

**INFLUENCE OF ICT INTEGRATION ON PERFORMANCE IN  
MATHEMATICS IN PUBLIC SECONDARY SCHOOLS IN EMBU  
NORTH DISTRICT OF KENYA**

By

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## DECLARATION

This research project is my original work and has not been presented for approval or examination in any other University.

\_\_\_\_\_ **Date: 31 /10 /2014**

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This research project has been submitted for examination with my approval as the University supervisor.

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## DEDICATION

Dedicated to my loving mother Margaret Njeri Maina for her support in my education endeavor since my childhood all through and in my career development, to her I owe my achievement in this research work. To my late passionate dad John Gachinu Muthui, the one who instilled in me the value of hard work and pursuit for higher learning in quest for search for knowledge, I will forever be indebted to his love for my success in all spheres of life.

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## LIST OF ACRONYMS

CFSK	Computer for Schools Kenya
GoK	Government of Kenya
ICT	Information and Communication Technology (mainly computers /its peripherals)
E- LEARNING	Use of computer based electronic technologies to learning
KCPE	Kenya Certificate of Primary Education
KCSE	Kenya Certificate of Secondary Education
KICD	Kenya Institute of Curriculum Development
KNEC	Kenya National Examination Council
MOE	Ministry of Education
MoEST	Ministry Of Education Science And Technology
UNESCO	United Nations Education, Social And Cultural Organization
NEPAD	New Partnership for African Development
NCETM	National Centre For Excellence In Teaching mathematics
CEMASTEAM	Centre For Mathematics Science And Technology Education In Africa
UNDP	United Nations Development Program
NML	New Millennium Learners
MDG	Millennium Development Goals
EFA	Education For All
INSET	In-service Education And Training
NCST	National Council For Science And Technology
KESCP	Kenya Education Sector Support Program
KESI	Kenya Education Staff Institute
ASL	Above Sea Level
SMASSE	Strengthening Mathematics and Science in Secondary Education
SPSS	Statistical Package for Social Sciences
TTC	Teacher's Training College
CBI	Computer Based Instruction
3D	Three Dimensional Geometry
DEO	District Education Office

## ABSTRACT

Performance in mathematics examinations in Kenya and world over has generally been poor and it has been attributed either to how the subject is taught and/or the negative attitude towards the subject. Although much research has been done on factors affecting Information and Communication Technology (ICT) integration and implementation, little has been done on how it affects performance. This study therefore sought to investigate whether ICT integration influences performance in mathematics specifically studying its influence on pedagogy. The study hypothesized that when ICT components with specific reference to computers and their integration in teaching and learning are used in presenting abstract concepts in mathematics such as 3D geometry, it could help overcome such limitations on both the learner and the teacher and therefore impact on the performance in test scores.

The study used an experimental research design to evaluate the extent to which ICT integration influences performance in mathematics. A total of two hundred and eighteen (218) students from ten different schools who were all in form four were selected with one group of one hundred and four (104) students from five different schools being taught a concept in mathematics using the traditional method of teaching i.e. face to face with a teacher and the other group of one hundred and fourteen (114) students taught the same concept using ICT components. After a period of two weeks the two groups sat for a standardized assessment test whose results were exposed to an analysis using a paired t-test to determine whether there was a significant difference between the average values of the same measurement made under two different conditions of teacher-led pedagogy and ICT integrated classroom. Both measurements were made on each unit in a sample and the test was based on the paired differences between the two variables using the SPSS software.

Key findings from the analysis indicated that in schools where ICT was integrated in the pedagogy of mathematics which was learner-centered, the learners performed much better than similar groups taught using the teacher-led method which was teacher-centered in the achievement test.

The study recommends that further research need to be done so as to evaluate the impact of integration of ICT fully in teaching of all topics in mathematics on the performance.

With the key findings in the research, it is the recommendation of this work that the teaching of such abstract concepts like 3D geometry which are perceived challenging in terms of its presentation to learners by the teacher and its conceptualization on the part of the learner in the traditional classroom method, should adopt the ICT integration to enhance academic performance in mathematics.

# CHAPTER ONE

## 1 . 0 I N T R O D U C T I O N

### 1.1 Background of the Study

The twenty first century has been named as the information age hinged on knowledge-based economy. Information in the 21<sup>st</sup> century is largely computed based and this has led to increased usage of computers in schools and at home. The use of computers in schools for pedagogical activities and information sourcing has led to the belief that access to computers could give learners an advantage in academic performance and in the job market (Delen and Bulut 2011). The resulting effect has increased and sectors of the economy including education is spelt out in Vision 2030 and it is on this background that this study attempted to determine the extent which integration of Information and Communication Technologies, hereafter referred to as ICT, in the teaching and learning of mathematics in Kenyan schools could impact on academic performance. The ICT in this study was used to refer to the use of computers in learning mathematics as compared to the Ministry of Education (MoE) definition of ICT as a range of technological tools and resources used to communicate, create, disseminate, store and manage information GoK, (2010) and the definition of ICT by Kafyulilo (2010) as all products that can store, retrieve, manipulate, transmit or receive information electronically in a digital form.

The potential of ICT in enhancement of pedagogical methods, management of schools, research and general enrichment of the curriculum is great and growing. This study considered ICT as integrated in learning when it was used to support and enhance the attainment of curriculum objectives and to engage students in meaningful learning in mathematics. The assumption of this study was that if ICT were to be integrated in learning mathematics, performance would vary from that of teacher only led learning of mathematics. ICT integration implies that the subject teacher incorporates the digital media in imparting knowledge and skills to the learners and as Gakuu and Kidombo (2010) report on effective ICT integration, there is a difference in having computers in a school and pedagogical integration of ICT in teaching since in most of the schools teaching is done using the chalk and blackboard method (traditional teaching). The

problem addressed in this study therefore was that could integration of ICT in learning mathematics lead to improved performance in mathematics.

A number of attempts have been made to improve the economy of Kenya, one of which is the economic blueprint (Vision 2030) anchored on knowledge based economy with ICT as the main driver in all sectors including education. To achieve the Vision 2030 in education, a number of initiatives have been started to introduce computer studies in schools and to integrate ICT in pedagogy. Some of the initiatives included the teacher in-service training (inset programs) aimed to start computer studies in schools and integrate ICT to teaching through training some teachers in secondary schools as trainers of trainers, the New Partnership for African Development (NEPAD) led model schools project and most recently the laptop programs in primary schools. Ayela, et al (2010) are of the view that Kenyan schools participating in a project sponsored by (NEPAD) which introduced ICT integration would act as model schools and other schools would replicate the successes achieved. This study sought to establish the gap that could be filled through the ICT integration in mathematics performance.

The need to introduce ICT in mathematics teaching in Kenya has been occasioned 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). This study attempted to measure the difference in performance in mathematics between teacher-led and ICT integrated classes respectively in Embu North District with the objective of having some measure of ICT integration in teaching mathematics as a possible solution to challenges in mathematics performance.

