of students per stream, the teachers and the head teachers in the participating schools was gathered directly in the field. Secondary data involving total number of schools and student population in West Pokot County was obtained at the CDE office, KNEC examination reports on past KCSE analyses was used to get information on mathematics performance over a period of 8 years, from 2006 to 2013.

3.3 Data Collection

3.3.1 Pilot Survey

Reconnaissance survey to establish schools with ICT facilities that are suitable for teaching and learning as well as location and accessibility of these schools was carried out. It aimed at establishing the viability of this study, establish the number of streams and students per stream in order to come up with the appropriate sample sizes in each school and to ensure that the topic/ sub-topic in question had not been taught for reasons of reliability and validity. All these was necessary to reduce sampling error. It was also used to seek consent and approval from the concerned authorities as well as co-operation of the concerned teachers and induct them on the intended study. It was established that only 5 schools in West pokot County had a computer laboratory that could be used to math through ICT.

3.3.2 Target Population and Sample Size

According to Mugenda and Mugenda (1999), target population refer to the entire group of individuals, events or objects having a common observable characteristic, where population is the aggregate of all that conforms to a given specification. The target population comprised all public secondary schools in Kenya whereby the study population was all public secondary schools in West-Pokot County which were 84 with student population of 20564 (Source; CDE west pokot-2015, see appendix iii) but only 5 schools with ICT facilities constituted the study population as these were the schools that had the common characteristic (computer laboratory) that was to influence the variable (performance) the research intends to investigate. These schools were St. Theresa Tartar Girls, Karas mixed Day, Chewoyet Boys, Nasokol Girls and Kapenguria Boys. Form three students in the 5 schools, who numbered 1240 formed the student target population (Source; statistics office, CDE west pokot -2015). According to Kerlinger (2000),sampling refers to taking a portion of a population to be a representative of that population and therefore, based on the Krejcie (1970) model; $n = (\chi^2 Npq) / (d^2 (N-1) + \chi^2 pq)$, where n is the desired sample, N is the target population, p is population proportion, q is 1-p , d is the degree of accuracy and χ^2 being the table chi square value and generated by Morgan (1990), the following sample size were recommended.

Table 3.1 Recommended sample size for a given population

Pop. size	10	30	50	100	400	1500	3000	20000	50000
sample	10	28	44	80	196	306	341	377	381

From the target population of form three students in West Pokot and the five schools, a sample of 435 students, which is above the required as par table 3.1, was drawn based on the number of streams and student population in each sampled school. 2 streams from each of the four 5-stream schools were randomly selected whereas in the single stream school, the class was split into two groups by assigning random numbers to learners. In each school, 1 stream formed the experimental group while the other the control group. Two groups was necessary from each school for control and experimental to ensure that the variables do not interfere with the outcome and that homogeneity of the population from which the sample is selected is ensured. These schools and students served as cases for in-depth investigation for the relationship between study variables.

All form 3 teachers of mathematics in the sample schools were targeted whose total was 21 but a sample size of 10 was used based on the fact that it was their class being used in the study and therefore only 10 was required. 5 teachers in the experimental group and the rest in the control group. Teachers were selected on the basis of their willingness to participate in the research study and taught mathematics in these particular schools and classes in 2015 and had not covered the sub-topic 'Trigonometric graphs' in the topic Trigonometry II.

3.3.3 Data Collection Instruments

Tools used in the study for collection of data to answer the question posed included the Standardized test containing 4 extended items examining all the four knowledge dimensions, in terms of factual, procedural, analytical and meta-cognitive dimensions and the six levels of Blooms cognitive taxonomy. Projector to exhibit the specific objectives of the sub topic as outlined in the syllabus and the tasks which learners were expected to perform was used. Subject teachers invigilated and supervised the examination, a common marking scheme was carefully used for fairness and test marks were scored based on factual, analytical, creativity and originality. A camera was used to capture photo-clips of the sessions in the experimental class during the actual teaching and learning (see appendix viii) which aimed at relating the different learning environments and the learning outcomes.

3.3.4 Data Collection Procedure

The teaching and learning duration for the two groups was a double lesson of 80 minutes, during which the objectives of the sub topic was achieved. Efforts were made not to disclose to the participants that they are taking part in an experiment, otherwise it would have interfered the natural setting, hence performance. After 1 week, a written standard achievement test comprising of four extended items was administered by the respective teachers during the day which lasted 40 minutes under normal examination conditions to the two groups in the study. 1 week period was allowed to enable all participating schools and students to cover the said content and do the necessary practice.

The 6 levels of cognitive development in Blooms taxonomy was considered while formulating the test items. Item1was about using a calculator to fill a given table in the range of 0-360^0, and use the said table to construct a sine graph and answer question on the drown graph. This item constituted 10 marks. Item 2 was on cosine graph within a range of -180^0 to +180^0, the table was filled, graph constructed and question answered with reference to the graph. Item 3 was about sine and cosine graphs superimposed on the same set of axes, questions were answered in relation to the constructed graphs. Item 4 was on the equation involving addition of sine and cosine angles. A graph was constructed from the sum of the values in the table and answered with reference to the graph. Each item constituted 10 marks as this was the case for all extended section ii KCSE examination. The test was marked out of total possible score of 40 by the researcher using a common marking scheme.

435 students were used in the study in which 219 constituted experimental group and 216 the control group. Learners' raw scores were tabulated to be used to evaluate the influence of integration of ICT tools in comparison with traditional practices. The resulting scores were recorded in the excel spreadsheets, codes of 1 and 2 were used for experimental and control groups respectively and subjected to independent 2 sample t test analysis. This exercise lasted 5 weeks during the months of May-June 2015. Quantitative data obtained from the scores were used to measure the difference in the two methods of teaching on performance.

3.4 Data Processing and Analyses

3.4.1 Data Processing

Data in form of students' scores was prepared and cleaned by checking for incorrect entries and missing ones. Data was put into computer software, in this case the Statistical Package for Social Sciences (SPSS), for purposes of identifying and coding variables. Analyses were ran to obtain output. Further analyses and presentation of the output to facilitate interpretation was done, scores were coded 1 for the experimental group of learners and 2 for the control for the purpose of testing the significance of difference between means of 2 independent samples.

3.4.2 Data Analyses Techniques

The data file was subjected to statistical procedures to generate means and standard deviations of the two groups in the various schools as well as the mean of these means. Statistical Package for Social Sciences (SPSS) was used to define the variables, categorize the data in classes, create tables and generate graphs. Analyses of test results and summaries of study findings were presented using tables, charts, histograms and graphs. In the descriptive analyses, mean and standard deviation were used for summary and interpretation. The statistical hypothesis was that the means of the two populations do not differ by certain fixed amount; mathematically;

$\mu_{ICT} = \mu tp$; Where μ_{ICT} is the mean for the experimental class and μtp the mean for the control class.

A student t-test, to test the significance of difference between means of 2 independent samples at 95% confidence limit with 2 tails was generated.

3.5 Scope and Limitation

The study was designed to gather information on how ICT integration in mathematics teaching may influence performance of the subject in public secondary schools in West-pokot County in Kenya. The study involved students with almost equal academic background. The study was limited to public secondary schools and should not be generalized to cover special needs public secondary schools, tertiary institutions and universities. These findings are only applicable in developing countries.

Time and finances were limited for the researcher to carry out the study on a wider scale, in private and heterogeneous groups. Confounding variables (C.V) like teachers' experience, learners' entry behavior, teachers' willingness to participate and the ratio of learners to computer may also have posed a challenge to the study. Internal and external validities for example time lag between content delivery and seating for the test may have had some influence.

CHAPTER FOUR

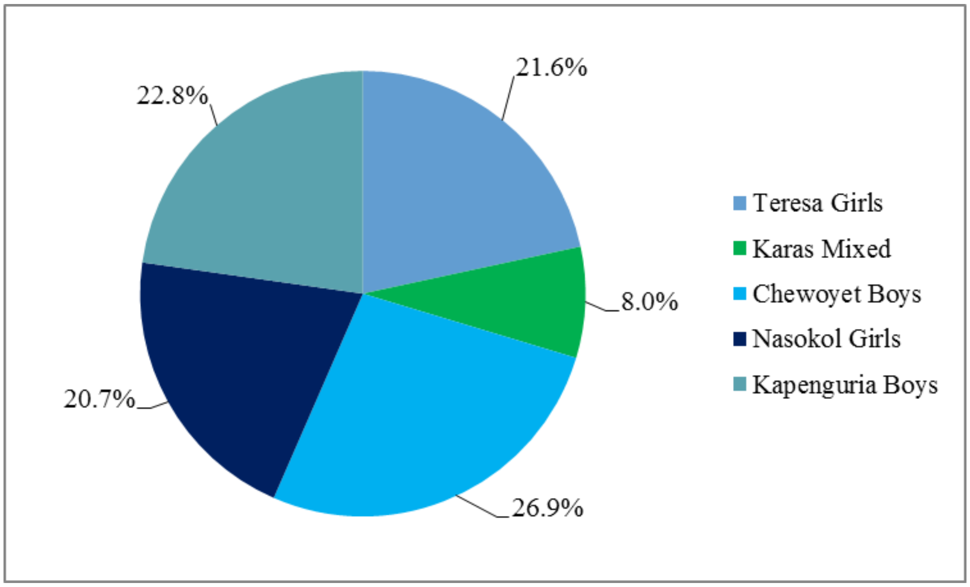
4.0 RESULTS AND DISCUSSION

4.1 Group Performance

This was a quantitative research and therefore called for both descriptive and inferential data analyses techniques.

