Effects of Computer Interactive Multiple Mice Technique On Learners' Performance in Fractions In Primary Schools In Kenya

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A Thesis Submitted In Partial Fulfilment For the Requirements of the Award of Degree of Doctor of Philosophy in Mathematics Education of Masinde Muliro University of Science and Technology.

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DECLARATION

This thesis is my original work prepared with no other than the indicated sources and support and has not been presented in any other university for a degree or any other award.

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CERTIFICATION BY SUPERVISORS

The undersigned certify that they have read and hereby recommend for acceptance of Masinde Muliro University of Science and Technology, a thesis entitled "The effects of computer interactive multiple mice technique and conventional methods of instruction on learners' performance in fractions in Kenyan primary schools."

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DEDICATION

This thesis is dedicated to my daughter Camilla whose encouragement has been the source of inspiration, hope and confidence during the pursuit of my studies.

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LIST OF ABBREVIATIONS AND ACRONYMS

A.L.A	Annual Learning Assessment
APHRC	African Population and Health Research Centre
CEMASTEA	Centre for Mathematics and Science Technology in Africa
C.I.S	Course Interest Survey
CT	Cognitive Tool
D.E.O	District Education Office
F.P.E	Free Primary Education
I.C.T	Information Communication Technology
INSET	In-service Education and Training
IWB	Interactive White Board
K.C.P.E	Kenya Certificate of Primary Education
K.I.C.D	Kenya Institute of Curriculum Development
K.I.E	Kenya Institute of Education
K.N.E.C	Kenya National Examination Council
LMQ	Learner Motivation Questionnaire
MAT	Mathematics Achievement Test
MLOC	Mathematics Lesson Observation Checklist

M.O.E.S.T	Ministry of Education Science and Technology
N.A.C	National Assessment Centre
N.A.E.P	National Assessment of Education Progress
NCLB	No Child Left Behind
NGO	Non Governmental Organization
PISA	Program for International Student Assessment
SBTD	School Based Teacher Development
SMASE	Strengthening of Mathematics and Science Education
TIMSS	Trends in International Mathematics and Science Study
TPACK	Technological Pedagogical And Content Knowledge Model

ABSTRACT

Studies attribute poor performance in mathematics especially in fractions in public primary schools to teacher centred teaching methods. However, few researchers have tried out interventions based on computer interactive multiple mice technique that promises to offer interactive and collaborative learning benefits enabling learners in resource-constrained schools to share one computer each with their own mouse. The purpose of this study was to investigate effects of computer interactive multiple mice technique on learners' achievement, motivation and classroom interaction in learning fractions in public primary schools. The study was guided by the following objectives: to determine any difference in achievement between learners' taught using computer interactive multiple mice technique and those taught using conventional instructional methods, to find out any difference in motivation between learners' taught using computer interactive multiple mice technique and those taught using conventional instructional methods and to establish any difference in classroom interaction between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods. Computer Support for Collaborative Learning theory was used to depict the relationship between computer interactive multiple mice technique and conventional instructional methods as the independent variables and learners' performance as the dependent variable. The study adopted quasi experimental pre-test, post-test, non equivalent groups design. The target population was 5,487 Standard 6 learners in public primary co-educational schools in Kenya. A sample of 518 learners from 12 schools were selected. Sampling techniques used involved stratification, purposive and simple randomized sampling. Computer interactive multiple mice technique was used in the experimental group while conventional instructional method was used in the control groups. Two Mathematics Achievement Tests (Mathematics Achievement Test 1 and Mathematics Achievement Test 2) gauged learners' achievement in fractions. Mathematics Achievement Test 1 was used as a pretest for the two groups. Mathematics Achievement Test 2 was used to determine learner achievement after instruction. Mathematics Lesson Observation Checklist (MLOC) was used to gauge learners' classroom interactions. Learner Motivation Questionnaire (LMQ) was used to determine learners' motivation towards learning fractions. The instruments were piloted in two public primary co-educational schools of Hamisi Sub County. Face and content validity were determined by experts in mathematics subject. Test retest reliability method was deployed. Reliability was established using Pearson's Product Moment of Correlation Coefficient to determine if the instruments were reliable. Class observations was employed to provide comparative findings to supplement the quantitative data. To test the hypotheses, inferential statistics (t-test) were used at significance level of .05. Qualitative data was summarized using descriptive statistics (frequencies, percentages, mean and standard deviation) and presented using tables and figures. A response rate of 89.1% (476) was realized. The findings revealed that on the pretest, the two groups were comparable. The posttest revealed significant difference with mean performance of the experimental group higher than the control group. The findings revealed significant difference in achievement between the groups ($t_{474} = 21.925, p = .000.$), improved mean scores in motivation and enhanced classroom interactions. Therefore, computer interactive multiple mice technique enhanced learners achievement in fractions, improved learner motivation and enhanced classroom interaction as compared to conventional instructional methods in public primary schools of Hamisi Sub County.

CHAPTER ONE

INTRODUCTION

1.1 Chapter Overview

This chapter presents the background to the study, statement of the problem, purpose, objectives, hypotheses, significance, scope, limitations and assumptions of the study. Theoretical and conceptual frameworks, operational definition of terms are also highlighted.

1.2 Background of the Study

Governments around the world recognize the importance of mathematics for national development (Barnett, 1995; Stacey, 1998). Its usefulness in science, technological activities, economics, education and even humanities has been noted (Tella, 2008). Learners' competency in numeracy in early grades affects their academic achievement more generally in later years and affects how they master other subjects (Oketch, M., Mutisya, M., Ngware, M., & Sagwe J., (2010). In Kenya, mathematics is a prerequisite subject to many careers like medicine, pharmacy, accounting, finance and banking (University of Nairobi, 2008). Despite the wide applicability and importance of mathematics, many learners still perform poorly in the subject.

In 2002, the No Child Left Behind (NCLB) Act was instituted to foster improvements in academic achievement for all learners in the United States. Even with federal support from NCLB, elementary learners' mathematics achievement in the United States has continued to be below average (NAEP, 2000, 2003, 2005, 2007, 2009; PISA, 2000, 2006, 2009; TIMSS 2003, 2007). This is an indicator that causes of low achievement in mathematics by learners at the elementary level should be investigated. These is because this level forms the foundation of further learning of mathematics by learners.

According to Opolot, O., *et al,.* (2010), poor performance of learners in national mathematics examination in Uganda has continued to draw much debate among the public. In their study, factors that hinder learners' opportunities to learn mathematics in primary schools were investigated. The findings revealed that 83 % of the factors were teacher-related factors which included poor teaching methods. These raises a lot of concern on need to investigate methods of teaching mathematics that could promise to offer enhanced learner performance in the subject.

The Kenya Education Sector Support Programme (KESSP) for 2005–2010, established the National Assessment Centre (NAC) to monitor learning achievement. In 2009, in collaboration with the NAC, Uwezo Kenya conducted an assessment of the basic numeracy skills of children aged 6 to 16 years in 70 former districts out of 158 across the 47 Counties in Kenya. Mathematical concepts addressed during the study included: number recognition 10-99, counting and matching, addition, subtraction, multiplication and division of whole numbers which form prerequisites in learning of fractions. Children assessed who could not do subtraction was as follows: In Standard 2 were 79 %, Standard five were 30 % and in Standard 8 were 10 %. Furthermore, according to Uwezo (2012) Numeracy and Literacy Report less than one third of the learners possess basic numeracy skills. This has raised concern on pedagogical skills employed during the teaching and learning process especially in their classroom interactions. This was particularly observed following the implementation of Free Primary Education (FPE) which has introduced large classes in Kenyan primary schools.

The Kenya National Examination Council (KNEC) is the body responsible for the administration of Kenya Certificate of Primary Education (KCPE) examinations. At the end of eight years cycle of primary education, KNEC measures performance in the curriculum by administering the KCPE. Poor performance in mathematics at KCPE has and still is a subject of much debate among educational experts, teachers and parents (Makewa et al., 2012). In its annual reports, KNEC has reported that between 2005 and 2014, learners overall understanding of mathematical concepts depict an unsteady trend over the years as evidenced in their performance in KCPE Mathematics national examinations (KNEC, 2007-2014) especially in fractions. In the period 2007-2014, the national mean score has been below 50 %. This is evident as follows: Kenya National Examination Council registered 698,364 candidates for the KCPE in 2006 and raw mean for mathematics was 49.4 %. In 2007, 695,777 candidates were registered and a mean of 48.7 % in mathematics was registered. In 2008, 727,054 candidates were registered with a mean of 48.3 % being attained. In the following year, 746,080 candidates were registered for KCPE with a mean of 49.4 % while in 2010 and 2011, 776,214 and 811,930 candidates were registered respectively. They registered means of 49.8 % and 48.6 % respectively, in 2012 and 2013, 829,000 and 831,779 candidates were registered for KCPE with a mean of 39.0 % and 36.8 % respectively (KNEC, 2007-2014: Kariuki, et al., 2014).