## 1.2 Statement of the Problem

This study addressed the problem of poor performance in mathematics in secondary schools of Kenya by considering the possible role of ICT integration in improving teaching and learning in classroom. This was accomplished through an experiment involving 10 schools with 5 control schools as teacher-led mathematics learning and 5 experiment schools as ICT integrated mathematics learning. The 10 schools were then subjected to a common mathematics examination of 50 minutes duration, the results of which was used as a measure of performance. The performance measures were then subjected to statistical tests to determine if there was a

significance difference in performance between the teacher-led mathematics classes and the ICT integrated mathematics classes. The results of the statistical tests were used as measures of the influence of ICT integration of mathematics learning in performance in public secondary schools in Embu North District of Kenya. In the study area, most schools where computer studies were offered, it was mainly to prepare learners for computer learning as a discipline on its own merit without any link to other disciplines. To improve on the integration of ICT in other disciplines, the study used mathematics as a starting point since computer studies and mathematics tend to be closely related and therefore transition from computer studies to computers in mathematics was expected to be relatively easy. The integration of ICT in mathematics was expected to ease understanding of some abstract concepts in mathematics and representation of 3D elements in geometry to be visually consumable given the computer graphic abilities thus making learning and understanding geometry easy. If this were to be the case, then ICT integration in learning mathematics would not only improve performance but also solve the problem of lack of teachers in many secondary schools in Kenya.

### 1.2.1 Research Question

The specific question addressed in the study was:

1. Has teaching pedagogy due to ICT integration influenced performance in mathematics in public secondary schools Embu North District?

### 1.3 Objectives of the Study

The specific objective in this study was to determine:

1. The impact of ICT integration in mathematics learning on performance in public secondary schools of Kenya.

To achieve the stated objective, the study used the following hypothesis as research guide to be tested using the collected data.

### 1.4 Research Hypothesis

There is no significant difference in performance between the teacher-led mathematics classes and ICT integration in mathematics classes of public secondary schools of Embu North District.

## 1.5 Significance of the Study

Among those who may find the findings of this study of relevance include the MoE officials. As an evaluation study, the findings of this study may serve as a feedback and assist them in strategic planning.

Another beneficiary of this report may be the Kenya Institute of Curriculum Development (KICD) which is the national curriculum development and research centre. The findings of this study thus may be an important feedback and fundamental basis for curriculum revision especially following the launching of the e-learning content at KICD for schools.

The Teachers Service Commission (TSC) may also find this report useful as it may serve as a source of information from schools about the use of ICT in public secondary school. This may put TSC at a better position not only to recognize its resources in terms of teaching personnel but also be able to advice training institutions on what to train and the practical qualitative skills needed in classroom situation in relation to ICT.

The public secondary schools may also stand a chance to benefit from this report. This is because these institutions are the key players in the education system hence the findings of this study may be an essential eye opener to school principals, teachers and students since it indicates to them the performance disparities due to ICT integration in the teaching pedagogy.

## 1.6 Operational Definition of Terms

<b>Computer literacy</b>	Knowledge and ability to use computers and technology efficiently
<b>ICT</b>	The range of technological tools and resources used to communicate, to create, to disseminate, to store and manage information
<b>ICT Integration</b>	Use of ICT in support and enhancement of attainment of curriculum objectives engaging students in meaningful learning
<b>Hypertext-</b>	A link in the internet pages that links to another page
<b>Hypermedia-</b>	An extension of hypertext providing multimedia (combined use of many media) such as sound, text graphics and video
<b>Mathophobia-</b>	Fear or anxiety of learning or doing mathematics
<b>Teaching Pedagogy</b>	The methodology used in teaching a particular skill or value by a teacher
<b>Technophobia</b>	Fear of technology

## 1.7 Study Matrix

Embu County is located approximately 120km (75miles) north east of Nairobi and on the south eastern slopes of Mt Kenya bordering Tharaka Nithi to the north, Kirinyaga to the west, Machakos to the south and Kitui to the east. It has a temperature range of between 12<sup>0</sup>- 21<sup>0</sup>c, average rainfall of 1499mm annually, and an average elevation of about 1,350m asl (4429ft). The County's major strengths are: natural resources such as wildlife, forest, hills, arable land, tourist attractions e.g. waterfalls, Karue hills, and diverse economic activities which include dairy farming, coffee, tea macadamia nuts, and commercial business. This vibrant economy was expected to impact on the education standards in the county in relation to support from stakeholders especially in the agricultural-rich parts of the county.

Embu County covers a land mass area of 2,818 km<sup>2</sup>, with a population of 516,212, male 49% female 51%, and a population density of 183 people per km<sup>2</sup> and out of the 131,683 households, 40.8% of the population live below the poverty line. The total population with primary education is 71.3%, and with secondary education 15.5%. The population attending school between age 15-

18years is 71.3%, and the population that can read and write is 92.7%, (Kenya's population census data 2009).

There are 494 primary schools and 147 secondary schools. The primary school enrollment is 125,418, with a teacher: pupil ratio of 1:32 in public schools. The enrollment in secondary schools is 27,173 with a teacher: pupil ratio of 1:23 in public schools. This information is a key indicator to the measure of access and perceived quality of education in the county. The transition rate from primary to secondary school currently stands at 68%. The County has over 15 tertiary institutions (including a university affiliate college, youth polytechnics, TTC's, technical colleges and several commercial colleges. Adult literacy classes' enrollment is over 1500. Most of the areas in the county are served by power lines which has been intensified by the rural electrification program which means that most of the schools can be able to use ICT in learning.

# 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, study trends and methods in ICT integration in pedagogy and to assist in identifying gaps in the field of study. The review was conducted topically as guided by the stated problem, the objective and the hypothesis and this resulted into six sub-sections starting from the general literature on ICT in education, ICT and pedagogy, ICT integration in mathematics, teaching and performance of mathematics to the approaches taken in mathematics learning. The review was concluded by a summary of the key findings which were used in the conceptualization of the study.

### 2.2 Review of Literature

#### 2.2.1 ICT in Education

World over, computers are becoming important tools for everyday use in many sectors, in education and in school setup where learners may have similar uses of the ICT technology depending on exposure. Kang et al (2011) refers to a new generation of children who grew up in an environment of ICT, the New Millennium Learners (NMLs), as people who are likely to refer to the internet whenever faced with a question and that ICT among students was therefore used in a variety of ways such as to construct and acquire knowledge, to solve complex problems, to acquire new skills among other functions. This study sought to show that the new generation of learners would suitably identify with the method of teaching that incorporates ICT in the learning process.

The year 2015 was the target specified by Millennium Development Goals (MDGs) and the Education for All (EFA) initiatives to achieve universal primary education access. Many countries, Kenya included are far from reaching these goals mainly due to shortage of teachers, infrastructure, and resources. One way which governments employ in order to improve, expand instructional objectives and increase quality education accessibility is the use of ICT because it allows students' interests, needs, strengths and weaknesses to drive the learning process with

teacher facilitating rather than dictating (Rogers, 1995). Findings in America revealed that ICT has the power to dramatically remake American schooling, raising performance standards while potentially simultaneously cutting costs. The report established that ICT enabled the emergence of a new kind of pedagogy that was focused on meeting the needs of individual students (mass customization). This ICT enabled approach marks a departure from the current pedagogy in which all learners are treated more or less alike mass production (Kozma, 1992). In this study therefore integration of ICT as a teaching pedagogy was used to evaluate the performance impact in mathematics as a discipline.

The new technology in education where students use ICT to personalize learning can produce even stronger results, enable and empower students to pursue their own knowledge, provide asynchronous learning and enhance content and information rich resources that are not limited to one physical copy that resides in only one location. Given the role ICT plays in global economy, educationists would not accept to reduce investment in ICT based learning resources and the ICT infrastructure in the educational institutions, (Morrison, 1998). The objective of this study was thus to underscore the role of ICT integration in enhancing academic performance using multimedia.