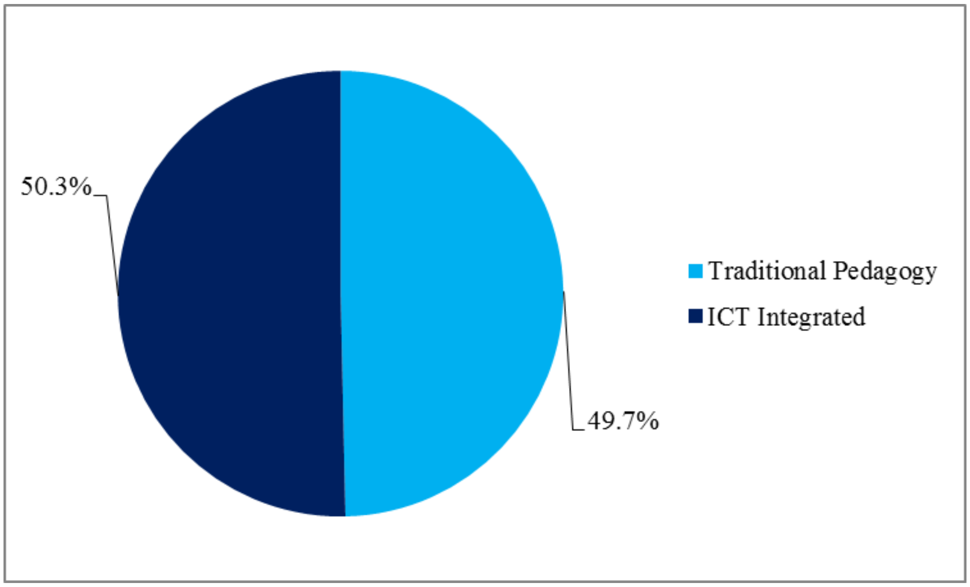
a) Descriptive Analyses

Graph 4.1 Student participant percentage by school (N=435)



Students from boys' schools who took part in the study constituted 49.7%, girls' schools 42.3% and students from mixed school 8.0% meaning that there were more male participants than the female, this was also the picture in the mixed school. This confirms gender disparity in schooling at secondary school level in West pokot County.

Graph 4.2 Percentage by teaching method (N=435)



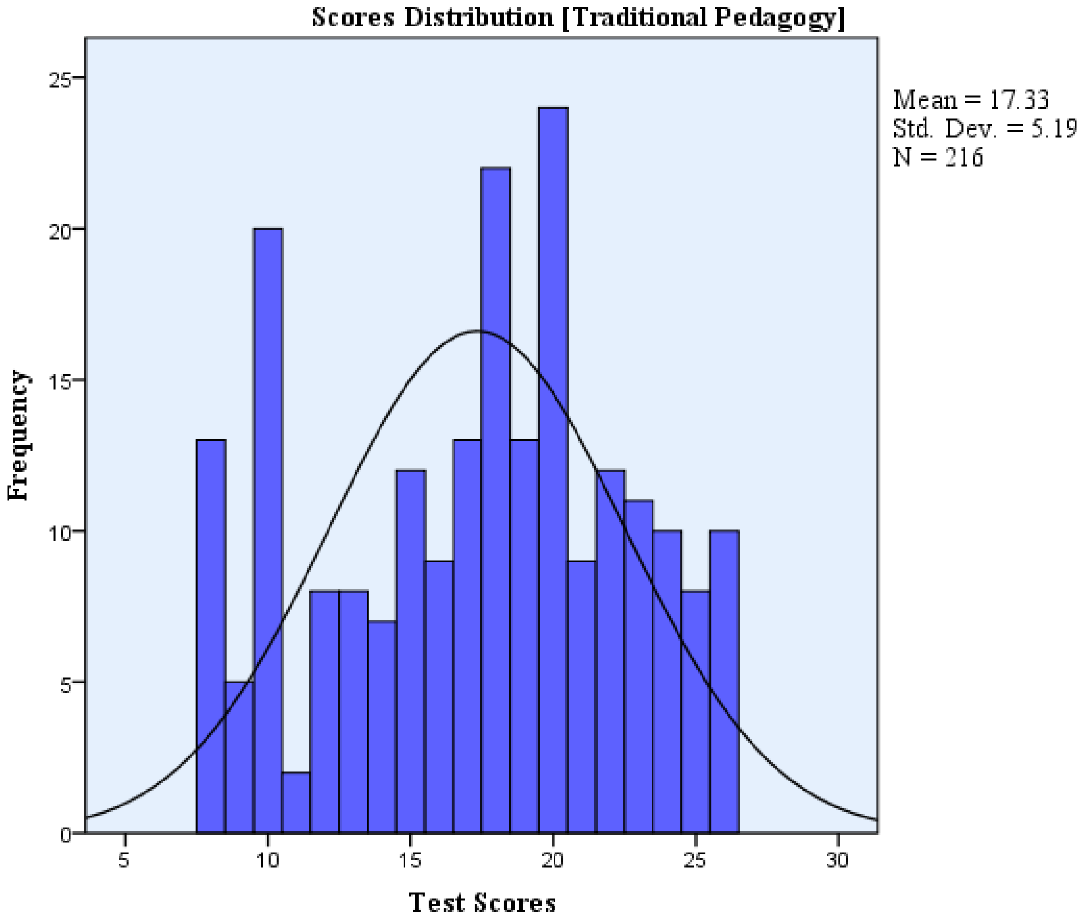
The number of student Participants taught/learnt mathematics content via the two methods is almost equal and therefore errors were minimized.

Table 4.1 Group performance by school

	School	Mean	N	S.D	Minimum	Maximum
	Teresa g.	26.50	46	4.396	19	37
	Karas m.	25.56	18	3.148	19	30
ICT	Chewoyet	28.62	60	4.080	19	37
	Nasokol g.	26.64	44	4.155	19	34
	Kapenguria	29.82	51	3.235	22	37
Total		27.80	219	4.154	19.6	35
	Teresa g.	17.69	48	6.682	8	26
	Karas m.	14.82	17	4.290	8	22
Non-ICT	Chewoyet	16.56	57	4.260	8	26
	Nasokol g.	17.13	46	5.045	8	25
	Kapenguria	18.96	48	4.524	8	26
Total		17.33	216	5.190	8	25

Boys' mean score in the ICT integrated classes were higher than the girls', whereas in non-ICT group the situation was different, the two girls' schools were ahead of one the boys' school. This could be interpreted that boys gained more than girls when ICT was used in teaching and learning.

Graph 4.3a Histogram



Where ICT was the mode of teaching and learning, score distribution tend to be close, compact and left or negatively skewed implying that more students passed (graph 4.3b) as compared non-ICT group whose distribution is less compact and positively skewed (graph 4.3a).