Further scrutiny of the national KCPE mathematics results by KNEC shows that the most poorly performed topics in mathematics were fractions, algebra, statistics, ratio and proportion and scale drawing (KNEC, 2007 and 2010). A further analysis of Hamisi County KCPE mathematics mean scores as compared by the Sub County and County mathematics mean scores was done by the respective Education Sub County offices. Table 1.2 shows County and Sub-County mathematics mean scores since 2009.

The performance trends in the public primary schools in Hamisi Sub-County depict a similar trend. The Sub-County registered 3,508 candidates for the KCPE in 2009 and raw mean for mathematics was 48.7 %. In 2010, 3,447 candidates were registered and a mean of 49.8 % in mathematics was registered while in 2011 and 2012, 3,430 and 3,752 candidates were registered respectively. They registered means of 49.4% and 48.7 % respectively. In 2013, 2014 and 2015 the Sub County registered 3,812, 3840 and 3,789 candidates respectively. They recorded a mean of 48.8 %, 49.8 % and 48.8 % respectively (Hamisi Sub-County Office, 2015). This means that learners overall performance in fractions is still poor as evidenced in their performance in KCPE mathematics examinations in the Sub County.

Table 1.2 County and Sub-County KCPE Mathematics Mean scores in Percentage

Year	Vihiga Sub County Mean	Hamisi Sub County mean	Sabatia Sub County	Emuhaya Sub County mean	Vihiga County Mean
2009	51.23	*48.56*	51.29	49.26	50.09
2010	49.98	49.77	50.04	50.03	49.96
2011	50.93	49.38	50.32	49.87	50.13
2012	50.28	48.70	49.78	50.82	49.90
2013	49.99	48.83	49.81	49.86	49.62
2014	51.09	49.77	57.97	51.34	52.54
2015	51.31	48.82	56.54	47.99	51.27

Source: Vihiga, Sabatia, Hamisi and Emuhaya Sub Counties (2010-2015)

From Table 1.2, the overall mean score in KCPE mathematics for the Hamisi Sub-County has been lower than that of the other Sub Counties of Vihiga County in KCPE mathematics mean scores from 2009 -2015 (Sub-Counties Offices, 2009-2015). This can be inferred to mean fractions is one of the causes of registering a low mean in KCPE mathematics scores since KNEC reports indicated fractions as one of the most difficulty concepts to learners.

An analysis of the KCPE mathematics question papers reveal that questions on fractions as compared to other topics are set yearly yet no remarkable improvement has been realized in terms of learners' performance (KNEC, 2006). Table 1.1 hereunder shows the frequency of questions set on fractions since 2006.

Table 1.1 Frequency of Questions Set on Fractions Between 2006-2015

YEAR	QUESTION NUMBER
2006	17, 25, 32, 35, 37, 39 and 48
2007	4, 5, 10, 14, 20, 28, 44 and 47
2008	2, 18, 25, 32, 42, 44 and 47
2009	2, 11, 17, 21, 26, 32 and 47
2010	5, 8, 10, 14, 18, 22 and 47
2011	2, 7, 9, 19, 28, 30, 47 and 50
2012	6, 15 and 43
2013	9, 11, 17, 22 and 37
2014	3, 5, 8, 13, 24 and 41
2015	2, 3, 10, 31, 14 and 39

***Source:* Kenya National Examination Council (KNEC) KCPE Mathematics Paper (2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014 and 2015)**

From Table 1.1 it is evident that questions on the topic fractions are set every year. It therefore means that if the learner does not understand fractions even the other topics where fractions is a prerequisite will be abstract to the them and therefore in turn may have a great effect on learners' overall performance in KCPE mathematics.

This trend is an indicator that something is wrong as far as performance in fractions is concerned in this Sub-County. If this trend continues then Kenya might not be able to realize its Vision 2030 where mathematics skills and knowledge especially in fractions are a prerequisite. In addition, it is imperative that learners perform well in fractions since it forms a basis for the study of other topics like percentages, decimals, scale drawing, ratio and proportion (SMASE, 2009).

According to Ngaru and Kimamo (2011), the conventional methods (dictation, drill and practice, explanation, rote learning, memorization and lecture) for teaching fractions in most public primary schools in Kenya are blamed for learners' inability to acquire meaningful learning. Several weaknesses of conventional methods of instruction as compared to learner centred approaches have been cited by researchers. According to Diggs (2009), conventional methods of instruction in fractions hinder much questioning, investigating or individual development of understanding. Orlich *et al.*, (1998) argue that teaching fractions using conventional methods of instruction lead to the following scenario; the teacher controls the instructional process; learning mode is passive and the learners play little part in their learning process and there is insufficient interaction with learners in classroom. Furthermore, emphasis placed on theory without any link to practical or real life situations and learning from memorization but not understanding is the trend. Despite the many weaknesses cited, Ngaru and Kimamo (2011) further argue that teachers in public primary schools continue to teach using the conventional methods of instruction in their classroom practices limiting the classroom interactions which eventually affect learners' academic performance in mathematics.

In contrast to the conventional methods of teaching, modern methods of instruction create strong self directed learners who actively construct own knowledge and ideas (Trilling and

Fadel, 2009). The goal is to shift student learning away from passively sitting and listening to a more active and dynamic learning experience. This approach leads to learners being more actively involved in the learning process and having a control over instructional activities and constructing own knowledge which can enhance motivation (Wilson and Corpus, 2005). In an attempt to actively engage learners in the learning process using constructivist approach to learning, Wilson and Corpus (2005) assert that it has the potential to accelerate, enrich, and deepen skills in the learning of fractions in public primary schools. Besides, it can motivate, increase interaction and reception of information and engage learners. This helps relate school experience to work practices, giving way to new scenarios which favor both individual and collaborative learning (Yusuf, 2005). In learning fractions using collaborative learning, learners in groups work together to search for understanding and joint problem solving. There is therefore a need for mathematics teachers to use constructivist methods to transform lessons in fractions into learner focused environment with meaningful activities that promote efficient learning.

It is hoped that this type of learner centred environment could be realized with the roll out of of the government lap top project (Digital Literacy Program) loaded with the KICD approved content in five subjects among them mathematics (Ministry of Information, Communication and Technology, 2016). The government argued that the Millennium Development Goals (MDGs) and Kenya's Vision 2030 are anchored on technology and science where knowledge of mathematics is pertinent. Rwanda, one of the East African countries that have successfully implemented "One Laptop per Child project," was show cased as successful in this regard (Ayodeji *et al.*, 2013; Republic of Rwanda Ministry of Education, 2016).

Strategies that address learners' problems in learning fractions should be investigated. This study utilizes an instructional strategy that allows the sharing of a computer screen using multiple learner input. This strategy, computer interactive multiple mice technique, encourages several benefits. These include: collaboration, active participation, interaction between learners, motivation and better assessment of learning (Pal, Gupta & Toyama, 2006; Pawar *et al.*, 2007; Stewart, 2009). Learning fractions in public primary schools in Kenya would be enhanced through use of computer interactive multiple mice technique due to its great potential in learning. Mathematics teachers can no longer ignore better and modern methods of instruction that have been known to work elsewhere and in other subjects (Trilling and Fadel, 2009). This study established the effect of computer interactive multiple mice and conventional methods of instruction on learners' achievement, motivation and classroom interaction in fractions in public primary schools, Kenya**.**

1.3 Statement of the Problem

Poor performance in KCPE mathematics examinations at both national and Hamisi Sub County levels has continued to draw debate among educational experts, parents, teachers and other stakeholders. KNEC reports indicate fractions as one of the difficulty topics for learners to comprehend. Further analysis of the KCPE mathematics question papers reveal that questions on fractions as compared to other topics are examined yearly yet no remarkable improvement in performance by learners in this topic has been realized. This unsatisfactory achievement has been attributed to many factors. Conventional instructional methods has been cited as a major contributing factor. The conventional instructional methods currently in use for teaching fractions in most public primary schools in Kenya are strongly thought to contribute to learners' inability to achieve meaningful mathematics learning.

Several initiatives have been put in place to improve performance in the subject. The government of Kenya in collaboration with the Japanese government cascaded the Strengthening of Mathematics and Science Education (SMASE) in primary schools. The purpose of SMASE primary project was to entrench effective classroom practices in mathematics that ensured a strong foundation was laid for the subject. However, even with such efforts, performance of learners in KCPE mathematics continues to decline.

Strategies that address learners' problems in learning fractions need to be investigated. This study utilizes an instructional strategy that allows the sharing of a computer screen using multiple learner input. The new strategy targeted at improved learner achievement, enhanced motivation and classroom interaction of learners in learning of fractions. The study sought to find out the effects of computer interactive multiple mice technique as compared to conventional instructional methods on learners' achievement, motivation and classroom interaction fractions in public primary schools.