In his study on the extent of ICT in education, (Kozma, 1992) observed that while ICT continues to advance in the developed western countries, Africa and other developing countries still experience a lag in its implementation in education. According to the survey on the use of ICT in South African schools however, results indicated that although still in the early stages, the nation had made significant progress towards integration of ICT in schools. In line with these findings and like the rest of African countries, Kenya is no exception and has made strides through the MoE by recognizing the role played by the ICT in education noting that in the current globalized economy, a country needs an ICT literate workforce that will enhance its participation in the knowledge economy. The ministry admits that ICT in education was the natural platform for equipping nations with ICT skills for dynamic and sustainable economic growth. The ministry warns that any country that fails to integrate ICT risks serious marginalization on the global scene, (MoEST, 2006). In order not to be left behind, the Kenyan government through the education ministry is currently working on a number of strategies as articulated in the Sessional Paper Number 1 of 2005 to address the challenges of ICT in education. Some of these strategies include the mobilization of resources to promote ICT access, digitalization of the curriculum as

is being undertaken by Kenya Education Sector Support Project (KESSP), identifying pilot schools to serve as demonstration for future roll out to other schools and integrating ICT in the syllabus for pre-service teacher training as well as organized in-service capacity building to equip serving teachers with ICT skills. The Kenyan education sector has also been at the forefront of ICT integration in transforming the citizenry and enhancing digital formats or e-learning in educational institutions including secondary schools. Recently the KICD launched the e-learning content in which educational materials in form of CD ROMs and DVDs were produced for school. This in essence is a step forward towards curriculum digitization, (KICD, 2010).

A study by Gakuu and Kidombo (2010) show that although ICT integration is a commonly embedded policy in private schools, such policies are missing in public schools in Kenya and gives an example of some private schools sampled where it was a mandatory requirement for a teacher applying for a job to be computer literate so as to qualify. Integration of ICT in these schools was done with a view to attract students to such schools and to improve their performance. The head teachers' ICT skills seemed to influence the decision to integrate ICT to teaching and as Gakuu and Kidombo, (2010) report, schools where the head teachers had higher qualification in ICT they were more likely to encourage their use in a greater way in teaching and learning.

Reports by the GoK (2005, 2006), proposed the need for the KICD and other stakeholders in the education sector to come up with custom made digital content to meet the local demands for education. The report particularly observed that since computer discs do not come preloaded with relevant teaching content in line with Kenyan curriculum and language there was need to customize the content. This study attempted to address a particular topic, 3D geometry which is in tandem with the outlined specific objectives of the topic in the secondary school mathematics syllabus.

### 2.2.2 ICT and Pedagogy

Kelleher, (2000), reviewed recent developments in the use of ICT in teaching and observed that ICT cannot replace the normal classroom teaching but it could be a positive force in classrooms

enhancing deeper understanding of the principles and concepts of mathematics that could provide new, authentic, interesting, motivating and successful learning experiences. The net effect of this would be better performance in the subject. The new ICTs have other potential benefits as tools for enhancing teaching of mathematics (Skinner and Preece, 2003). These tools include those for data capture, multimedia software, for simulation, presentation tools, digital recording equipment and computer projection. This study was focused on multimedia software as a means to pedagogical alternative in mathematics teaching and learning.

The National Centre for Excellence in Teaching Mathematics (NCETM) in England makes use of computers in a number of ways; interactive tutorials, hypermedia, simulations and even educational games NCTEM, (1996). Tutorials as a type of software application presents information, checks learning by question and answer method, judge response and provide feedback while providing students an opportunity to study personally (Newhouse et al, 2002). This study found this particular implication of great input as a form of ICT integration in learning of mathematics especially in regard to interactive benefit of ICT integration in mathematics class. Furthermore, teachers can use ICT tools to increase student productivity particularly with repetitive, low level tasks involving writing and computation. While it may be necessary for teachers to develop student's skills on most occasions, they are beneficial as a prerequisite to some higher level tasks, (Newhouse et al, 2002). Mathematics teachers who use computers are likely to develop more positive attitudes towards their work when they use computers and this is likely to help maintain interest in a wider range of students. The interactive and multimedia features can be used to help students grapple with more challenging concepts such as 3D in mathematics and in their performance which this study sought to evaluate in public secondary schools in Embu North District.

In Kenya efforts are being made to transit from teacher-led method to e-learning through ICT integration for example participants selected from TTCs, Centre For Mathematics Science and Technology in Africa (CEMASTEIA), KICD, Kenya Education Staff Institute (KESI) have been incorporating e-learning teaching methods in readiness to teach others (Gitonga, 2009). Kenya vision 2030 which is the nations' new development blueprint for the period 2008-2030, aims at transforming Kenya into a newly industrialized "middle income country providing high quality life for all its citizens by the year 2030 (NESC, 2007). The education goals for the vision are to provide globally competitive literacy by increasing access to education, improving the transition

from primary to secondary and raising the quality and relevance of education. Specific educational development projects for 2012 are to increase the number of secondary schools, establish a teacher recruitment program to employ 28,000 more teachers and to establish a computer supply program that will equip the students with ICT skills, (MoEST, 2006). In this vision therefore, the government has a focus on governance, access, quality, relevance, equity, strategic collaboration and partnership research. This study sought to address itself on the quality and relevance of the human resource graduating in our secondary schools in line with the vision blueprint.

### 2.2.3 ICT integration in Mathematics

Introducing technology into the learning environment has been shown to make learning more student-centered, to encourage cooperative learning and to stimulate increased teacher student interaction and that teachers using ICT applications in their pedagogy are likely to show gains on measures of progressive thought and reflection, (Newhouse, 2002). The use of ICT thus encourages teachers to use more cooperative work and less teacher lecturing as this study sought to find out that in schools where ICT was integrated, teachers enabled their students to be field independent (i.e. learners who rely less on contextual clues in defining meaning) thus enabling them perform better than field dependent learners (Weller, 2002). The use of ICT in teaching mathematics can therefore raise understanding and give better insights into mathematical concepts and the support of ICT to mathematics teachers comes in handy when helping their students design and produce their own knowledge presentations and thereby engage with powerful learning experiences. Therefore application of ICT employs methods that intensify understanding of mathematical concepts through a wide range of technologies could be available to teachers and whose applications could be designed to match user characteristics and the requirements of mathematics curriculum tasks (Leask et al, 1999). This study sought to investigate the underlying impact of the use of ICT in enhancing performance in mathematics through a student-centered approach. Gachenga, (2007) identified assignments, demonstration as well as drill and practice as the most common methods used in teaching mathematics. These teacher-led methods however, only tended to slow down learner creativity and problem solving cues, and instead this study found out that offering unlimited access to use learning technologies

could be a very important aspect in teaching mathematics concepts in abstract topics especially 3D geometry which would stimulate the learner towards better performance.

While reporting on the use of ICT to teach mathematics, (Rahman *et al.* 2003) linked ICT in three ways; using the technology as a data analysis tool, using the technology as a problem-solving or modeling tool and also using it as a tool to integrate mathematics with context. This study addressed itself to the use of ICT integration in mathematics context.