Graph 4.3b Histogram

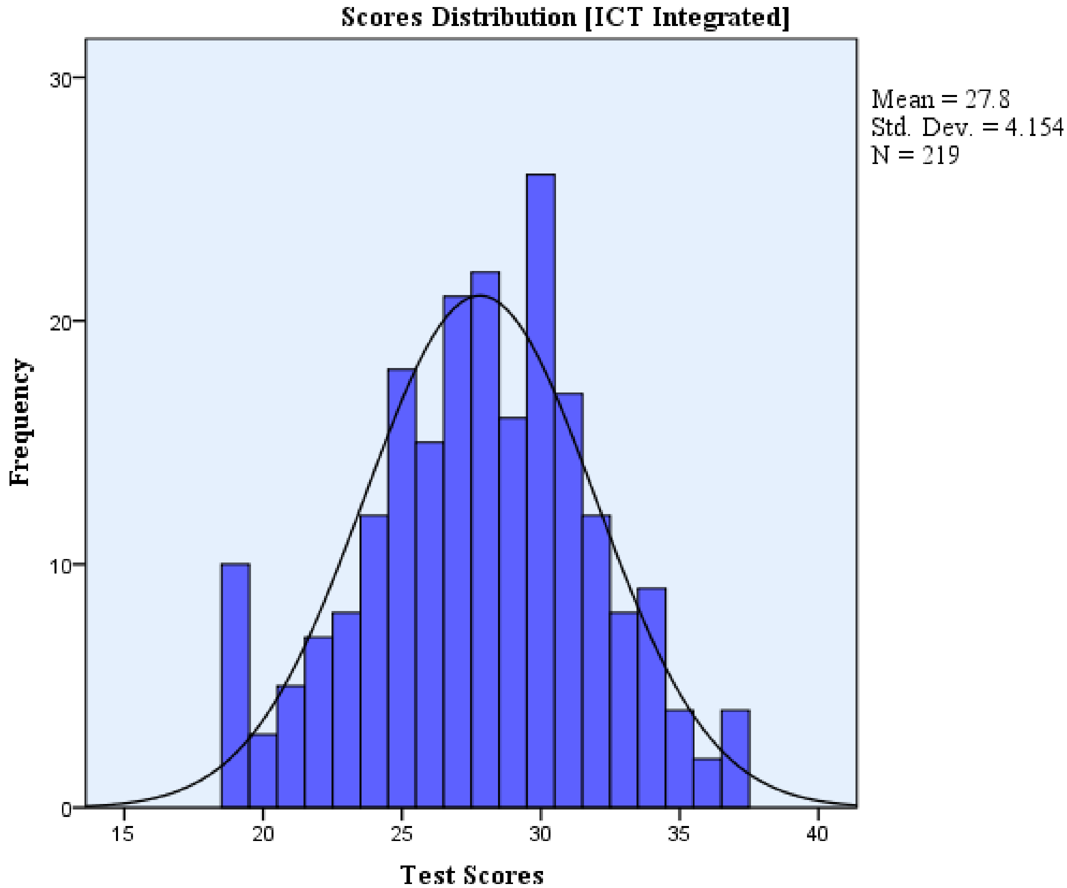


Table 4.2 Group performance

OLAP Cube

		Mean	Std. Deviation	Variance	Minimum	Maximum	Sum	N
Traditional Pedagogy	St. Teresa G.	17.69	6.682	44.645	8	26	849	48
	Karas Mixed	14.82	4.290	18.404	8	22	252	17
	Chewoyet B.	16.56	4.260	18.143	8	26	944	57
	Nasokol G.	17.13	5.045	25.449	8	25	788	46
	Kapenguria B.	18.96	4.524	20.466	8	26	910	48
		Mean	Std. Deviation	Variance	Minimum	Maximum	Sum	N
ICT Integrated	St. Teresa G.	26.50	4.396	19.322	19	37	1219	46
	Karas Mixed	25.56	3.148	9.908	19	30	460	18
	Chewoyet Boys	28.62	4.080	16.647	19	37	1717	60
	Nasokol Girls	26.64	4.155	17.260	19	34	1172	44
	Kapenguria B.	29.82	3.235	10.468	22	37	1521	51

DESCRIPTIVE VARIABLES
=V2 /STATISTICS=MEAN STD.DEV. MIN. MAX. SEMEAN.

[DATASET0]
Group = ICT integrated class

Table 4.3a: Descriptive Statistics[a]

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Score	217	19	37	27.87	.279	4.154
Valid N (list-wise)	217					

a. Group = ICT integrated class

Group = Non-ICT class
Table 4.3b:Descriptive Statistics[a]

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Score	216	8	26	17.33	.353	5.190
Valid N (listwise)	216					

a. Group = Non-ICT class

There was significant differences in mathematics performances between ICT integrated and non-ICT classes from the analyses computed and represented in the form of frequencies and histograms. These differences are attributed to the teaching modes used in content delivery of simple trigonometric graphs. This findings suggested that ICT integrated teaching of simple trigonometric graphs in public secondary schools influences performance. ICT integrated classes had an overall smaller standard deviation than the non-ICT classes which is also the case with individual schools. This is an indicator that scores from ICT-led classes are more consistent and reliable when compared to teacher-led groups. The impact was that the smaller standard deviation the more consistent the group is in terms of performance differences.

b) Inferential Analyses

Inferential analyses were used to draw inferences between the variables in this study and help to make predictions about student population in west pokot County and Kenya in general.

Table 4.4: t-test Group Statistics

GROUPS=V 3(1 2)
/MISSING=ANALYSIS
/VARIABLES=V2
/CRITERIA=CI (.95).

T-Test

[DataSet0]

	Group	N	Mean	Std. Deviation	Std. Error Mean
Score	ICT integrated class	217	27.87	4.111	.279
	Non-ICT class	216	17.33	5.190	.353

Table 4.5a: Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
Score	Equal variances assumed	16.395	.000	23.434	431
	Equal variances not assumed			23.422	408.718

Table 4.5b: Independent Samples Test

		t-test for Equality of Means			
		Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
					Lower
Score	Equal variances assumed	.000	10.54	.450	9.658
	Equal variances not assumed	.000	10.54	.450	9.657

Table 4.5c: Independent Samples Test

		t-test for Equality of Means
		95% Confidence Interval of the Difference
		Upper
Score	Equal variances assumed	11.426
	Equal variances not assumed	11.427

In terms of groups' mean performance from the analyses, the ICT integrated classes showed significant difference in mathematics scores when compared to the control group. ICT integration enhanced deeper understanding of principles and concepts of the subject matter in simple trigonometric graphs. ICT did not replace a teacher but assisted the teacher to deliver the content more easily and appropriately. Kelleher (2000) reviewed that ICT use in teaching cannot and will not substitute teachers in the classroom but can only promote understanding and retention of content learnt and enabling learners to go beyond the stated area of study. ICT integrated classes showed a high mean mark in all the individual 5 schools when compared to the classes that were taught by the traditional ways in overall terms. The findings in this study has shown that ICT integration in mathematics teaching raises student understanding and provokes them to think beyond and even apply knowledge which is in agreement with what Leask et al (1999) had postulated. The effective use of ICT integration had the potential to engage learners and supported various types of interactions in terms of learner-content, learner-learner, learner-teacher and learner-interface. Lim and Tay (2003), exploring the use of ICT tools to engage students, observed higher students' engagement in higher order thinking skills by use of ICT.

Table 4.6 ICT Integrated and Non-ICT Mathematics class performance summary statistics

Teaching method	N	Mean	Standard Deviation
ICT	219	27.8	4.154
Non-ICT	216	17.33	5.190
Total	435	22.57	4.672

Based on the findings above, the decision is to reject the null hypothesis and subsequently conclude that there is a significant difference in performance between classes of mathematics taught in traditional methods and ICT integrated in public secondary schools of West pokot County.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The purpose of this study was to investigate the impact of ICT integration on mathematics performance in public secondary schools of West pokot County. The research design was experimental in which students from five schools, two boys' schools, two girls' schools and one mixed day school participated. These schools were purposively selected due to the fact that they have computer laboratories. A subtopic 'simple trigonometric graphs' in the topic Trigonometry II was taught to two groups of students in two different methods; ICT integration and non-ICT integration in each of the schools. An achievement test was administered a week later after the learning. Results were analyzed and conclusions made.

Literature reviewed ICT in education, ICT and pedagogy, ICT integration in mathematics, teaching and performance of mathematics, and approaches taken in mathematics learning and the conceptual framework. It was found that integration of ICT has faced many challenges despite the efforts, the main being insufficient ICT resources for mathematics learning.

The key findings of the study were that the experimental groups performed extremely better than the control groups in all the five school and even when combined in the achievement test. This was attributed to the digital content offered by ICT for the ICT integrated classes over the non-ICT classes as the learners had unlimited access to the learnt materials.

The influence of ICT was significant in view of different mean scores and standard deviation from the two groups. This does not in any way imply that classroom teacher could be replaced by technology, but the teacher is there to influence the direction of technology integration and be able to bring out the creativity and innovativeness of teaching and learning. The knowledge and skills of the teachers are captured in their capabilities of understanding and negotiating the relationships between technology, pedagogy and content, hence, representing a form of expertize different from and perhaps broader than the knowledge of a disciplinary expert.

5.2 Conclusion

From the summary, the study made the following conclusions;

- ICT integration in teaching of mathematics brings about better results in concepts of trigonometry. In all the five schools, ICT class posted superior results and indeed percentage pass was 100% compared to 45% for the non-ICT class based on the performance criteria set in the study. These results do suggest that students who are taught through ICT integration may be able to transfer skills in trigonometry from concrete to abstract situations.

- Some factors were found to impact negatively in the use of ICT; Computers were not adequate for each learner for the entire class, time was not enough for practice and a good number of teachers were shy to integrate the technology or participate in study. ICT lesson preparations tend to consume more time but in terms of lesson delivery it is faster.