1.4 Purpose of the Study

The purpose of this study was to investigate the effects of computer interactive multiple mice technique on learners' achievement, motivation and classroom interaction in learning fractions in public primary schools of Hamisi Sub-County in Vihiga County, Kenya.

1.5 Objectives of the Study

The following specific objectives guided the study;

i) To determine any difference in achievement in fractions between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods.

ii) To find out any difference in motivation between learners' taught using computer interactive multiple mice and those using conventional instructional methods.

iii) To establish any difference in classroom interaction between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods

1.6 Hypotheses of the Study

The following null hypotheses guided the study:

H01 There is no difference in achievement in fractions between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods.

H02 There is no difference in motivation between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods.

1.7 Research Question

The following research question also guided the study:

i) What is the difference in classroom interaction between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods.

1.8 Significance of the Study

The findings of this study have both practical and theoretical implications. They are envisaged to contribute to the existing stock of knowledge in shedding light on the efficacy of computer interactive multiple mice technique in comparison to conventional instructional methods on learners' achievement, motivation and classroom interaction in learning fractions in public primary schools. The study formed a basis of the switch to more effective pedagogy in mathematics.

The findings of this study are envisaged to help Kenya Institute of Curriculum Development to incorporate computer interactive multiple mice technique in their primary school mathematics curriculum in order to improve the learning and teaching of fractions.

The findings will be useful to the Kenya National Examinations Council in the setting of KCPE mathematics examinations that require use of computer interactive multiple mice technique in answering questions.

The findings will provide mathematics teachers with a framework for addressing learners' understanding of mathematical concepts and skills in fractions through appropriate instructional techniques. It is hoped that the computer interactive multiple mice could become an integral part of mathematics instruction in fractions.

The research findings will also be beneficial to the authors and publishers of mathematics textbooks for primay schools. They could consider writing activities in fractions for learners in their textbooks that require use of computer interactive multiple mice technique in learning.

Finally, the study findings will be useful and relevant to Quality Assurance and Standards Officers (QASO), providing them with insights on how they can promote higher academic performance using effective instructional methods in teaching concepts of fractions. They may also recommend the use of computer interactive multiple mice in the respective public primary schools and the results will serve as one of the references in mathematics instructional techniques.

1.9 Scope of the Study

The study involved Standard 6 learners in co-educational public primary schools. Standard 6 was chosen because it is at this level where more advanced concepts of fractions are introduced. The topic 'fractions' was chosen for this study because questions are examined on this topic yearly yet studies reveal that it is one of the poorly performed topics by learners' (KNEC Report 2005- 2015). The study addressed the following specific concepts: multiplication of fractions, squares of fractions, square root of fractions, reciprocals, division of fractions and number sequencing involving fractions.

1.10 Limitations of the Study

The schools exposed to treatment had inadequate mice, some lacked projectors, USB hubs and cables. The researcher provided starter equipment to mitigate these. These included 15 wired mice, four seven-port and six four- port USB hubs, six USB cables, one power-strip extension cord and projector. In larges classes, the limitation was mitigated by use of team mode where learners carried out activities in small groups.

1.11 Assumptions of the Study

The study was carried out under the following assumptions:

i) That the learners' had not yet been exposed to the Standard 6 topic 'fractions' at the time of carrying out this study.

ii) That all the learners would take a short time of two weeks to gain mastery of learning how to use computer interactive multiple mice technique.

iii) Subjects from experimental group and control group did not interact to share questions on MAT 1, MAT 2, LMQ and MLOC before or during the administration of the tests. To ensure this the participant schools were either control or experimental.

1.12 Theoretical Framework

The current study was guided by Computer Support for Collaborative Learning theory (CSCL) propounded by Koschmann, 1994. The theory draws heavily from a number of learning theories that emphasize that knowledge is a result of learners interacting with each other, sharing knowledge, and building knowledge as a group. These include: social constructivism theory by Schwandt, 1994; Cognitive theory of interactive multimedia, 1994; Rodriquez, 1998; Staver, 1998; Vygotsky and Wood,1998.

Social constructivism claims that learning is an active, constructive process and the learner is an information constructor. Furthermore, learning is a contextualized process of constructing knowledge rather than acquiring it. Knowledge is constructed based on personal experiences and hypothesis of the environment. Cognitive Theory of Interactive Multimedia emphasizes mental processes. Learning is based on how the learner processes information. Learning styles includes visual, auditory and tactile learning. Cognitive theories believe that an observable behavior is as a result of internal processes and cognitive style of the learner.

Furthermore, the study also heavily draws from the Technological, Pedagogical and Content Knowledge (TPACK) model as propounded by Mishra and Koehler (2009) as shown in Figure 1.1

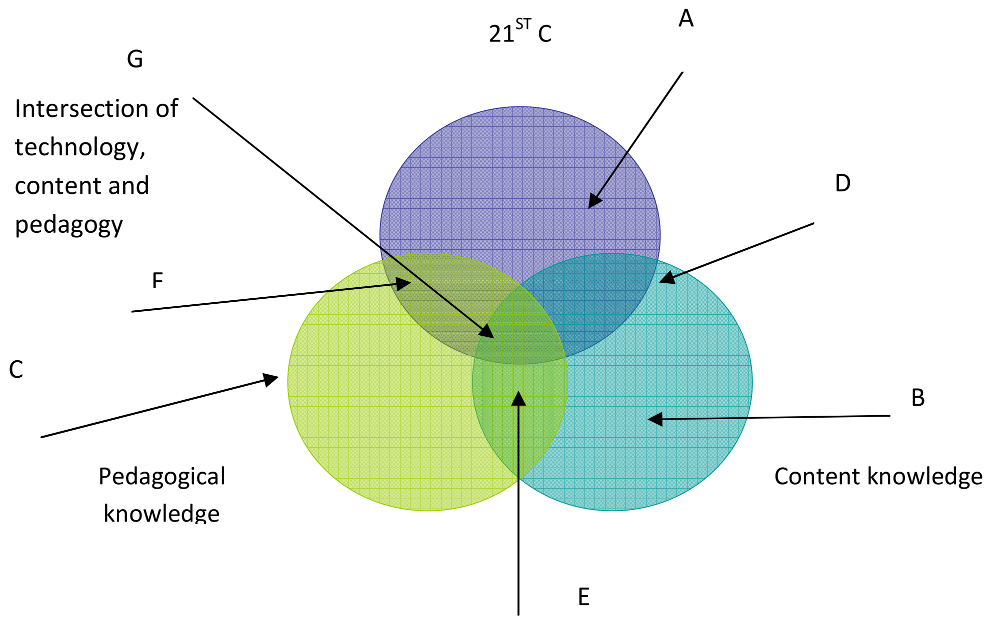


Figure 1.1: The TPACK Model (Koehler and Mishra, 2009)

A: Technology- Master of information technologies and able to support use by learners

B: Content- Master in content in subject matter earning the designation' highly qualified'

C: Pedagogy- Master of classroom strategies, application of learning theory, differentiated techniques, grading practices

D: Modern but limited-Use of technology to enhance exploration of content but minimal learning theory present

E: Good but dated-Masterful 20^{th} Century classroom with strong content and good application of learning theory

F: Exciting but disconnected- Use technology in classroom but activities stray away from the essential learning

G: Masterful 21st Century classroom focused on essential learning, applying good learning theory supported by technology

The main principles of TPACK include: teacher being open to experimentation with technological tools and willingness to experiment with new lessons using technology in their classrooms, offer clear pedagogical strategies and classroom management. An understanding of what it means to integrate technology in the learning process; knowledge of instructional strategies and representations for teaching particular topics with technology; knowledge of students' understandings, thinking, and learning with technology; and knowledge of curriculum and curriculum materials that integrate technology with learning. However, teachers should first make decisions about the instructional objectives, activities and assessments that will shape the learning experience.

The model also emphasizes that learning is an active process and acquisition of knowledge is the result of learners interacting with each other, sharing knowledge, and building knowledge as a group. Knowledge is constructed based on personal experiences, hypotheses of the environment and accomplished in the socio-cultural contexts to which the learner belongs. Mathematical tasks are mediated through a set of resources, which directs the individual's intentional acts. Resources include natural language (oral and written), gestures, objects, artifacts, bodily actions and mathematical symbolic language. This allows the growth of mutual understanding and co-ordination between the individual and the rest of the community.

This framework, combines appropriately selected technology with content-based learning experiences and pedagogical approaches. Figure 1.1 shows the TPACK graphic, the overlapping of the discrete knowledge bases is the centric overlap of all three (Mishra and Koehler, 2009) . It is this area, when teachers can expertly understand and integrate all three knowledge bases, that the TPACK model postulates high quality and effective integration of technology, pedagogy and content as part of the teaching and learning experience. As Foulger, *et al*., (2013) contend, while teacher educators may be well versed in the pedagogies associated with specific disciplines, and may teach using modern technology; these individuals may not be experts in how to teach with technology. It is this distinction, however subtle it may be, where the nature of deconstructing the TPACK theoretical model into usable and practical applications.