In a study done in Kenya and Uganda it was found that mathematics teachers rarely used ICT to teach (Kidombo, 2010). In Kenya for instance, one of the challenges the country faced in efforts to integrate ICT to learning was coming up with appropriate digital content yet excellence in mathematics as a subject was viewed as a key subject and a formidable link to numerous careers as well as a gateway to easier learning of other subjects in school. According to Rahman *et al.* (2003), Mbugua *et al.* (2012) and Shikuku, (2012), problem solving was an activity mathematics teaching must be centered on and which this study articulated through ICT integration in teaching pedagogy. Earlier studies by Polya (1957) noted that the process of problem solving in mathematics involved four steps: understanding the problem, devising a plan (solution), implementing the plan and looking back (examining the solution) all of which demanded the ability to develop a deep understanding of the problem and to devise a plan to solve them. To this extent therefore this study identified these existing loopholes in the pedagogical approach in the teaching of mathematics and that endeavored to have the learner get more involved in the learning process.

Teaching of mathematics and causes of its poor performance has previously been widely researched on and Rahman *et al.* (2003) for example identified other challenges which affected effective teaching of mathematics such as incompetence of the teacher in problem solving skills, the pressure to cover the syllabus on time and the pressure to perform well in exams. Such key factors compelled teachers to opt to drilling the learners on how to get answers rather than how to solve the problem. On a related study done by Ozgun-Koca et al, (2002) on the extent of ICT integration in mathematics, there was very little of its use in classrooms and instead there existed intensive lecturing and note-taking, loading students with lots of information in the broad curriculum, matters which became the key factors that led to poor performance in mathematics. This was further supported by Cey, (2001) who argued that authentic learning in classes had

been replaced by use of discussions, lectures and paper and pen method of teaching which failed to let students discover knowledge on their own. This study therefore sought to find out the alternative to this approach by teachers and instead involve learners in their own cognitive development through heuristic method by integrating ICT in teaching and learning.

#### 2.2.4 Teaching and Performance of Mathematics

The current mathematics syllabus in Kenya has 68 topics (23 in Form 1, 20 in Form 2, 15 in Form three and 10 in Form four) to be taught within the four years (KIE, 2002). Recent developments in teaching mathematics in Kenya such as introduction of the use of scientific calculators for instruction and examination in the year 2005 (MOE 2005) as a form of computer based instruction (CBI) in the teaching of mathematics was thought of as a way forward in integration of ICT components in the subject. Although some statistical parameters such as weighted averages are applied by the national examinations body KNEC to arrive at marks and grades distribution very year, the performance of the subject in national exam in Kenya has not been satisfactory as exemplified by the table below which shows performance in mathematics in national exams in both papers for the lasts 8 years.

Table 2.1: KCSE Performance in Mathematics over the last 8 years

Year	2005	2006	2007	2008	2009	2010	2011	2012
<b>P1 Mean mark</b>	19.95	22.71	19.55	22.76	22.37	26.21	21.36	29.46
<b>P2 Mean mark</b>	19.51	15,36	19.91	19.82	19.89	19.92	28.22	27.86

Source: KNEC: 2009, 2010, 2011 and 2012).

Although there exists a rich literature on possible causes of this poor performance for example the congested syllabus and perceived difficulty of content in some topic areas by the students, (Kanja *et al*, 2001) and Ogwel, 2008), this study sought to investigate the impact of teaching pedagogy on the performance of mathematics.

Some learners have exhibited lost interest along the way in mathematics as they moved from junior to senior classes in secondary schools partly attributed to low motivation among students, the teaching pedagogy adopted by teachers, overloaded curriculum and poor management of the subject by the schools. Following these findings this study delved into an analytical insight on

the impact the teaching styles of the subject teacher in the mathematics classrooms on academic performance.

Ogwel, (2008), argued that integration of ICT in mathematics education necessitated a re-examination of the curriculum and a shift from the result-oriented pedagogy. He alludes that the curriculum emphasis ought to guide the learners the ‘how’ of doing the mathematics in order to solve problems rather than just to get the answer to a problem. This study sought to investigate the link to this work done by Ogwel in the sense that mathematics teaching ought to have a practical aspect in its approach just like any other science subject whereby theorems learnt in class were made practical.

In a related study, (Kanja et al, 2001) were of the opinion that the education system in Kenya was so much exam oriented that students were just keen to take information from teachers without questioning and upon doing the exam they were not keen to go back to mathematics which has lots of application in real life. This study found out through the topic 3D geometry that learners needed to shift their objectives of learning mathematics from just doing a test to having knowledge in it that they would apply in real life experiences. This study also sought to give hope to such students so that they could excel and advance in the various fields of mathematics through an integrated approach that links it with other discipline areas.

Another major challenge in teaching of mathematics identified in this literature was the lack of adequate resources. To this end the government sponsored in-service course: Strengthening of Mathematics and Sciences in Secondary Schools Education (SMASSE) program advocated for the teachers to improvise teaching and learning materials from the environment in what was called: Activity, Student, Experiment and Improvisation (ASEI) lesson, which was an endeavor to demystify the concepts thought difficult to conceptualize such as 3D using local resources to bridge the existing gaps.

### 2.2.5 Approaches Taken in Mathematics Learning.

The Kenya National Examinations Council KNEC, (1996) and the GoK, (2005) reported that lack of mastery of basic concepts in mathematics contributed to student’s poor performance. Furthermore, understanding the language used in mathematics had been cited as a cause of poor performance in a study carried out by Githua (2013), who argued that mathematics tests used terms which meant other things in the other subjects and learners had difficulty in understanding

exactly what the teacher and the question meant. This study sought to use an ICT component through a source that would use a mathematical language with clear meaning to the concepts.

Kaffash *et al.*, (2010) observed that the use of ICT in learning contributed to mastery of complex cognitive skills which couldn't be determined by means of simple standard tests and therefore ICT integration in mathematics was projected to make students acquire concrete skills and be more analytical in their responses to tests. In a related study, (Cey, 2001) observed that knowledge did not come from someone else but from experiences which needed to be internalized to make meanings to a student and in turn the student needed to construct knowledge which was deeper to be able to apply what was learnt in class to real life situations.

Some of the tools used in schools to teach mathematics included models to teach geometry, hypermedia and digital encyclopedia such as Encarta. Rahman *et al.* (2003) postulated that the use of technology saved time and gave learners access to powerful new ways to explore mathematics concepts at a depth that had not been possible in the past. For students to learn online and using ICT, Tsai, (2012) emphasized on students' involvement or heuristic learning and termed this teacher- facilitated student- centered pedagogy as most productive, a finding this study sought to investigate through ICT integration.

Integrating ICT in learning mathematics was said to have the benefit of motivating students in learning especially in instances where activities were challenging, multidisciplinary and multi-sensorial. It also had the advantage of simplifying abstract concepts to real life situations, foster a sense of inquiry and exploration and allowed students use information acquired to solve new problems besides formulating new ones (GoK, 2005). Such students could be creative and collaborative with other students within the country and around the world in learning through virtual linkage, blogs and electronic bulletins to exchange information with others over the electronic platform, (Kang *et al.*, 2011). This approach had the benefit of making learning concrete rather than abstract whereby learning became more effective because the learners were able to manipulate learning and teaching resources in the modern ICT integrated approach.