5.3 Recommendations

The following are the recommendations of this study

Policy recommendations

- In as much as there should be investment in technology and information in schools, more should also be invested in new ways of teaching and learning. There is need to motivate teachers in order to develop their pedagogy and practice. Teachers of mathematics need frequent in-service courses on the new innovations in terms of instructional skills and approaches whereas those with the necessary skills to increase their competency.

- Institutions working in ICT for Education at the ministry should fast track their strategies in terms of mobilization of resources and digitalization of curriculum and equipment. KICD should prepare standard software materials and programs to be used in teaching trigonometry and indeed all other mathematics topics and make them easily available to all schools.

- Technology skills should be integrated into the total curriculum during the entire education processes through holistic approach. Research is needed therefore in ICT integration at Meso level (entire topic) and at macro level, that is, ICT to be exploited to support the complete mathematics content and learning experience.

Recommendation on Evaluation

- Alternative assessment methods that are authentic are needed to provide opportunities for student learning. These assessments require students to construct an original response. These performance assessments to be centered on the extent to which each learner has mastered a given skill.

Recommendations for further research studies

- More studies are needed to assist teachers to focus on development of suitable environments for knowledge construction rather than its transfer. There is a greater need to integrate the 3R's with the 4C's. Studies should look more closely in the ways of thinking in terms of creativity, innovation, critical thinking, decision making and meta-cognition as well as tools for working in terms of information literacy and ICT.

- There is a complex relationship that exists between technology, mathematics content and pedagogy. Studies are inadequate for effective technology integration to negotiate these relationships in different contexts. An educator may start by looking at the content and building in the pedagogy and technology or may begin with technology component and building in the pedagogy and content or begin with pedagogy and build in the technology and content. Studies are needed in these three approaches to determine their impacts.

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APPENDICES

Appendix I

Budget and the Work Plan

Project Budget

Item	Quantity	Cost	Subtotal	Total
Laptop computer, Digital camera	1 1	45000 8000	48000	53000
Transportation	4 weeks	1500	6000	
Subsistence allowance	4 weeks	1000	4000	
Stationery	3 rims, 5 pens,2notebooks,20CDs	2 500	2500	
Printing and photocopying	500	5	2500	
Email	3 months	1000	3000	
Internet and software	3 months	2000	6000	25000
Administrative Fee		2000	2000	2000
Grand Total				80000

Project Time Frame

January 2015- July 2015

Activity	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
Proposal development, literature review	■							
Survey items development, literature review		■						
Review and revise items, literature review		■						
Pretest items with sample of target population			■					
Fieldwork survey, literature review				■	■	■		
Statistical data analyses and transcription					■	■		
Writing of draft chapters						■		
Revision							■	
Final approval and completion							■	

Appendix II

Research Authorization Letter

REPUBLIC OF KENYA

MINISTRY OF EDUCATION, SCIENCE & TECHNOLOGY
STATE DEPARTMENT OF EDUCATION

-Email: elimu|cdewest pokot @ education.go.ke
Web: www.education.go.ke
-cdewestpokot@yahoo.com.
When replying please quote date $ Ref.

COUNTY EDUCATION OFFICE
WEST POKOT COUNTY
P.O. BOX 17
KAPENGURIA.

11TH MAY, 2015

REF: WPC/EDUC/ADM/15/20/VOL.1/26

Peter B Chesitit
University of Nairobi
Department of Psychology
P.o. Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORITY

Following your authorization from the College of Humanities and Social Sciences I hereby permit you to carry out research on "***ICT integration verses mathematics performance in public secondary schools and education office in West Pokot County, Kenya***".

Through this letter, all public administration officers are kindly requested to accord you the maximum support.

COUNTY DIRECTOR OF EDUCATION
WEST POKOT COUNTY
11 MAY 2015
P.O. Box 17, KAPENGURIA

(OWINO O.J)
COUNTY DIRECTOR OF EDUCATION
WEST POKOT COUNTY.

Appendix III

Student Enrolment

ENROLLMENT IN PUBLIC AND PRIVATE SECONDARY SCHOOLS 2013/2014 -WEST POKOT DISTRICT

CLASS	ENROLLMENT - SUMMARY											
	PUBLIC						PRIVATE					
	2013			2014			2013			2014		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
FORM I	1573	1112	2685	1880	1748	3628				23	25	48
FORM 2	1334	915	2249	1651	1615	3266				25	41	66
FORM 3	1312	744	2056	1355	1307	2662				37	46	83
FORM 4	1103	600	1703	1060	1043	2103				30	35	65
TOTAL	5223	3371	8594	5946	5713	11659				115	147	262

ENROLLMENT IN PUBLIC SECONDARY SCHOOLS 2013/2014 -NORTH POKOT DISTRICT

CLASS	ENROLLMENT - SUMMARY											
	PUBLIC						PRIVATE					
	2013			2014			2013			2014		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
FORM I	20	91	111	277	253	530						
FORM 2	24	95	119	343	125	468						
FORM 3	16	82	98	279	106	385						
FORM 4	26	70	96	239	79	318						
TOTAL	86	338	424	1138	563	1701						

ENROLLMENT IN PUBLIC SECONDARY SCHOOLS 2013/2014 -CENTRAL POKOT DISTRICT

CLASS	ENROLLMENT - SUMMARY											
	PUBLIC						PRIVATE					
	2013			2014			2013			2014		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
FORM I	774	563	1337	869	578	1447						
FORM 2	668	383	1051	718	543	1261						
FORM 3	611	336	947	586	351	937						
FORM 4	403	204	607	539	276	815						
TOTAL	2456	1486	3942	2712	1748	4460						

ENROLLMENT IN PUBLIC SECONDARY SCHOOLS 2013/2014 -SOUTH POKOT DISTRICT

CLASS	ENROLLMENT - SUMMARY											
	PUBLIC						PRIVATE					
	2013			2014			2013			2014		
	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
FORM I	70	137	207	215	161	376						
FORM 2	59	121	180	203	181	384						
FORM 3	29	118	147	186	153	339						
FORM 4	27	68	95	114	123	237						
TOTAL	185	444	629	718	618	1336						

Appendix IV

Mathematics Form Three: Students activities

TOPIC: TRIGONOMETRY II

Sub-topic: simple trigonometric graphs

i) Y =sin x
ii) Y =Cos x where X : $-360^0 \leq x \leq 360^0$

Lesson / Sub-topic Objectives:

By the end of the lesson the learner should be able to

i) Determine trigonometric ratios of angles in degrees by use of computer
ii) Fill values in the table of simple trigonometric functions/equations
iii) Use values in the filled table to draw graphs of trigonometric equations
iv) Use the graph of trigonometric equation drawn to answer questions.

REF; KLB, Secondary mathematics; Book 3, third ed. KIE Nairobi, 2013, PP. 62-65

Advancing in mathematics; Form 3, pp. 40-43

Teaching / Learning activities

- Learners to be familiarized with the Computer
- Objectives of the lesson to be outlined by the teacher
- Students to open and use excel to enter values in a table for the functions i) y = sinx and ii) y = cos x where; $-360 \leq x \leq 360$
- Learners to Use excel to plot and draw graphs of the functions above
- Students to answer questions using the drawn graphs.

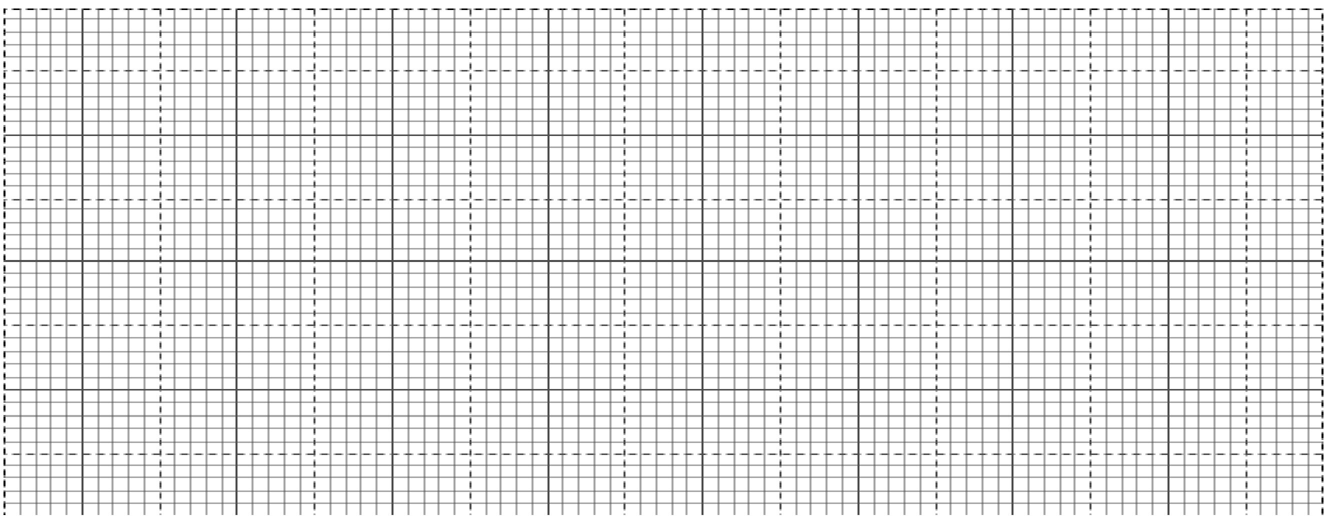
Students' Activities Worksheet

Activity 1

a) Use Computers to obtain the values for the equation Y =sin x; $0^0 \leq x \leq 360^0$. Fill the table

x	0	30	60	90	120	150	180	210	240	270	300	330	360
Sinx													

b) Draw the graph of y = sin x by use of computer



c) Use the graph to solve i) sin x = 0.25 ii) sin 25^0=?