The model guided the study in the following ways: mathematics teachers as mediators of the learning process controlled learning through the presentation controls (advance to the next slide or previous slide, pause or play the mice, click to show the answer pane and reset the slide). The teacher's cursor was a special mouse that controlled all activities on the screen hence it was important that they were open to experiment with the computer interactive multiple mice technique due to the nature of the facilitation role they played. Clear pedagogical strategies that guided drawing on the slide, march and circle the correct answer, develop multiple choice questions and assign plausible answers to this questions, supervision of team activities, how to lead a whole class discussion using polling slides all required clear pedagogical strategies for meaningful learning of fractions. Understanding and use of in built help tool kit in the technology system took care of classroom management issues. For example, number of active mice disappearing from screen or a child accidentally stepping on cables hence interfering with progress of lesson. Knowledge of students' understanding, thinking and learning with technology was important for identification of learners entry behavior to find out the gaps in the topic fractions, listening to learners thinking while explaining a concept to infer meaning and identify error patterns for remedial purposes. It was important for the teachers to make decisions on the instruction objectives that addressed: multiplication and division of fractions, squares and square roots of fractions, reciprocals and sequences involving fractions. These concepts informed the activities to engage the learners in to help achieve the stated instructional objectives. In addition, immediate feedback from learners activities were assessed through observation and giving them two written tests. Through these, the mathematics teachers measured learners on achievement, motivation and classroom interaction.

Computer Support for Collaborative Learning Theory is a composite learning theory that borrows heavily from the above theories and model. The computer interactive multiple mice technique focuses on collaborative learning and borrows from the Computer Support for Collaborative Learning Theory. Based on the CSCL, the following propositions are possible: learners actively and collaboratively construct knowledge in social cultural contexts by interacting with resources like objects, artifacts, gestures, bodily actions, natural and mathematical symbolic language. Teaching with technology means that as teachers think about particular concepts in fractions, they are concurrently considering how they might teach the important ideas embodied in the concepts in such a way that the technology places the concept in a form understandable by their learners. More importantly, considering all three domains of content, technology and pedagogy together results in a lesson in which all the component parts are aligned to support the learning goals and outcomes of the instructional plan. The ideas of these scholars provided a basis for this study in order to investigate effect of computer interactive multiple mice technique as compared to conventional instructional methods on learner achievement, motivation and classroom interaction in learning fractions in public primary schools in Kenya.

1.13 Conceptual Framework

Arising from the Computer Support for Collaborative Learning theory (CSCL) , conceptual framework depicted the relationship between the key variables in the study. This study compared computer interactive multiple mice and conventional instructional methods (dictation, drill and practice, explanation, rote learning, memorization and lecture) on learners' achievement, motivation and classroom interaction in learning fractions. The independent variables were computer interactive multiple mice technique and conventional instructional methods. The dependent variables were achievement, motivation and classroom interaction in learning fractions. Teacher self efficacy, learner entry behavior and learner computer literacy skills as intervening variables were likely to affect the learner performance in fractions. Other intervening variables were: quality of infrastructure and teacher-learners ratio. Intervening variables were minimized as follows: Mathematics teachers who had three years teaching experience in handling Standard 6 mathematics content participated in the study. Those in the experimental groups were trained on how to use computer interactive multiple mice technique in learning of fractions. There after they practiced together with their learners for two weeks. In both groups, they were taken through their roles as research assistants. This boosted their efficacy in participating in the study. Learners in both groups were exposed to a pre test of MAT 1 covering concepts they learnt on fractions in Standard five. Learners in the experimental groups practiced on how to use the computer interactive multiple mice technique in learning fractions to ensure harmonization in all the 6 participating schools. All experimental groups were given similar starter set of equipment consisting of the following: 15 wired mice, four seven-port and six four- port USB hubs, six USB cables, one power-strip extension cord and projector for each experimental school. Issues of teacher-learner ratio were minimized through use of team mode.

The relationship of variables under study can be represented in a conceptual form as shown in Figure 1.2

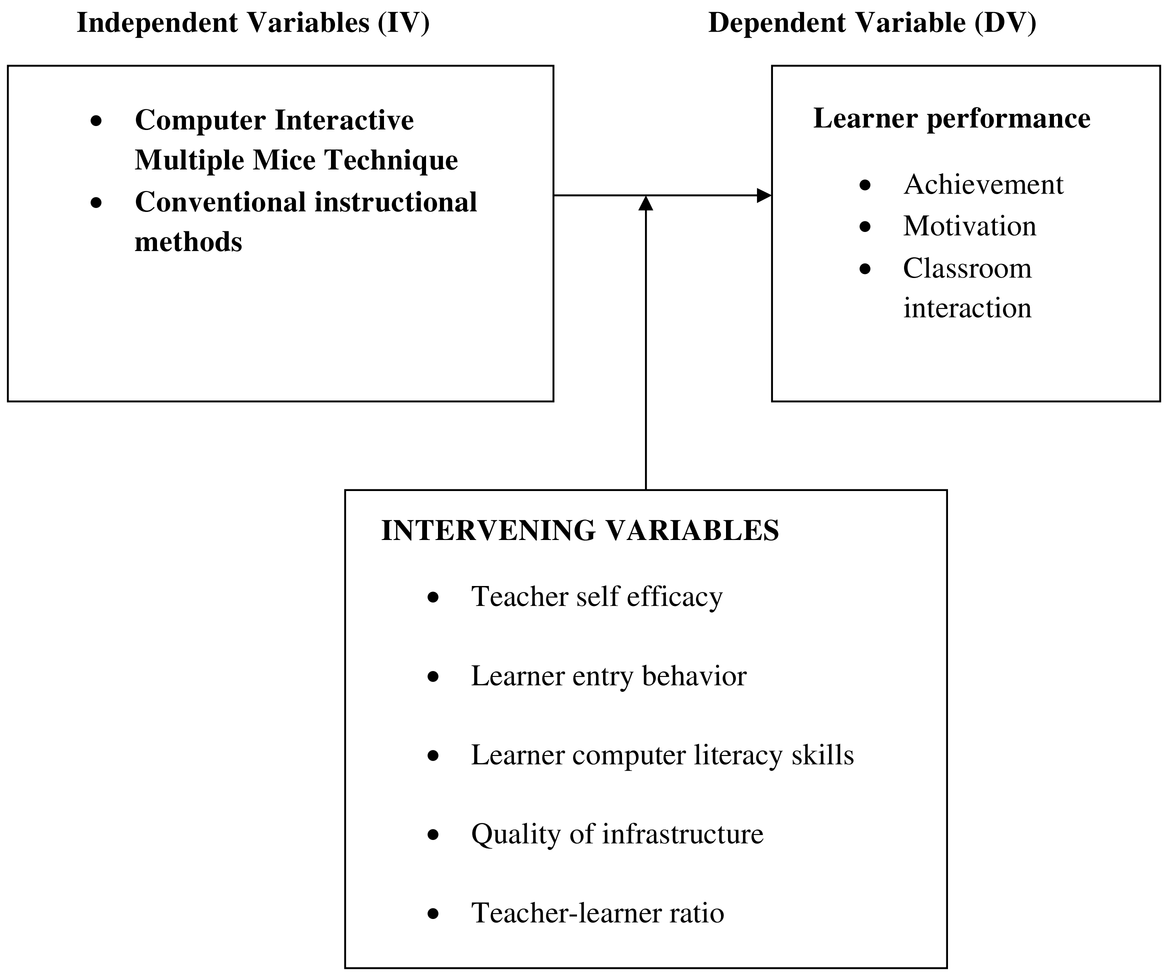


Figure 1.2: Conceptual Framework of the Study

Source: Researcher

1.14 Operational Definition of Terms

Achievement: Used in this study to mean the overall score obtained by learner in fractions test administered measured by MAT 1 and MAT 2.

Classroom interaction: Used here to refer to all the ways in which learners in classroom interact with one another, including oral interaction, non-verbal interaction and shared activity. Will include: learner-learner interaction, teacher-learner interaction and learner-teacher interaction

Collaborative learning: Is used to refer to groups of learners working together to search for understanding, meaning, or solutions or to create an artifact or product of their learning with activities like; collaborative writing, group projects, joint problem solving, debates, study teams, and other activities in which learners team together to explore a significant question or create a meaningful project.

Conventional Instructional methods: Used in this study to refer to instructional methods which are teacher centred where learner is passive with emphasis on drilling and practice, rote learning, dictation, explanation, talk and chalk commonly used in mathematics where the teacher presents the material in a lecture form and uses aids like chalkboard, textbook as a source of reference.