Kizlikaya and Askar, (2008) observed that pedagogical interface agents such as software character assisted social learning and presented computer simulations to create an interactive learning environment. Their study concluded that when these were used to teach, learners were

given instant feedback and motivation and hence learnt better and faster and could remember more when a test was administered than the control group. This was also correlated in this study findings.

Commenting on methodology and transition rates, (Gakuu et al, 2010) were of the opinion that the use of ICT integration could make learning more interesting hence reduce drop out from the schools which was a common feature in developing countries. They gave an example of a study involving street children who were trained using internet and later found out that they recorded a higher than usual rate compared to students going back to the teacher-led schools. Related to this was an observation by Wimbish, (1992) which found out that weaker students were often better able to succeed with the help of technology, and thus concluded that mathematics was not just for their more able classmates, but that the approach mattered most in enhancement of performance which this study sought to investigate. Lee et al, (2009) in their study found that students using computers to learn at least one hour a day had better performance in mathematics and reduced learning gaps among students of varied backgrounds, and on this basis this study sought to find out the impact of a purposeful ICT integration on teaching methodology and performance.

ICT based learning could change students' perception or attitude that mathematics was a difficult subject because ICT integration could open an opportunity where students and teachers may access a variety of information relevant to solving specific learning difficulties, exposure to more tests and a varied type of questions which the teacher couldn't be able to give to the learners in class. It was therefore found important to understand the concepts in mathematics rather than just follow steps and get satisfied with getting the right answers. This thought was shared by Tsai, (2012) who was of the opinion that problem-solving approach in students' collaboration through ICT medium could help students be more confident and more involved in the learning context and in their courses.

Low ratio of text book per student was cited in the literature by Shikuku, (2012) as a cause of poor performance in mathematics. Mathematics being a practical subject where students needed to exercises regularly yet text books were inadequate or rapidly worn out, led to students developing learning difficulties. However, ICT approach could solve this problem of low book ratio since a soft copy of the book could be easily duplicated to many computers and have a

larger group of students do mathematical exercises regularly over and over again. This study sought to relate this finding using an ICT integrated methodology.

In their research, Yara and Wanjohi (2013) found that teachers' qualification and experience had an effect on performance of mathematics and so was the category of school, for example boys' only schools on average did better in mathematics than girls' only schools. Coupled with this this, the newly posted teachers were found to be inadequately endowed in preparation of candidates for national examinations compared to the experienced teachers who had perfected the art over the years. This study sought to investigate the import of a teacher's skill and teaching style on performance in mathematics.

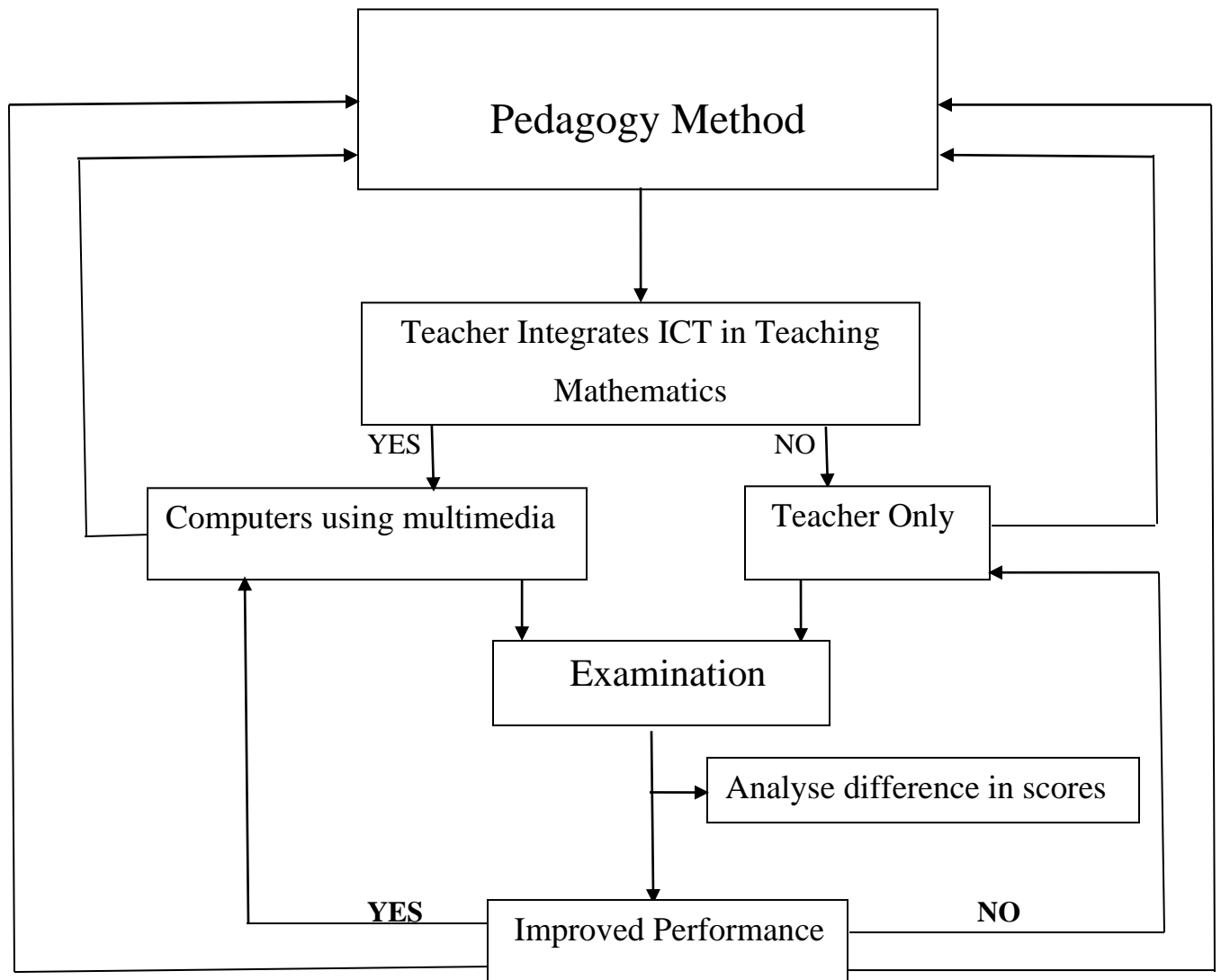
### 2.3 Summary of Literature

This literature revealed that there were several factors that would determine how much ICT integration could be done in a class of mathematics to enhance performance. There existed massive empirical data on benefits of the progressive thought that ICT integration as a teaching pedagogy would impact on performance that education stakeholders, teachers and learners would reap if fully utilized. Literature also revealed that the use of ICT could help make the learning concrete and less abstract. This study sought to address gaps existing in the use of ICT to change teaching pedagogies.

Although there were lots of data showing how integration could solve the challenges of teaching, there was little or no empirical data that showed how deep and widespread ICT integration had been done in mathematics classes in Embu north district public secondary schools and in the entire country. Little had been mentioned on what extent learning mathematics had been made less abstract by integrating it to ICT. The study sought to bridge this gap by using examples in Embu north district and whose results could be used to generalize in the rest of the country.

## 2.5 Conceptual Framework

Figure 1.1 is a schematic diagram showing the influence of ICT integration on academic performance of public secondary schools in Embu North District.