Activity 2

a) Fill the table below for y = cos x

x	0	30	60	90	120	150	180	210	240	270	300	330	360
Y=cosx													

b) Draw the graph of y = cos x

c) Use your graph to find angles whose cosine are i) 0.45 ii) -0.84

Activity 3

a) On the same set of axes draw the graphs of y = sin x and y = cos x (use tables in activities 1 and 2)

b) i) List coordinates of intersection

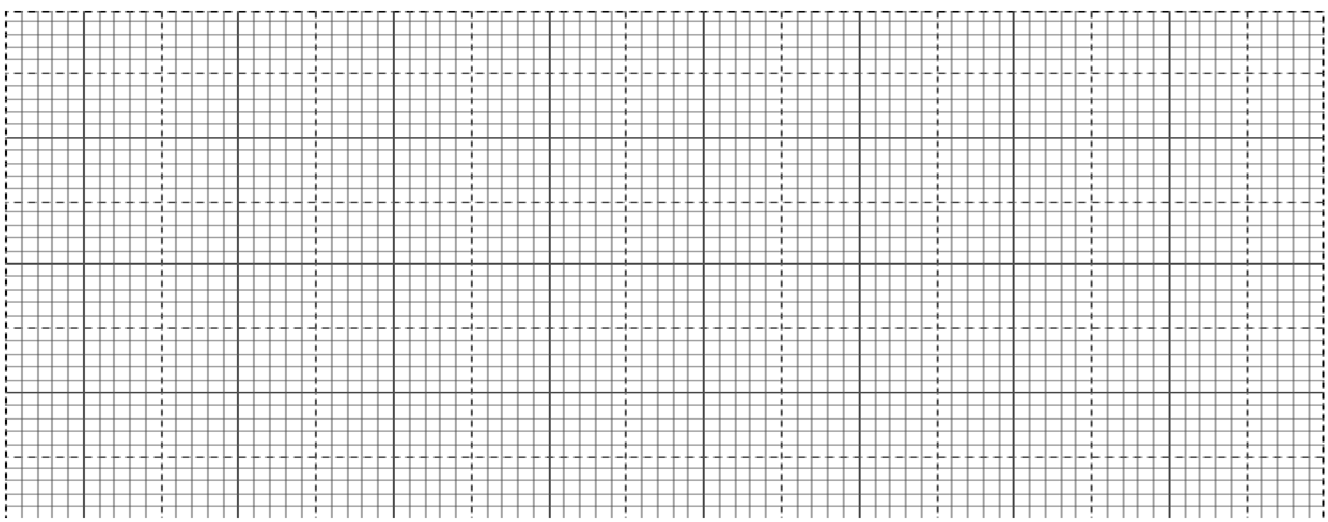
ii) State the range of angles where sine curve is above cosine

Activity 4

a) Fill the table below for the equation y = cos x – sin x

x	0	30	60	90	120	150	180	210	240	270	300	330	360
cosx													
sinx													
Y=cosx-sinx													

b) Use values in the table to draw the graph of y = cos x- sin x



c) State the angles at which the curve cuts/crosses the x-axis.

Appendix V

Mathematics Test

A Test on Trigonometry II: Sub-Topic; Simple Trigonometric Graphs

Instructions to the candidates

- **Write your details accurately**
- **Answer all the questions**
- **All the working to be written on this paper in spaces below each question**
- **Time allowed: 40 Minutes**

Name……………………….School………………….Adm. no…………Class/Stream…….

Question 1

(a) Complete the table below where $0^0 \leq x \leq 360^0$ (2marks)

X	0	30	60	90	120	150	180	210	240	270	300	330	360
Y=sin x	0.00	0.50			0.87		0.00		-0.87			-0.50	

(b) Draw the graph of y = sin x for the range above (4 marks)

(c)Use your graph to solve the following equations

(i) Sin x = 0.71

(ii) Sin x = -0.81 (4 marks)

Question 2

(a)Complete the table below where $-180^0 \leq x \leq 180^0$ (2 marks)

X	-180	-150	-120	-90	-60	-30	0	30	60	90	120	150	180
Y=cos x	-1	-0.87		0	0.5			0.87	0.5				-1

(b)Draw the graph of y = cos x for the range above (4 marks)

(c) Use your graph to find the angles whose cosine is

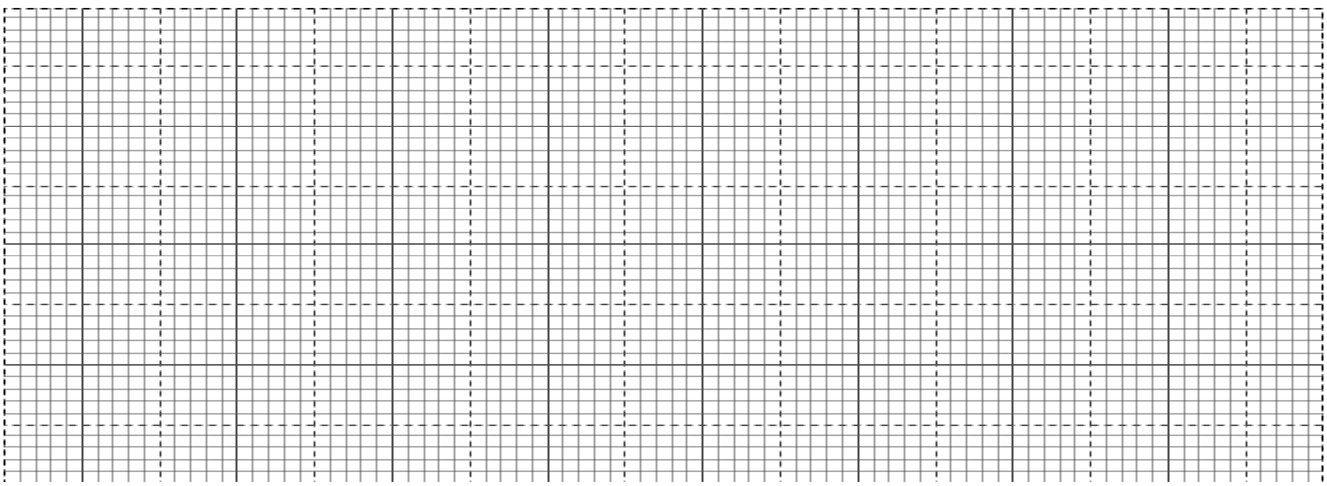
i) 0.4

ii) -0.6 (4mks)

Question 3

a) On the same set of axes, plot and draw the graphs of y = sin x and y = cos x for the range

$0 \leq x \leq 360^0$ (Hints; values of tables in questions 1 & 2 may be used) (6 marks)



(b) State the co-ordinates of points of intersection for the graphs y = sin x and y = cos x (2marks)

(c) Describe a transformation that maps the graph y = sin x onto the graph y =cos x (2 marks)

Question 4

(a) Complete the table below (3 marks)

x	0	30	60	90	120	150	180	210	240	270	300	330	360
Sin x	0	0.5			0.87		0		-0.87			-0.5	
Cos x		0.87	0.5				-1		-0.5		0.5	0.87	
Y=sinx + cosx	1	1.37		1			-1		-1.37			0.37	

(b) Draw the graph of y = sin x + cos x for $0^0 \leq x \leq 360^0$ (4 marks)

c) State the range of angles for which the graph y = sin x + cos x is above the x-axis (Horizontal axis) (3 marks)