Cooperative Learning: In this study it is taken to mean an instructional strategy that simultaneously addresses academic and social skill learning with emphasis on need for interdependence in all levels, providing learners with the tools to effectively learn from each other. The success of the small group depends upon everyone pulling his or her weight. The teacher observes, listens and intervenes in the group where necessary and learners assess individual and group performance.

Motivation: In this study, refers to learners' perceived likelihood of success and enjoyment in learning fractions which involves attention, confidence, satisfaction and relevance

Multiple mice technique: Used in this study to mean a technique that allows multiple learners to share a single personal computer simultaneously using several wired mice.

Performance in fractions: In this study, its used to include learners' achievement, motivation and classroom interaction in learning fractions.

Single communal display: Used here to refer to one computer, one projector, one special mouse for the teacher as mediator and one mouse for each learner or team involved in the activity.

Public primary school: In this study, its used to mean a school that is maintained by public expense where children receive elementary education from the age of about five to twelve years coming after pre school and before secondary school

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter deals with literature which is divided into five sections namely: Usage of technology in mathematics instruction; computer interactive multiple mice technique and learner achievement. Furthermore, computer interactive multiple mice technique and learner motivation, computer interactive multiple mice technique and classroom interaction, and gap in the literature are reviewed.

2.2 Usage of Technology in Mathematics Instruction

Cuban (2001) and Bebell *et al.*, (2010), observe that technology has become apparent in many classrooms, yet very few researchers have focused on the effect of technology in the elementary mathematics setting. Numerous academic studies have shown the significant positive correlation between technology, student learning, and mathematics achievement (Hamilton, 2007; Mendicino and Heffernan, 2007; National Council of Teachers of Mathematics, 2008; Rosen and Beck-Hill, 2012).

Mendicino and Heffernan (2007) indicated that learners in web-based conditions learned significantly more when given computer feedback than traditional paper-and-pencil homework. Hamilton (2007) focused on the philosophy of integrating technology in the primary grades. He shows that integration of technology with classroom content improved learner achievement. Thoughtfully planned, such lessons engage learners to a higher degree than traditional teaching and lead to the development of 21st-century skills such as complex thinking, creative problem solving and collaboration.

Rosen and Beck-hill (2012) focused on intertwining digital content and a one-to-one lap top environment effect on learner mathematics achievement and differentiation. This concerned fourth and fifth grade learners. Findings indicated consistent and highly positive findings of the efficacy of a constructivist one-to-one computing program. The study dealt with one to one computing program in mathematics achievement, differentiation in teaching and learning, and decreased disciplinary actions. It suggested a range of possible educational benefits that can be achieved through a comprehensive one-to-one computing educational environment.

Boyraz (2008) carried out a study titled "The effects of computer based instruction on seventh grade pupils' spatial ability, attitudes toward geometry, mathematics and technology (dynamic geometry software) as compared to traditional textbook based instruction." The results of the interviews indicated that computers created a dynamic learning environment which supported learners' development. The computers also helped learners to explore mathematics in a far more meaningful way.

Tafakari Mindset KIE Project initiated in 2007 developed digital content curriculum for mathematics and science targeting Kenyan primary school grades 4, 5, and 7 in video, print, and computer based multimedia educational support materials. The content was designed to demonstrate practical application of knowledge by bringing the outside world directly into the classroom. However, video content makes learner passive in the learning process and offer limited learner interaction (David, *et al*., 2005). Computer interactive multiple mice enhanced more active learner participation and enhanced unlimited learner interaction in the learning process. According to David *et al*., (2005) some responses found that there was limited learner interaction for solutions. In addition, the interactive multimedia content used lacked content on the topic fractions hence the pressing need for the current study (KICD, 2012).

Computer interactive multiple mice is a free add-in system that integrates into Microsoft Office Power Point allowing teachers to create interactive presentations and to engage and excite every learner in the classroom (Stewart, 2009). The program enables teachers to create and insert questions, polls, and drawing activity slides into Office PowerPoint lessons. When the lessons are played, learners' can actively respond to these slides, individually or in teams simultaneously, by using their own mice to click, circle, cross out, color in, or draw answers on the screen (Neema, 2008; Pamela, 2012). This significantly contrasts with the conventional methods of teaching mathematics where one learner occasionally works out a question on the chalkboard or explains as others observe.

Stewart *et al.*, (1998) asserts that today's computers are designed under the assumption that a single person interacts with the display at any given moment, manipulating the input device exclusively. Computer interactive multiple mice allow multiple learners to share the same space and interact simultaneously over a single communal display, each learner with their own input device. As noted by Pal & Toyama, (2006) and Pawar *et al.*, (2007), the purpose is to provide each learner with a mouse and cursor facility that control their own objects on the screen. This effectively multiplies the amount of interaction per learner. Computer interactive multiple mice technique helps learners to be actively engaged and support collaborative learning, improved classroom management and overall learner participation (Stewart *et al.*, 2009).

According to Stewart (2010) and Marsha (2010), once there are two or more kids writing on the Interactive White Board (IWB), they become very un-interactive. In the computer interactive multiple mice each learner in the classroom has an active presence on the screen via own mouse. Besides, through this method of teaching, the teacher can instantly access individual learners' progress and hence a review of the material again can be affected. This helps in providing immediate feedback to both teacher and learner on the lesson instructional progress. This way teachers can gauge individuals and whole group status quickly and frequently. In addition they can implement and apply a diverse set of teaching styles. In the conventional methods of instruction, such was not the case.

2.3 Computer Interactive Multiple Mice Technique and Learner Achievement

According to Wenglinsky (1998) national study of impact of technology on mathematics achievement, eighth grade learners who used simulation and higher order thinking software showed gains in math scores of up to 15 weeks above grade level as measured by NAEP.

Kenneth (2004) explored an interdisciplinary strategy for teaching fractions to second graders. It involved ability to transform visual, aural, and kinesthetic rhythm experiences into mathematical symbols in order to equate and add fractions with unlike denominators. Results showed that the experimental groups' gain scores ranked significantly higher than the gain scores for the control group.

Mofeed (2005) determined the effect of computer-aided instruction on student achievement in eighth grade mathematics using the 'I CAN Learn' computer aided instructional system. The results from the statistical analysis showed those learners who received instruction using the I CAN Learn computer program scored higher than those who did not.

Dissanayake, Karunananda & Lekamge., (2007) studied use of computer technology for the teaching of primary school mathematics. The findings revealed that learners showed significant gains in their performance after using the computer package. They found out that computer based instruction could be used as a generic framework to teach abstract mathematical concepts meaningfully at the primary school level.

Hamilton (2007), focusing on the philosophy of integrating technology in the primary grades shows that integration of technology with classroom content improved learner mathematics achievement. Besides, there was improved acquisition of higher order thinking skills that make use of a variety of Information Communication Technologies (ICTs). These ICTs include cameras, the Internet, learner information systems, multi–media devices, LCD projectors, and a plethora of other tools.

Alejandro, E., Francisca, G., & Miguel, N., (2009) explored two technological platforms to teach electro-statistics. The results showed that learners increased their conceptual understanding of electro-statistics. In addition, the results of pre and post tests showed an increase in the average number of correct answers from 4.27 to 6.22 for learners who played the multiple mice. These studies were done to teach electro-statistics using games. The current study was in mathematics on the topic of fractions. Furthermore, they compared use of two different technological platforms while the current study sought to find out effect of computer interactive multiple mice technique as compared to use of conventional instructional methods.

A study by Ochanda and Indoshi (2011) focused on challenges and benefits of using scientific calculators in the teaching and learning of mathematics in secondary school education. The study aimed at establishing teacher's challenges in the teaching and learning of mathematics in Form Four in Emuhaya Sub County of Vihiga County, Kenya. The study established that scientific calculators had great potential in developing learners' conceptual understanding of mathematics. Learners were able to increase the volume of calculations in a given time because calculators made computation faster. Other than this benefit, scientific calculators were seen as simple tools which the learner could use to save on time, especially where large volumes of calculations were involved. However, this study used scientific calculators in secondary school mathematics whereas the current study used computer interactive multiple mice technique in primary school mathematics which enabled learners to work out questions on the screen simultaneously, received immediate feedback and the system kept on generating new questions from the system. This afforded learners adequate and varied questions to the learners. Moreover, the study was a descriptive study that lacked information on whether the scientific calculator could improve mathematics results. The current study sought to establish if there was an improvement between the pre test and post test results of learners in fractions in primary schools of Hamisi Sub County in the Vihiga County.

In a study by Stewart (2010), the findings indicated that computer interactive multiple mice technique helped students who were unsuccessful at mathematics, who could not focus and had trouble understanding. When they did multiplication lessons results indicated they moved from lower achieving to higher achieving students.