**Fig. 1.1: Schematic Diagram**  
(Source: Researcher, 2014)

The conceptual framework summarizes the expected linkage of the impact of ICT integration in education and mathematics performance with main focus on the specific objective related to the teaching pedagogy. It was hypothesized that an integrated pedagogical approach to the teaching of 3D concept influenced mathematics performance resulting in improved quality grades and it was therefore recommended to integrate ICT in education, the alternative would be to resort to the traditional method of teaching in instances of absence of significant difference in the two approaches.

# CHAPTER THREE

## 3.0 RESEARCH METHODOLOGY

### 3.1 Research Design

The research used a modified experimental design which was accredited to Solomon (1949) and it incorporated a learning exposure followed by a written test. The design consisted of one experimental group and one control group. A small number of participants was chosen so as to obtain a more refined information. For that reason and for efficient management and control of the experiment conditions, it was then necessary to use a small number of schools in the teaching experiment reported here.

Five schools were therefore used to provide experimental groups. According to the design the five (5) schools provided one hundred and fourteen (114) participants distributed over the cluster region. These were schools that had computer laboratories and computers with DVD drives which were to be used by the students to learn the concept of 3D as provided in the CD that was issued (plate ii). The CD contained a structured lesson on 3D as outlined in the syllabus. They were required to use it during the scheduled time table sessions and at any other time at their own convenience during the specified duration of the study which was 10 hours 40min.

The other category was of the control group drawn from five (5) schools also within the cluster region which provided one hundred and four (104) participants for the study. They were exposed to the traditional teacher method of teaching and learning of the concept of 3D for a similar duration of time as the experimental group. They were also required to seek the assistance of their teacher other times besides the lesson times to consult on areas they had challenges with.

Immediately after the stipulated time of learning, the two groups then sat for a similar standard achievement test based on the specific instructional objectives outlined after the two different modes of teaching. Their scripts were marked and scores recorded for further analysis. The

learners were then given back their marked scripts and their respective teachers given a brief report on the outcome on their various groups' performance.

### **3.2 Data Types and Sources**

The study used primary sources of data whereby a recorded CD was integrated in the teaching of 3D lesson in the experimental group via the use of computers in the computer laboratories. On the other hand a classroom teacher was used in the control group to teach the same concept in the actual classroom environment using his/her own pedagogical skills to deliver on the topic's specific objectives.

Secondary sources were also used to obtain the data on the number of schools in Embu North district through the DEO's offices (Appendix III). The KNEC examination report of past KCSE analysis also was used as a secondary source of data to obtain information and report of mathematics performance over time (Table 2.1)

### **3.3 Data Collection**

#### **3.3.1 Pilot Survey**

The main purpose of conducting the reconnaissance was to identify the number of public secondary schools within the Embu North District, their distribution, accessibility and infrastructural resources in terms of ICT integration in teaching and learning or otherwise. It was also used to identify mathematics teachers of Form Four (F4) classes, induct them on the intended study and seek their assistance where applicable.

A list of public secondary schools in Embu North District was obtained from the DEO's office (Appendix III). From the list the researcher sampled the schools with computer integration in the teaching of mathematics and these became the experimental group while those without computer integration in teaching and learning became the control group. The schools with (F4) students that were yet to cover the topic of 3D were selected and their mathematics teachers briefed about the research.

#### **3.3.2 Target Population and Sample Size**

The total population was all the students in the 24 public secondary schools in Embu North district in the year 2014 which was 35,642: distributed as follows; 6,234 (F4), 7,985 (F3), 9,106 (F2) and 12,317 (F1). The target population was all the students in form four which was 6,234 distributed in those public secondary schools. A purposeful sample size was calculated arrived at from the number of schools which had integrated ICT in the teaching of mathematics and those using traditional method divided by the total number of schools in the district and this yielded a representation of 42% of the target population giving 10 schools as the sample size. The number of students who were in these schools earmarked for the study was 2,158. The number from those schools which had ICT integration in teaching of mathematics was 1,246, from which only 114 were included in the study. This number was arrived at from the five schools depending on the computer: student ratio whereby in most schools the ratio was on average 1 computer to 7 students. The study was intended to have the ratio of 1:1 for effective measure of the intended variables. The number from the schools which had not integrated ICT was 912 from which only 104 was included in the study. The number was arrived at so as to have a manageable sized class and for fair comparison with the experimental group. These schools served as cases that in-depth investigation was done and whose analysis was used in justification of the relationship between the study variables. A total of 10 mathematics teachers from the selected schools were involved in the experiment. Each study group had one mathematics teacher in charge, and taught mathematics in the respective class where data was collected and particularly the groups of learners from whom data was collected.

### 3.3.3 Data Collection Instruments

The experimental group had an exposure on the topic of 3D whose thematic areas were recorded in a CD and distributed to them through their teacher. They were allowed to use it at their convenient without limit in their computer laboratories for a duration of two weeks same as their counterparts in the control group. The CD was copied to each of the computer's desktop and the learners could access the video any time. The role of the CD was to have the learning approach being wholly learner-centered whereby the learner had the opportunity to repeatedly revisit the area of study using multi-dimensional means of the computer and at own pace. There were tasks in form of sample questions in the CD through which the learners were expected to exercise and make self-evaluation on their progress.

A camera was used to capture some of the learners during the actual teaching and learning sessions while listening, discussing and doing assignments. The learners had the opportunity to consult their mathematics teacher either during class lesson time or thereafter for clarification or reinforcement in areas not well understood. The camera was also used to capture some shots during the computer laboratories sessions when learners had access to the computers. The role of the camera was to relate the different learning environments to the learning outcome especially on the class size and the different individualized leaning opportunities.

An effort was made to conceal to the participants the fact that they were taking part in an experiment so as not to interfere with their natural and spontaneous responses that could affect their performance.

Both groups had a written achievement test (appendix vi) whose duration was 50 minutes, the average duration of school based continuous assessment tests, marked out of maximum 45, and then converted to percentage. The results were then used to evaluate the impact of integrating ICT components versus the traditional teacher method in the performance of mathematics in 3D concepts. A recorded score sheet showing the performance of the learners in the test was then shared with the respective teachers for further analysis after brief discussion on their inference. The results from the study vividly indicated that the teaching pedagogy used had a great and significant influence on the performance of learners in the topic of 3D.

### 3.3.4 Data Collection Procedures

A random sampling procedure was applied whereby similar ruffled papers written YES/NO were picked for a desired number of students depending on the number of computers in the computer laboratories available in the various schools. This was done so as to determine the exact number of learners to select for the ICT integrated classes especially in schools that had more than one stream such as Nguviu Boys, Ngiviui Girls, and Muvandori mixed day school. Since the intended computer: student ratio was 1:1 the method was therefore used to obtain the desired sample size for the ICT integrated classes. Similarly the choice of the teacher involved in the study depended on their willingness to participate in the research and whether the teacher had covered the topic of 3D according to their schemes of work. After a brief induction with the mathematics teachers,

the teaching began simultaneously in all the school where the study was undertaken so as to also complete the exercise at the same time.

The teaching duration for both groups was 16 lessons totaling 640 minutes or 10hours 40 minutes, during which the target areas' instructional objectives in 3D were expected to have been achieved. The teachers kept in touch with the researcher on their progress during the period of the study particularly on lesson attendance.