Appendix VI

Mathematics Test Marking Scheme

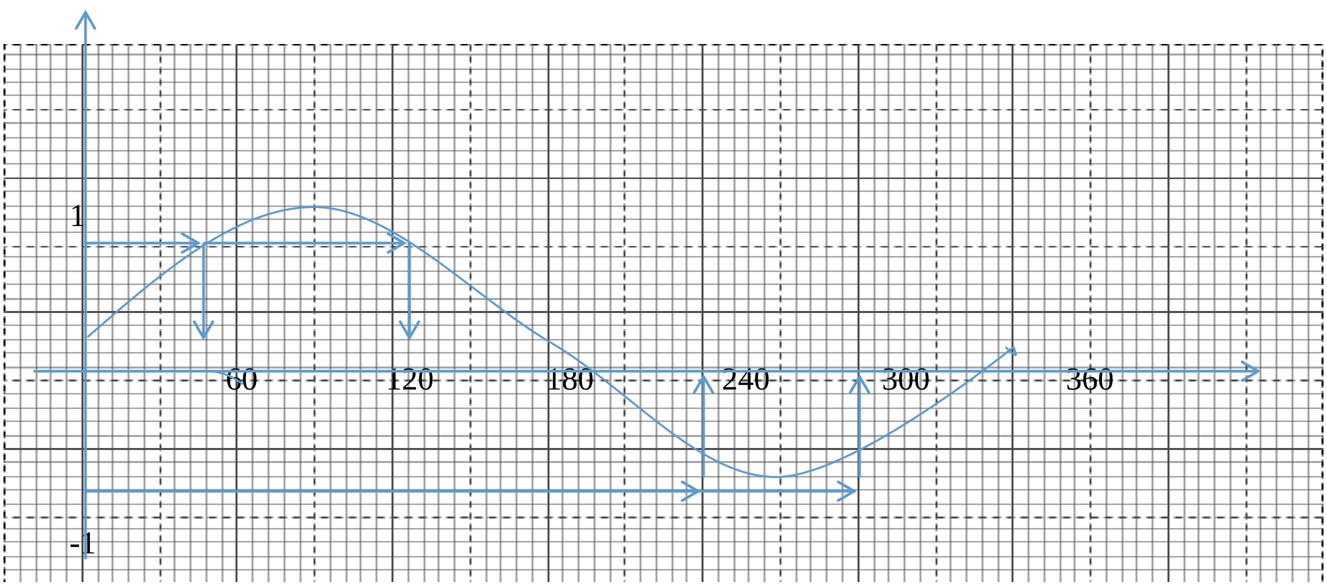
Question 1a

x	0	30	60	90	120	150	180	210	240	270	300	330	360
Y=sinx			0.87	1		0.5		-0.5		-1			0

- ✓ 0-2 no mk
- ✓ 3-4 1mk
- ✓ 5-6 2mk /2mks

Question 1b

- ✓ scale 2mk plot 1mk curve 1mk / 4mks



Question 1c

- ✓ i) 48^0, 126^0 +_1 2mks
- ✓ Ii) 240^0, 300^0 +_1 2mks /4mks

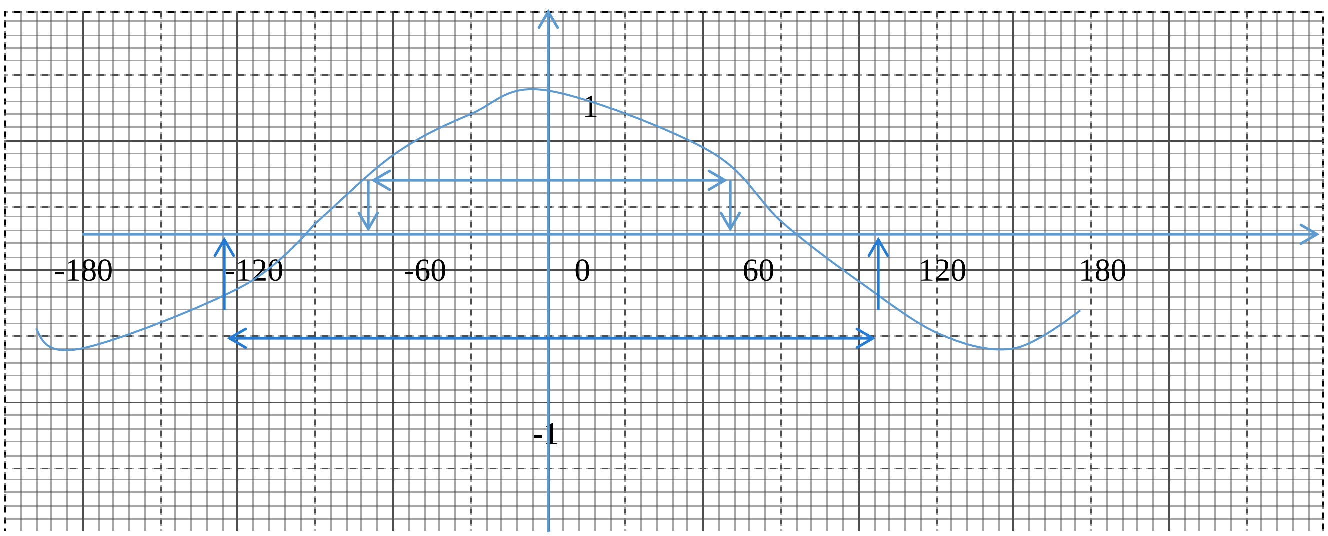
Total 10mks

Question 2a

x	-180	-150	-120	-90	-60	-30	0	30	60	90	120	150	180
Y=cosx			-0.5			0.87	1			0	-0.5	- 0.87	