Rosen and Beck-hill (2012) carried out a study on intertwining digital content and a one-to-one lap top environment in teaching and learning. The results showed increased mathematics achievement scores. The findings demonstrated that fourth grade experimental learners significantly outperformed the learners in the control in mathematics scores.

Jennie (2012) investigated mathematics achievement when iPads and game-based learning were incorporated into fifth-grade mathematics instruction. The control group had a posttest score of 62.25 %. The experimental group had a posttest of 67.79 %, significantly higher than the control one.

Alcoholado *et al*., (2012) did a study on One Mouse per Child: interpersonal computer for individual arithmetic practice among third grade learners. The study established statistically relevant results and observed that the technology proved most beneficial for the below average learners. There was also greater improvement on percentage of correct answers (20.96 %) for learners who had the lowest initial results.

Siswa (2012) wanted to determine learners experience with triangles. The study found out that there was a significant increase in learners' test scores. The experimental group did have statistically significant higher scores on the posttest than the control group.

Remalyn (2013), in his article titled 'Scaffolding strategy in teaching mathematics: Its effects on students' performance and attitudes' aimed to determine the level of effectiveness of the use of scaffolding and traditional strategies in the selected topics in mathematics. The posttest mean scores of the experimental and control groups with 7.25 mean difference differed significantly as proven by the computed t-value of 4.848 which, was higher than the critical t-value of 2.093. From the results of the posttest performance of the two groups, it was concluded that there was a greater retention of the topics learned among the participants in experimental group which meant the scaffolding techniques were much superior compared to the conventional methods of learning mathematics.

Rochmad (2015) in his study titled 'Think Pair and Share (TPS) was based on mouse mischief for improving the ability to solve mathematics problem for senior high school students in Indonesia.' The results showed that the application of TPS improved the ability to solve mathematical problems for high school learners. It also improved students' participation in learning activities.

Al Jupri & Marja., (2015), investigated students' achievement in initial algebra through a technology-based intervention. They wanted to find out whether an intervention with digital technology enhanced learner performance. The experimental group's intervention focused on equations involving one variable. The control group used paper-and-pencil and digital work, and by the intertwining of word problems and bare algebra problems. The control group was taught in a regular way without digital tools. The designed experimental learning sequence included work with four applets: Algebra Arrows, Cover up Strategy, Balance Model and Balance Strategy. The results showed that the experimental group gained score was significantly higher than the control group score. A school factor was also found to affect learner achievement.

Lee and Chwen (2016) evaluated effects of different response systems (SRSs) interaction mode. These included: SRS individual, SRS collaborative and classroom were examined on the posttest scores for higher order thinking (HOT) and lower order thinking questions. The results showed that SRS collaborative mode had significant positive effects on science posttest scores of HOT questions. The study points to the potential of using SRS in collaborative tasks to solve problems that require HOT skills.

2.4 Computer Interactive Multiple Mice Technique and Learner Motivation

There are many factors that contribute to learners' motivation in the classroom during teaching and learning. According to Keller's (1993) these are interest, attention, relevance, confidence and satisfaction (ARCS). Wilson and Corpus (2005) emphasize that motivation is essential in determining academic success. The current research borrowed from Keller's motivational theory in order to measure the effect of computer interactive multiple mice compared to conventional instructional methods on learners' motivation in learning fractions.

Bruce and Tirotta (2009) sought to determine the extent to which use of Interactive White Board technology (IWB) was correlated with level of motivation in mathematics. They found out that learners in the treatment group reported elevated levels of motivation relative to control learners. Learners with teachers who were more supportive of IWB technology reported higher motivation levels. However, though the IWB is interactive, having more than one learner working on the IWB simultaneously reduces its interactivity unlike the computer interactive mice where all learners simultaneously access the platform. Moreover, this study was done using IWB while the current one made use of computer interactive multiple mice technique.

2.4.1 Motivating Learners by Increasing Attention

Allessi and Trollip (1991) argue that use of game technique; use of audio, visual and audio visual technique can enhance motivation. These increase learners' intensity of work, attention and encourage deeper cognitive processing. Interaction behaviour gives encouragement even when errors are made. Heinich *et al*., (2002) report that various emotional factors have been found to influence the direction of attention, duration of paying attention, effort invested in learning and how feeling may interfere with learning. They point out that many learners do not perform well in school subjects due to lack of interest. The argument provided is that learners who are motivated will work harder to learn more because of their personal interest in the materials. That learning arises out of direct interest in the materials to be learnt. However, these studies were not done using computer interactive multiple mice technique hence the need to carry out the current study to fill this gap.

Microsoft (2008) revealed that learners paid more attention and they were eager to participate in the learning activities when using computer interactive multiple mice. Additionally, learners enjoyed the change in active peer learning, welcomed the opportunity to work cohesively in small groups and were most enthusiastic about using computers in the classroom. They remained engaged because they enjoyed being able to work with content projected on a big screen. They paid more attention during class and once the teacher had learner attention, teacher was able to connect with learners. Huge classes looked 'smaller'. Research findings by Stewart (2010) stressed that the attention of students enhanced learning. Lower achieving students were more involved because there was no embarrassment in giving the wrong answer and use of computer interactive multiple mice helped review more content faster than the conventional methods. Immediate feedback was received to gauge understanding of content taught.

A study conducted by Baytak *et al*., (2011) established that most learners believe that their learning is improved by integrating technology into classroom curriculum. Learners participating in the study reported that using technology in school makes learning fun and helps them learn more. They believed that technology makes learning mathematics interesting, enjoyable, and interactive.

2.4.2 Motivating Learners by Increasing Satisfaction

The research findings of teacher and student interviews using computer interactive multiple mice technique indicated the following: learners felt their answers had greater impact since they were projected on a screen; feedback on group scores with highest scores were satisfied with their scores; they argued that the technique was able to offer a more engaging classroom experience than the conventional methods (Microsoft, 2008).

Murat (2010) did a study to investigate high school students' motivation to use technology for learning with respect to varying personal characteristics such as gender, grade level, content area of interest on science and mathematics, mathematics and social science. Results on the Satisfaction scale revealed that satisfaction differs in learners' grade level significantly. Thus, learners at lower grades tended to have more satisfaction in using technology compared to the higher graders.

Alcoholado *et al*., (2012) used mice with computers and observed superior technological abilities shown by the learners. This meant more demands towards the system and its proper functioning. When there was a problem (involuntary disconnection of one or more mice), the learners showed explicit dissatisfaction, and their motivation towards the activity decreased. The study also observed that learners in the experimental group constantly showed great satisfaction in using the technology, with most of them wanting to keep using it past the duration of the session.

Marks *et al*., (2013) in their study 'Does use of touch screen computer technology improve classroom engagement in children?' observed that engagement was higher in lessons based on apple's ipad than those not. Of particular significance was increase in engagement seen in boys, which resulted in their engagement levels increasing compared to those seen in girls.

Kevin (2014) did a study on the positive effects of technology in teaching and learning. The purpose was to examine the experiences of pre-service teachers implementing technology in mathematics lessons. The study showed a positive effect on learning in mathematics. The pre-service teachers noted that the internet provided mathematics activities at different levels, which gave learners an opportunity to choose the level they were comfortable working at. Findings showed that learners were engaged during the mathematics lessons using technology were able to discuss what they learned the following day. The teachers were surprised by the learners' recall of the lesson. Some learners who participated in the lessons believed that the computer helped them understand what the teacher was saying about the lesson.

Daniel *et al*., (2015) did a study entitled "do student self-efficacy and teacher-student interaction quality contribute to emotional and social engagement in fifth grade mathematics?" They examined the contribution of mathematics self-efficacy to learners' perception of their emotional and social engagement in fifth grade mathematics classes, and also determined the extent to which high quality teacher-learner interactions compensated for learners' low mathematics self-efficacy in contributing to engagement. Results of multi-level models indicated that learners initially lower in mathematics self-efficacy reported lower emotional and social engagement during mathematics class than those with higher self-efficacy. However, in classrooms with high levels of teacher emotional support, learners reported similar levels of both emotional and social engagement, regardless of their self-efficacy. No comparable findings emerged for organizational and instructional support. This study was done in grade five. The current study addressed the same sub scale of satisfaction on sixth grade learners in primary schools.

2.4.3 Motivating Learners by Providing Relevant Activities

Pintrich (2002) stated that teachers can enhance motivation by finding tasks and activities that are highly relevant and engaging for learners. Pintrich (2003) asks the question 'What Motivates learners in Classrooms?' He asserts that adaptive self-efficacy and competence perceptions motivate learners. Having as high as possible efficacy and competence beliefs would be useful and keep learners motivated.