At the end of the stipulated time, a written standard achievement test was given by the respective teachers during the day taking 50 minutes, (appendix v), marked by the same teachers using a similar marking scheme (appendix vi), and after two days the scores were recorded and later submitted to the researcher for further analysis. The test given was a representative of the syllabus content in 3D (appendix vii) with specific focus on remembering, understanding, interpretation, application, analysis, evaluation and creativity. The quantitative data obtained from the test scores (table 1) was used to measure the impact of the two approaches

### 3.4 Data Processing and Analysis

#### 3.4.1 Data Processing

Each of the participating schools had a code for students in each category, i.e. the ICT integrated and the Non- ICT traditional teacher method group so as to distinguish the entry of marks in their respective score sheets for accurate analysis of the outcome.

#### 3.4.2 Data Analysis Techniques

Mathematics teachers who were teaching the participating groups were involved. Their task was to teach the topic 3D using either the traditional teacher method whereby the teacher involved was at liberty to approach and apply his/her independent teaching pedagogies to ensure content delivery aimed at achievement of the desired instructional objectives

T-test was done to analyze the results from the test. Summaries of the data was classified according to the research objectives whereby the summary of findings were presented using tables and graphs.

### 3.5 Scope and Limitation

The research was designed to collect information of how deeply ICT was integrated in teaching and how it influenced performance of mathematics in Public secondary schools in Embu North District in Kenya. The study involved a homogenous group of students of almost similar academic performance in the public schools. However, due to limitation of time and financial resources; the researcher was not be able to carry out the same test in a wider scale, nor in private schools using heterogeneous groups.

The study was also faced with various challenges such as that of the influence of other confounding variables like the students entry behavior in the various schools where the study was conducted, the teaching experience of the various maths teachers, the willingness of some teachers to participate in the research, the student: computer ratio and absenteeism by the teacher and some learners during some days of the week when the research was undertaken.

For the study to be successful, it assumed that those schools that have integrated ICT into actual teaching and learning, do so to enhance academic performance. Some of the schools may not have integrated ICT into teaching and results from such a group could be difficult to predict and this limited the target population to only the schools which have integrated ICT into teaching.

## CHAPTER FOUR

### 4.0 RESULTS AND DISCUSSION

**Table 1: Summary Statistics Among ICT and Non-ICT per School Performance in Mathematics**

ICT or Non- ICT	NAME OF SCHOOL	Mean	N	Std. Deviation	Minimum	Maximum
ICT MARKS	ST. ANGELA NGUVIU GIRLS' HIGH	79.481	30	8.9211	62.2	93.3
	KAMAMA BOYS SEC SCH	77.677	22	7.4961	57.8	91.1
	ST. ANNES KIRIARI GIRLS HIGH SCH	76.732	17	10.3374	60.0	93.3
	ST. THOMAS NGUVIU BOYS SEC	78.370	30	9.6765	60.0	95.6
	ST. JOHN MUVANDORI MIXED DAY	74.667	15	7.8702	62.2	88.9
	<b>Total</b>		77.797	114	8.9452	57.8
NO ICT MARKS	KAVUTIRI BOYS SEC SCH	29.524	28	9.3864	15.6	46.7
	KIRIGI MIXED DAY SEC SCH	30.741	12	7.1434	20.0	42.2
	KIANJUKI GIRLS SEC SCH	30.505	22	8.6525	15.6	44.4
	ST. ALPHONSE MIXED DAY SEC	29.630	18	7.2711	17.8	44.4
	ST. PETERS KATHAKWA GIRLS SEC	29.722	24	7.1428	17.8	44.4
	<b>Total</b>		29.936	104	8.0091	15.6
OVERALL TOTAL	ST. ANGELA NGUVIU GIRLS HIGH	79.481	30	8.9211	62.2	93.3
	KAMAMA BOYS SEC SCH	77.677	22	7.4961	57.8	91.1
	ST. ANNES KIRIARI GIRLS HIGH SCH	76.732	17	10.3374	60.0	93.3
	ST. THOMAS NGUVIU BOYS SEC	78.370	30	9.6765	60.0	95.6
	ST. JOHN MUVANDORI MIXED DAY	74.667	15	7.8702	62.2	88.9
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	ST. ALPHONSE MIXED DAY SEC	29.630	18	7.2711	17.8	44.4
	ST. PETERS KATHAKWA GIRLS SEC	29.722	24	7.1428	17.8	44.4
	<b>Total</b>		54.964	218	25.4209	15.6

There were generally high scores in schools where there was ICT integration and the disparities in performance were large enough to suggest that there was a strong impact on the teaching pedagogy in the outcome of test scores among learners in public secondary schools in Embu North District.

**Table 2: Overall Summary Statistics Among ICT and Non-ICT Schools Performance in Mathematics**

ICT or Non-ICT	N	Mean	Std. Deviation
ICT MRKS	114	77.797	8.9452
NO ICT MRKS	104	29.936	8.0091
Total	218	54.964	25.4209

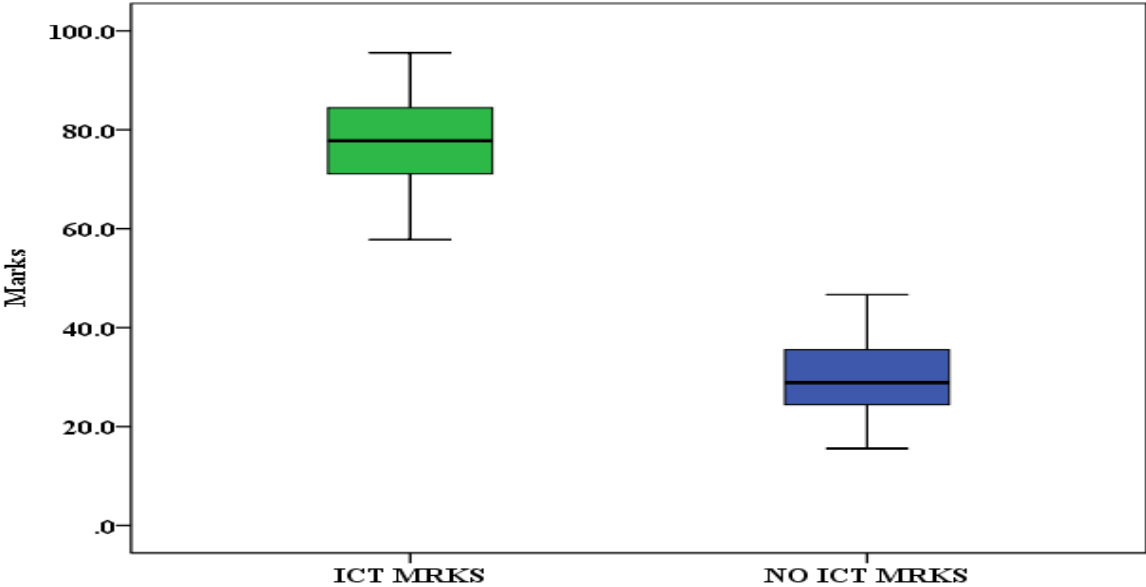
Table 2 evidently shows that there was a significant difference in performance in mathematics among ICT schools compared to Non-ICT schools despite the small difference in the sample size between the two groups.