- ✓ 0-2 no mk
- ✓ 3-4 1mk
- ✓ 4-6 2mks/2mks

Question 2b



- ✓ Scale 2mks plot 1mk curve 1mk / 4mks

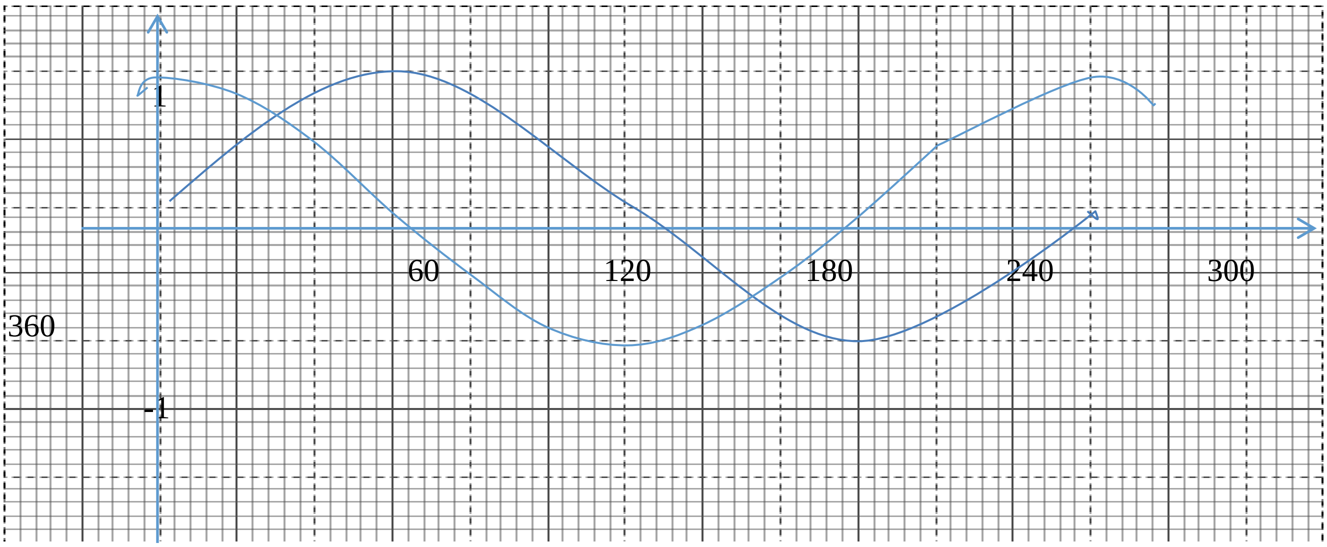
Question 2c

- ✓ i) 72^0 , -72^0 2mks
- ✓ ii) 124^0 , -124^0 2mks/4mks

Total 10mks

Question 3a

- ✓ Scale 2mks; plotting 2mks; curves 2mks/6mks



Question 3b

- ✓ (45^0, 0.7) 1mk
- ✓ (228^0,-0.7) 1mk /2mks

Question 3c

- ✓ Translation through vector (90^0,0) / 2mks

Total 10mks

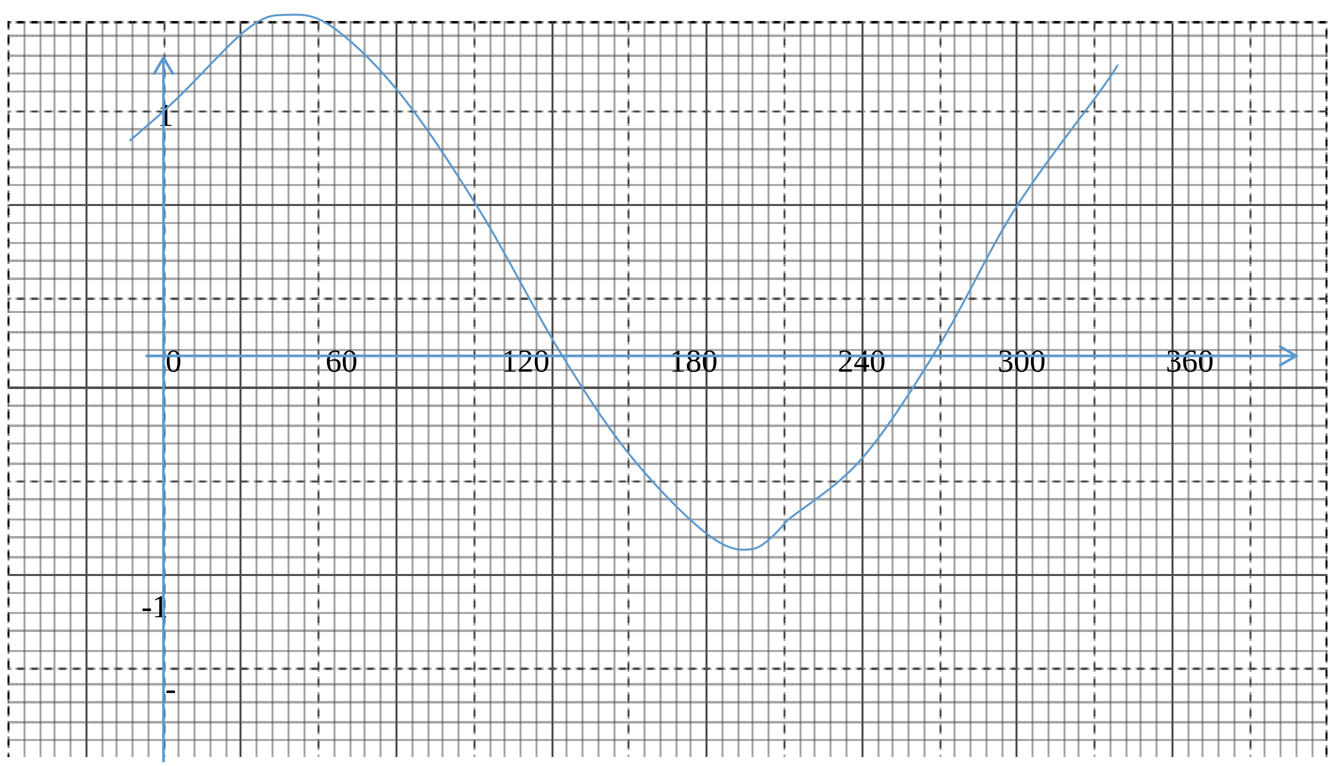
Question 4a

x	0	30	60	90	120	150	180	210	240	270	300	330	360
Sin x			0.87	1		0.5		-0.5		-1	-0.87		0
Cos x	1			0	-0.5	-0.87		-0.87		0			1
Y=sinx +cosx			1.37		0.37	-0.37		-1.37		-1	-0.37		1

- ✓ >4 correct values for sin values 1mk
- ✓ >4 " " cos " 1mk
- ✓ >4 " " for y 1mk / 3mks

Question 4b

- ✓ Scale 2mks; plotting 1mk; curve 1mk /4mks



Question 4c

- ✓ 0 -132^0 2mks
- ✓ 318^0 -360^0 1mk/3mks

Total 10mks

GRAND TOTAL 40MARKS

Appendix VII

Group performance frequency tables

ICT integrated class score distribution

score/school	Teresa girls	Karas mixed	Chewoyet boys	Nasokol girls	Kapenguria boys	total
19	4	1	1	4	0	10
20	0	0	2	1	0	3
21	3	1	0	1	0	5
22	2	1	2	1	1	7
23	2	2	1	3	0	8
24	3	1	2	5	1	12
25	5	3	5	2	3	18
26	6	1	4	2	2	15
27	5	3	6	4	3	21
28	2	1	7	3	9	22
29	0	2	3	7	4	16
30	2	2	10	3	9	26
31	7	0	3	3	4	17
32	2	0	2	3	5	12
33	1	0	3	0	4	8
34	0	0	5	2	2	9
35	1	0	2	0	1	4
36	0	0	1	0	1	2
37	1	0	1	0	2	4
total	46	18	60	44	51	219

Traditional Pedagogy learners class score distribution

score/school	Teresa girls	Karas mixed	Cchewoyet boys	Nasokol girls	Kapenguria boys	total
8	5	1	3	3	1	13
9	1	1	0	2	1	5
10	10	2	4	3	1	20
11	0	1	1	0	0	2
12	1	1	2	2	2	8
13	1	1	3	1	2	8
14	0	0	4	3	0	7
15	0	2	5	2	3	12
16	0	1	4	2	2	9
17	1	1	4	4	3	13
18	1	3	8	4	6	22
19	4	0	4	3	2	13
20	3	2	8	2	9	24
21	0	0	2	5	2	9
22	4	1	0	4	3	12
23	6	0	2	1	2	11
24	3	0	1	3	3	10
25	2	0	1	2	3	8
26	6	0	1	0	3	10
total	48	17	57	46	48	216

Appendix VIII

Photo Clips

Plate 1. A sample of students from Chewoyet Boys' high school in an ICT math lesson

Plate 2. A sample of students from Kapenguria Boys' H. School in an ICT mathematics class