Microsoft (2008) carried out a study on use of computer interactive multiple mice on learners learning in mathematics classrooms at the Le Quy Don school Hanoi, Vietnam. Teacher and learner interviews revealed the following: teachers felt they were connected to their learners because they were able to gauge individual and whole group status quickly and frequently; computer interactive multiple mice technique made huge classes 'feel smaller' than it really was; learners liked constant feedback on their answers to teacher's questions. The technique helped learners to develop teamwork skills where the group discussed their answer and made a final choice which was displayed to the teacher and whole class. They thought this was better and more relevant than the conventional classrooms, where the teacher would point to an individual learner, so only that learner answered. The present study sought to find out if the same results will be found in a Kenyan setting.

Jeng-Chung (2013) carried out a research study focused on digital game-based learning that supports student motivation, cognitive success, and performance outcome. The study was carried out on university learners. Measurements of learning motivation comprised the subscales of attention, relevance, confidence, and satisfaction. The results established that learners' responses regarding the ARCS motivation scale, for which the mean of the relevance subscale was the highest (6.37) and that of the attention subscale was the lowest (5.77). The means of the confidence and satisfaction subscales were 5.90 and 6.05, respectively. In addition, all of the motivational subscales attained standard deviations ranging from .67 to .78. The mean of overall learning motivation was 6.02. They concluded that although game characteristics, such as fun, fantasy, curiosity, and role-playing can attract learners' attention, they are not necessarily directly relevant to learning. Regarding the lack of corresponding game characteristics for the relevance subscale, this game involved adopting the following two design strategies namely: familiarity with product model examples, and realistic simulation. Furthermore, the relevance of learning environments can be increased by integrating learners' previous experiences. This may be the reason that the mean of the relevance subscale attained the highest score.

Rochmad (2015) found that the application of TPS (Think Pair and Share) based on the use of the program of Mouse Mischief could improve Senior High School (SHS) students in learning activities. They argued that activities are accompanied by politeness, learner discipline, and responsibility for tasks to solve the problem properly maintained.

2.4.4 Motivating Learners by Increasing Confidence

Theroux (1994) assert that computers intrigue learners and lead to higher quality work. However, computers alone do not create motivated learners. A combination of learner-centered methods and technology use is necessary for leading improved motivation among learners. The current study seeks to find out how learners gain confidence in use of computer interactive multiple mice technique in learning fractions. Each learner controlled their mice and work space hence it was premised to enhance learner centred instruction.

The research findings of teacher and learner interviews in a pilot study by Microsoft (2008) using computer interactive multiple mice technique in mathematics found out that the scoring of the computer interactive multiple mice technique helped improved the learning atmosphere. More competition and teamwork was evident. These were studies done in Vietnam and researcher sought to find out if similar findings could be found in public primary schools of Hamisi, Sub County, Kenya.

Moraveji *et al.*, (2010) argue that Single Display Groupware (SDG) model in particular, multiple mice have been shown to lead to higher engagement, better task performance, and a positive impact on collaboration and motivation. However, their research only focused on small-group SDG (3-5 learners), and has not been applied to whole class interaction. The present study indented to fill this gap by having a mix of individual tasks, whole class tasks and small group tasks to provide a deeper insight on the different groupings and sizes.

According to Kimberle *et al.*, (2010) in their study, teacher interview results indicated the following: teachers felt that the tablets were easy to use from the beginning, most had less than 30 minutes of training and quickly adapted their teaching style to instruct with the tablets. They unanimously reported that learners were motivated to use the tablets to try activities normally completed with paper and pencil. The teachers felt that tablet use changed the way the teaching and learning occurred in their classrooms making learning relevant and real. All teachers, however, felt that they wanted to continue using the technology and to develop more sophisticated and longer curriculum units in order to investigate how learning is affected. All teachers felt that increased learner engagement, focus, questioning, and work completion as a result of tablet use directly led to increased active learner participation in the learning process. This resulted in improved outcomes. Several teachers identified ways they saw the tablets providing options for teaching a lesson, providing a variety of entry points for different kinds of learners. Examples of such learners are those who: like technology, like communicating, didn't like writing but liked drawing, were shy, were slower, or who typically didn't complete assignments. This was a study done in different geographical area and population. The present study was carried out to find out if similar results could be realized using a different technology in public primary schools in Kenya.

Murat (2010) investigated high school learners' motivation to use technology for learning. A comparative analysis with respect to varying personal characteristics such as gender, grade level, content area of interest in science and mathematics, mathematics and social science was determined. Previous experience in using technology for learning was also investigated. The results for relevance scale indicated that there was no statistical significant difference among learners with varying personal characteristics. The sub scale of confidence revealed that learners were confident in using technology. However, female learners were less confident in using technology compared to male students. Content area of interest had three categories of effect. Mathematics and social science showed lowest confidence compared to science and mathematics and undecided groups. Tenth graders exhibited highest confidence compared to other students like 9th graders and 11th graders.

Jeng-Chung (2013) established that the mean of the confidence subscale (5.90) was only slightly higher than the value of the attention subscale. The reason may be, as indicated by Squire (2005), conventional school-based professional knowledge acquisition cannot be realized by successful learners in a game-based learning environment. Such students do not believe that game-based learning can benefit their performance in college entrance examinations or university classrooms. This study was carried out on university learners using games platform whereas the current one will be done on primary school learners in Kenya. It was quite informative.

2.5 Computer Interactive Multiple Mice Technique and Learner Classroom Interaction

Stewart et al (1998) in their study compared the SDG model and the more traditional remote collaboration. The results indicated that Single Display Groupware (SDG) allows multiple learners to share the same space and interact simultaneously over a single display, on the same machine, each with his own input device. The solution is to provide each learner with a mouse and cursor that controls his own objects on the screen, thus effectively multiplying the amount of interaction per learner for the cost of few extra mice (Pal, Gupta & Toyama., 2006; Pawar *et al.*, 2007; Cao, Olivier & Jackson., 2008; Kaplan *et al.*, 2009). In the conventional methods of teaching, this is limited to one child answering a question at a time hence the present study was done to find out if same results will be realized.

Microsoft (2008) carried out a pilot study on "The Multiple mice." The study was a pilot program in classrooms at the Quy Don School of Hanoi, Vietnam. The results of teacher interviews and classroom observations established that compared to the conventional method of teaching, using multiple mice enables learners to interact with teachers, interaction with each other and to work well in small groups. It also developed teamwork skills and the whole class was involved. One teacher said, 'a small group of learners had to discuss among themselves more than usual to get a final answer because the system only allowed one answer and it was visible to everyone'. In conventional classes, the teacher would just point to an individual learner. Immediate feedback improved teamwork and the technique provided the opportunity to overcome large class issues. It created an active, collaborative learning experience that engaged learners.

Davies (2009) stresses that active participation can be achieved through interactive learning environments that provides feedback to the learners' actions. Feedback can be delivered through the evaluation of activities. These can be seen as an instance that promotes learning, as opposed to assigning grades. When children become involved in the evaluation process, it is viewed as learning, rather than a measuring process (Davies, 2000). In conventional methods this type of interaction and feedback is absent hence the need for the current study.

Rimm-Kaufman *et al.*, (2009) in Daniel (2015) states that the quality of teacher-learner interactions is an example of an influence external to the learner that has been shown to contribute to engagement. However, Ruzek, *et al.*, (2014) asserts that teacher-learner interaction quality is highly variable across the United States with some classrooms offering more support for learning than others. They conclude that teacher-learner interaction quality is multi-dimensional, in that teachers can provide support that is emotional, organizational, or instructional in nature. Teachers provide emotional support by being sensitive, responsive, warm, and aware of learners' interests and needs. Teachers facilitate organizational support by creating non-chaotic classroom environments characterized by clear expectations and productive learning. Teachers offer instructional support by giving clear feedback to learners, creating opportunities for conceptual thinking, and modeling new vocabulary.

Kimberle Koile *et al.*, (2010) investigated the role that pen-based wireless technology could play in upper elementary and middle school mathematics. They conducted tablet computing trials in eight schools in the Boston, in fourth, sixth and eighth grade teachers' classrooms. During each of these trials, the project team helped teachers adapt their lessons to make best use of the tablets and to think strategically about pacing the lesson, accommodating different types of learners, and dealing with unexpected technological challenges. The results indicated that tablets were particularly successful in facilitating learners' creation of drawings and other mathematical and scientific representations, and providing teachers with tools to promote classroom discussions. The following classroom behaviors were encoded and included in the analyses: lecture, demonstration, lecture with discussion, class discussion, small group discussion, teacher interacting with learner, tablet technology use, hands-on activity (non-computer), revising work, sending and receiving wireless data, interruption, passive learning and active learning. Findings suggested that on overall learners were highly engaged (85 % of the time). They also suggest that INK-12 tablet sessions provide ample classroom opportunities for interactive instructional methods (lecture with discussion), increased communication and feedback (send and receiving wireless data), and engaging learners in active learning. Learners adapted quickly to the tablet interface; very little class time was spent in technology training or support. This was a study done in grades 4, 6 and 8 using tablets.