**Table 3: Paired Samples Correlations and Chi-Square Tests**

Paired Samples Correlations	N	Correlation	Sig.
Pair 1 ICT or Non-ICT & Out of 100	218	-.943	.000
Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	218.000 <sup>a</sup>	32	.000

In Table 3 above, Paired sample correlations test were done which revealed that the additional variables related to ICT were helpful indicators that explained the achievement difference among students and schools. Using the Pearson chi-square=218.00 and the p-value=0000, this result showed that there was a significant difference in performance between ICT and Non-ICT schools which was also true when the same was tested using paired sample correlation as the table below explained.

**Graph 1: Box-Plot comparing between ICT and Non-ICT Schools Performance in Mathematics**



# CHAPTER FIVE

## 5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

### 5.1 SUMMARY OF FINDINGS

The purpose of this study was to investigate the influence of ICT integration on performance of mathematics in public secondary schools of Embu North district. The research design was experimental whereby five public secondary schools with ICT integration were taught a topic of 3D geometry and the other five public secondary schools taught using the teacher-led method. When an achievement test was given after a period of two weeks learning, the results were analyzed and conclusions drawn.

Literature was reviewed on the subtopics; 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 numerous challenges faced the effort to integrate ICT resources in mathematics pedagogies mainly insufficiency of ICT resources for mathematics learning.

### 5.2 CONCLUSIONS OF THE STUDY.

It was found that learner centered approach through ICT integration was more productive in teaching the concept of 3D geometry than the teacher-led method. In the study ICT integrated schools attained superior mean scores and better rank (Table 1) compared to non-ICT schools. Analysis of the test scores using t-test showed that the results were significant (Table 3), which seemed to suggest that learners who were taught using ICT integrated approach were able to transfer geometry skills from concrete to abstract situations.

A number of factors were found to impact negatively in the learning of 3D. These included the abstract nature of 3D, inability to apply basic skills, incorrect interpretation of 3D questions (including examination questions), poor instructional approach, lack of time, unavailability and inadequacy of text books and the rare testing of 3D concepts in national examinations.

Further there was a revelation from the study that preparing lessons using ICT was a challenge resulting from the insufficiency of ICT materials in public secondary schools.

### 5.3 RECOMENDATIONS FOR IMPLIMENTATION

#### (a) Workshops and Seminars

Teachers need to be inserviced on new and various innovations in mathematics education that can update their instructional skills and approaches. Poor instructional approaches for 3D can be overcome through workshops and seminars on mathematics teaching and learning. Seminars and workshops would provide a forum for mathematics teachers to freely exchange professional skills on mathematics teaching and learning. This would provide an opportunity for teachers who are not competent in handling specific areas of mathematics content a chance to build their competence in handling such areas.

#### (b) Instructional Approach.

The teaching of 3D in particular and mathematics in general should involve constructive learning whose strategies include cooperative learning projects, demonstrations, discovery, oriented methodologies and interactive approaches that incorporate up to date technology.

#### (c) Goals of Teaching.

Mathematics teaching should focus on developing the learner's potential in mathematical skills, concepts and principles together with their application to real life situations. Currently mathematics teaching seems to be examination oriented. Schools are competing for prestigious positions in the "ladder of academic excellence" The "competition" means that learners are rushed through the syllabus so as to complete the same with the hope of performing well in the national examinations.

#### (e) Resources.

The ministry of the education through the KICD should prepare a standard set of teaching models (for 3D in particular and mathematics in general) and encourage all schools to buy them in the same way schools buy laboratory chemicals and equipment for science subjects. This

should eventually be aimed at establishing mathematics resource rooms in Kenyan schools to be equipped with among other things models, completed project work, mathematics reference books, calculators and computers.

#### (f) Teacher Training Program.

An evaluation of the current teacher-training program is needed to determine its efficiency and effectiveness. Actual school practice should shift from drill and rote memorization of knowledge to interactive learning dominated by learner activity and construction of knowledge.

#### (g) Teaching Load.

A review of mathematics teaching load should be done with a view of reducing the number of lessons per week so as to provide teachers with adequate time for preparation of their lesson and incorporate necessary and appropriate teaching resources. A reduced teaching load would provide time for teachers to pay specialized attention to learners with mathematics difficulties. The time created should also allow teachers provide a more qualitative assessment of learner's assignments, tests and examinations.

#### (h) Basics

Emphasis is need in the mathematics content for form one and two that provide the basics for secondary education mathematics. Preferably, teaching of mathematics at the lower secondary class should be done by experienced teachers so as to provide a good foundation on which to build more demanding concepts.

#### (i) Evaluation

Efforts should be made to include constructive remarks that focus on learner's specific conceptual difficulties. This would assist learners (and teachers) to focus their private studies (and remediation) on the identified difficulty with the aim of overcoming the difficulty.

#### (j) Technical Terms

Meaning of technical mathematics terms should be emphasized during the teaching and learning of mathematics. Distinctions should be made between the technical meaning and daily language use of all mathematical terms. Teacher interventions through consultations between mathematics and language teachers to facilitate this are necessary for learners who can not verbalize their mathematical thoughts because of language deficiencies.

## 5.4 Recommendations for Further Research

A research is needed to:

- (a) Investigate learner's strategies of solving 3D problems.
- (b) Investigate the content validity of mathematics examinations at form 4 level and the reasons for the rare testing of 3D concepts in such examinations.
- (c) Investigate the possible link between performance in the language of instruction and performance in geometry.

## A.00 APPENDICES

### Appendix A: List of Public Secondary Schools in Embu North District

1. All Saints Kigari Mixed Day Secondary school
2. Kagumori Mixed Day Secondary school
3. Kairuri Mixed Day Secondary school
4. Kamama Boys Secondary school
5. Kamviu Mixed Day Secondary school
6. Kavutiri Boys Secondary school
7. Kavutiri Mixed Day Secondary school
8. Kianjokoma Mixed Day Secondary school
9. Kiriari Mixed Day Secondary school
10. Kirigi Mixed Day Secondary school
11. Kithunguriri Mixed Day Secondary school
12. Nguviu Boys Secondary school
13. S.A. Manyatta Mixed Day Secondary school
14. St. Alphonse Mixed Day Secondary school
15. St. Angela Nguviu Girls High school
16. St. Benedicts Karau Mixed Day Secondary school
17. St. Joseph the Worker Mixed Day Secondary school
18. St. Joseph Gituri Mixed Day Secondary school
19. St. Annes Kiriari Girls High school
20. St. John Chrysostom Muvandori Mixed Day Secondary school
21. St. John's Kianjuki Girls Secondary school
22. St. Martha Gatoori Mixed Day Secondary school
23. St. Mary's Mukangu Mixed Day Secondary school
24. St. Peters Kathakwa Girls Secondary school

(Source: DEO Embu North District, 2013)

## Appendix C

### The Syllabus

Specific Objectives;

At the end of the lesson the learner should be able to:

- (a) State geometric properties of common solids.
- (b) Identify projection of lines on planes.
- (c) Identify and calculate;
  - (i) The angle between a line and a line (including skew lines)
  - (ii) The angle between a line and a plane.
  - (iii) The angle between two planes.
- (d) Calculate length of lines in 3D.

### CONTENT

- (i) Geometric properties of common solids
- (ii) Projection of a line on a plane
- (iii) The angle between a line and a line (including skew lines)
- (iv) The angle between a line and a plane
- (v) The angle between two planes
- (vi) The skew lines
- (vii) Angle between skew lines.

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