Plate 3. A sample of students of Nasokol Girls in an ICT mathematics lesson

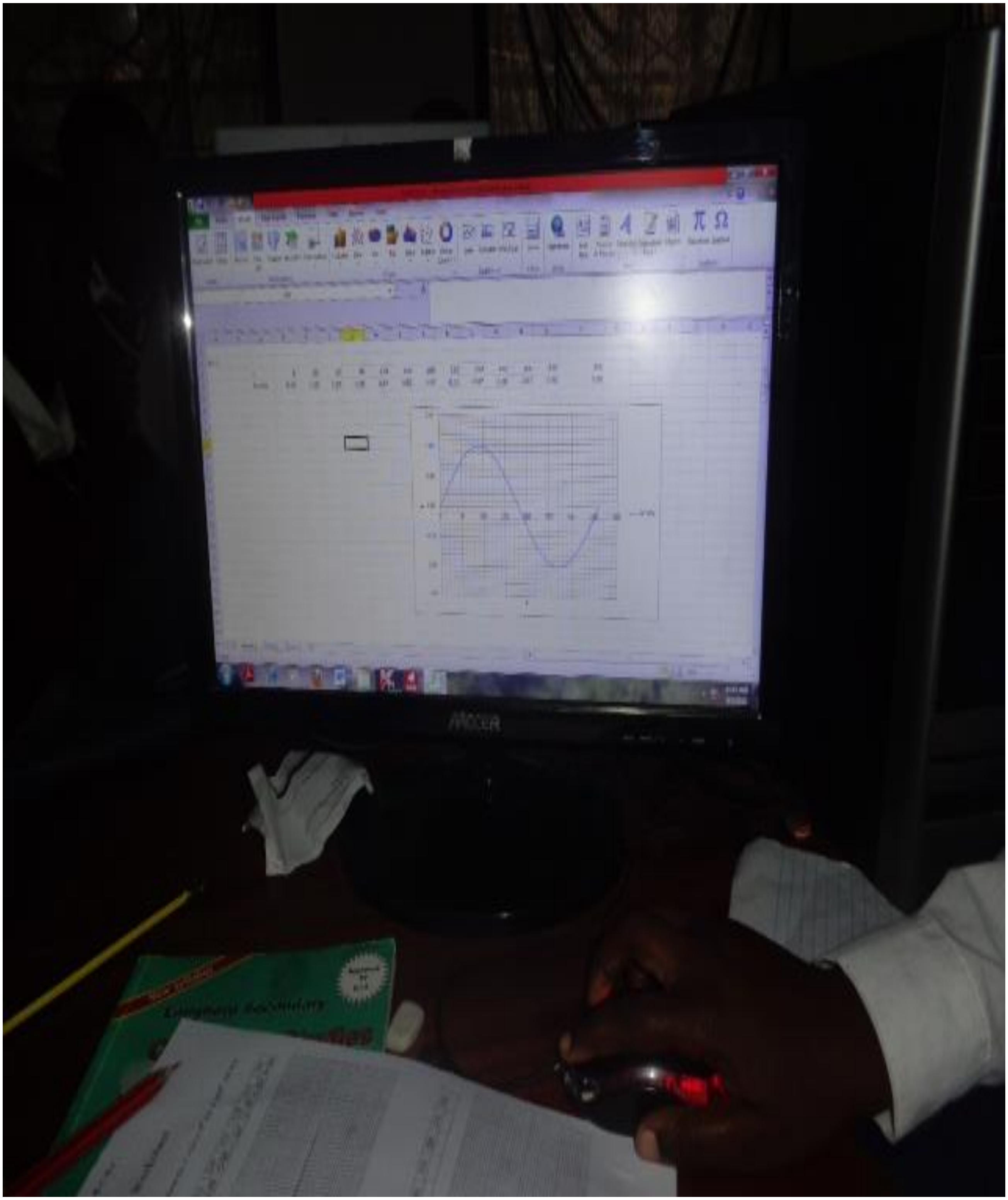


Plate 4. A sample of Tartar students in an ICT mathematics lesson

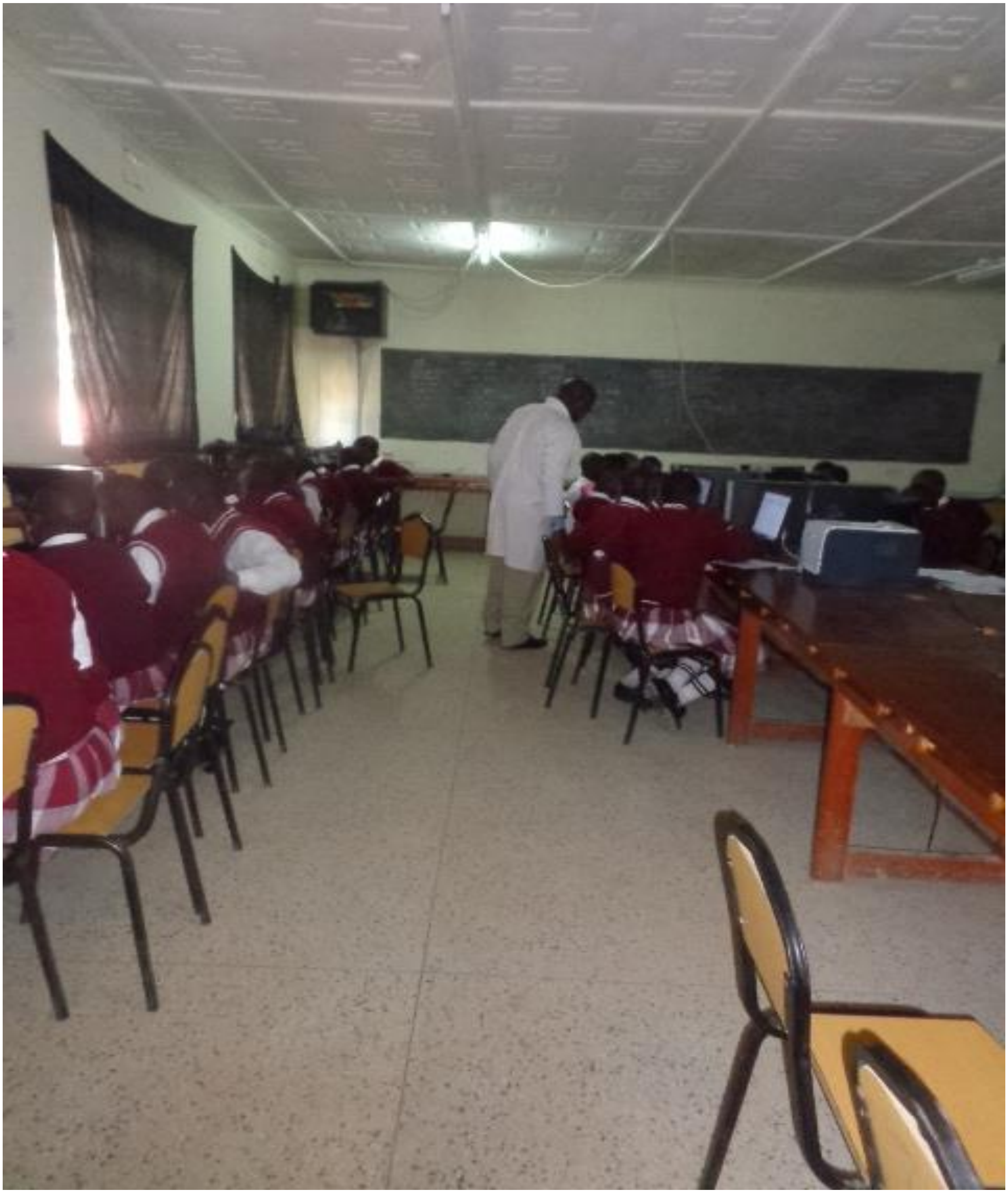


Plate 5. The researcher monitoring an ICT math lesson at Tartar Girls H. School

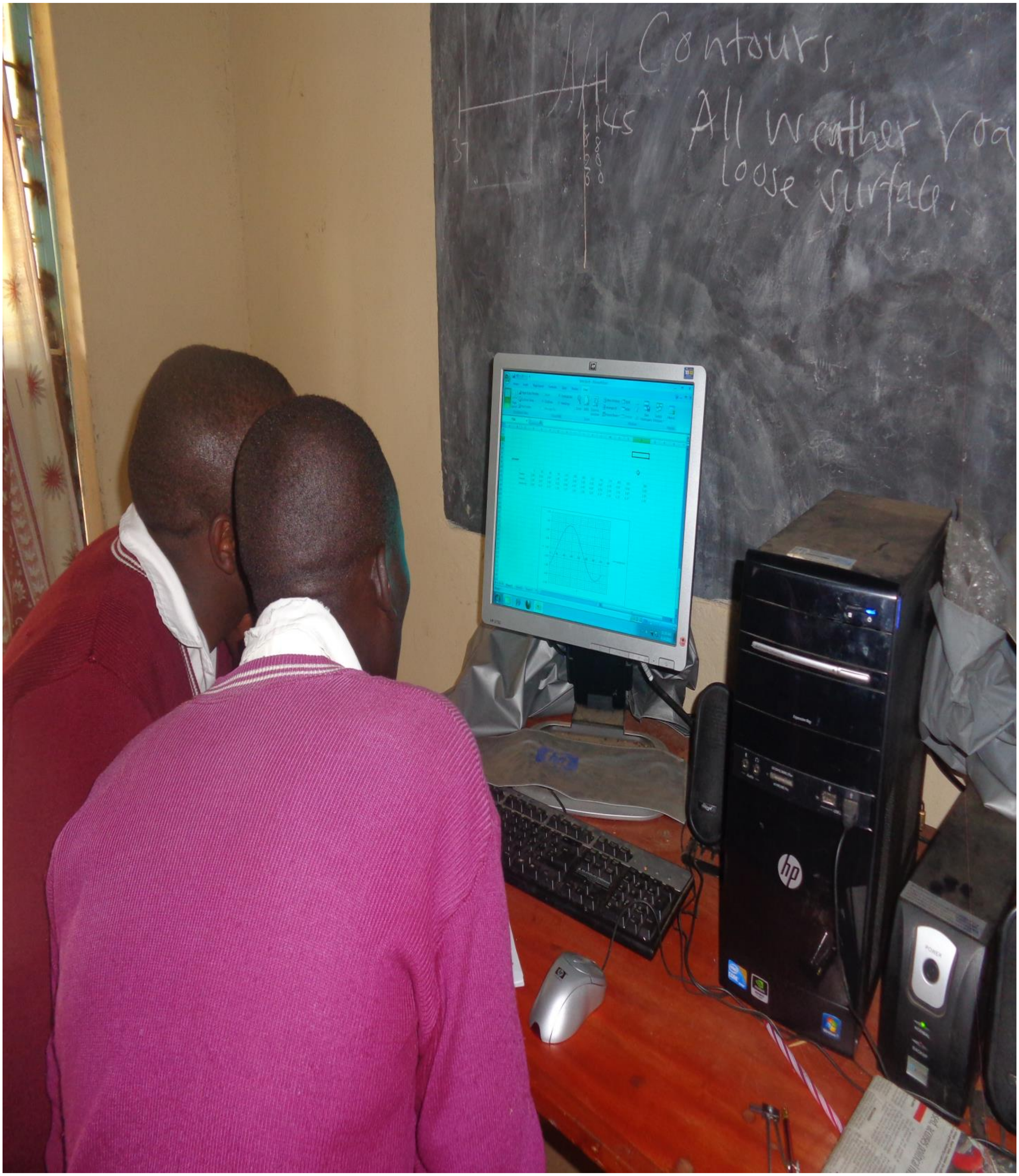


Plate 6. A sample of students of Karas Mixed day sec. school in an ICT math lesson.