Infante *et al.*, (2010) showed an increase in the average number of correct answers from 4.6 to 8.6, with standard deviations of 2.21 and 3.84 respectively. In the case of the experimental group, the learners showed an increase in the average number of correct answers from 4.6 to 8.7, with standard deviations of 2.32 and 3.71 respectively. The results of the t--student test were statistically significant for both the control group ($p < 0.00001$) and experimental group ($p < 0.0000001$). As noted by Infante *et al.*, (2010), computer interactive multiple mice technique is fundamental in favoring learner-learner interactions during the learning process. The activity will make each learner work with objects that are closely his. Each learner controls their own input device, which forces participation and becoming the protagonist of their own learning process. They indicate that learners' focus their attention on the common screen where individual resources are shared. The screen transforms it into a learning place in which learners discuss, collaborate and negotiate. The discussion is between the learner-learner in teams and between teacher and learners. Furthermore, Infante *et al.*, (2010) found that a video game, which was designed for multiple players to use one computer screen and several input devices, encouraged kinder gardeners to collaborate and communicate in order to complete the game tasks.

Siu (2011) focused on an evaluation study of the use of a Cognitive Tool (CT) in a one-to-one classroom for promoting classroom-based dialogic interaction. The study was done in grade four. The learners in the experimental group learned the target topic with the use of CT in a one-to-one classroom. Those in the control group learned the target topic under the conventional instructional approach. The results of a time allocation analysis showed that the use of CT in a one-to-one classroom enhanced learner engagement in terms of time on task for learning exploration during class time. The results of the post-attainment test indicated that learners in the experimental group performed better than those in the control group. Moreover, the questionnaire survey results indicated that learners liked to learn the target topic with the use of CT in a one-to-one classroom. This study reveals the potential of the use of CT in a one-to-one classroom to promote classroom-based dialogic interaction in mathematics lessons.

Siswa (2012) did a study on classroom collaboration in a participative instructional setting using Single Display Groupware (SDG) to understand triangles. Learners of one class (the experimental group) were each equipped with a mouse and shared one computer together that was connected to one big screen divided into four working areas. In four groups of six to seven learners each they had to identify and create different kinds of triangles on the screen, which they could only successfully do by collaboration within their group. Verbal communication during these activities was difficult due to seating arrangements, because of which they had to find a way of collaborating silently by using their mice. Group discussions were held after the activities to stimulate learners to gain deeper understanding of the material and to make sure that everyone understood the concepts they were taught. The teacher played a key role in controlling and organizing the process, and presenting the learners with concepts and ideas regarding triangles. An analysis of behavioural patterns showed that learners in the experimental group naturally found different ways to collaborate silently. In a control group the same domain information was presented by means of conventional instruction. Knowledge gains in the experimental group were compared to knowledge gains in the control group. Results showed a significant learning effect in both groups, but no significant difference between the groups.

According to Pamela (2012) it was observed that teachers believe that the use of clickers in the classroom increased participation as well as mental engagement. The learners believe that clickers should be used more often in their classroom. That clickers help to provide instant feedback on what is known. Survey data also revealed that both groups agreed that clickers increase participation in class. Fifteen of the 22 teachers surveyed (68 %) felt that clickers allowed them to design questions at either all levels or at least application and above.

2.6 Gap in the Literature Reviewed

Alejandro, E., Francisca, G., & Miguel, N., (2009) did a study to explore different technological platforms for supporting located collaborative games in the classroom. Multiple mice platform was one of the devices used to teach electro statistics. The results of two different technological platforms were compared. The results of pre and post test showed an increase the average number of correct answers from 4.27 to 6.22 for the multiple mice platform. These meant using multiple mice platform enhanced the learner achievement in learning of electro statistics.

Alcoholado *et al*., (2012) did a study on "One Mouse per Child". The results indicated 17.86 % of improvement ($p < 0.001$). The current study was to find out if it yielded similar results. Furthermore, these were studies done in a different geographical region different from Kenyan public primary schools hence need for the current study.

Moraveji *et al*., (2010), Pal, Gupta & Toyama, (2006), Cao, Olivier, & Jackson., (2008) Pawar *et al*., (2007) and Kaplan *et al*., (2009) argue that Single Display Groupware (SDG) model in particular, multiple mice have been shown to lead to higher engagement, better task performance, and a positive impact on collaboration and motivation. However, their research only focused on small-group SDG (3-5 learners) and has not been applied to whole class interaction. The present study indented to fill this gap by having a mix of individual tasks, whole class tasks and small group tasks.

Studies have been done on integration of computer technology on learner achievement but not specifically on use of computer interactive multiple mice technique (Mofeed, 2005; Jennie, 2012; Remalyn, 2013; Al Jupri & Marja., 2015). For those studies that used computer interactive multiple mice as the technological platform, the grade level and topics investigated were different (Alejandro *et al.,* 2009; Alcohado *et al*., 2012; Siswa, 2012; Rochmad, 2015). The first objective sought to fill this gap. The first, second and third objectives also went further to address gaps in Hamisi Sub County where no studies known to the researcher investigated effect of computer interactive multiple mice versus conventional instructional methods on learner achievement, motivation and classroom interaction. The only study findings available was done in Emuhaya Sub County, Vihiga County which focused on challenges and benefits of using scientific calculators in the teaching and learning of mathematics in secondary school education.

The first objective sought to find out any difference in achievement between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods. Previous studies (Wenglinsky, 1998; Hamilton, 2007; Rosen and Beck Hill, 2012; Jennie, 2012; Remalyn, 2013; Rochmad, 2015) compared various computer technology platforms versus conventional techniques on learner achievement. They all found statistically significant differences between the experimental and control group results on various variables and learner achievement. Variables measured in the previous studies included; time factor, problem solving, scaffolding technique, skills and knowledge acquisition, conceptual understanding and higher order thinking skills. No effort was made to link computer interactive multiple mice versus conventional instructional methods on learner achievement. The present study narrowed down to this.

The second objective sought to find out any difference in motivation between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods. This objective sought to fill the gap where studies had not established effect of computer interactive multiple mice versus conventional instructional methods on learner motivation in the Sub County. Previous researches (Heinrich 2002; Murat, 2010; Alcohalado *et al*., 2012; Baytak *et al*., 2011; Jeng Chung, 2013; Daniel *et al*., 2015) used various technological platforms like tablets, digital games, audio, audio-video, interactive white boards among others. Among the variables addressed in correlating with motivation in the previous studies included: academic success; duration of paying attention; eagerness; enjoyable; self efficacy; emotional engagement, fantasy; curiosity; personal characteristics like gender, grade level, content area among others. Besides, in most studies done focus was on motivation as general yet the current study was interested on the four sub scales of motivation: confidence, satisfaction, attention and relevance according to Keller (1993). Hence the pressing need of the present study.

The third objective sought to establish any difference in classroom interaction between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods. Previous studies revealed the following; active participation of learners; immediate feedback; teacher-learner interactions; collaboration; teamwork; learner engagement; all levels of Blooms taxonomy addressed and large classes looked smaller among others (Pal *et al*., 2007; Stewart, 1998; Davis, 2007; Rimm-Kaufma *et al.,* 2009; Kimberle *et al*., 2010 and Infante *et al.,* 2010). However, the previous studies did not narrow down on the different interaction styles namely; teacher-learner interaction, learner-teacher interaction and learner- learner interactions apart from the variables addressed above. The present study strives to fill this gap. Furthermore all the studies were done in developed nations under different geographical environment while the current one was done in public primary schools of Kenya.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides a description of research design adopted, study location, study population and sampling procedures. It also includes a section on research instruments, piloting, research validity and reliability of the instruments. Finally, the procedures of data collection and analysis are described.

3.2 Research Design

Quasi experimental studies are designed to examine cause and effect and minimize threats to external validity. In this study, Quasi non equivalent pretest post test non equivalent group design was used since it was appropriate to eliminate this problem. The design was also chosen because whole classes were used to minimize class disruption. The design is appropriate for classroom experiments when experimental and control groups are naturally assembled as intact groups. Table 3.1 illustrates this study design.

Table 3.1: The Quasi-experimental Pre-test Post- test Non equivalent Groups Design

Group	Pre-test	Treatment	Post-test
E	$\mathbf{O_1}$	**X**	$\mathbf{O_2}$
C	$\mathbf{O_3}$		$\mathbf{O_4}$

As shown in Table 3.1, two groups of subjects were used to take care of issues of internal validity: the Experimental Group (E) and the Control Group (C). Both groups received pre test (O_1 and O_3) to ascertain whether or not the two groups under study had comparable characteristics, homogenous and with similar entry behavior. Group E was exposed to the experiment (use of computer interactive multiple mice technique) while group C used conventional instructional methods of learning fractions. Both groups received the post-test. To avoid interaction of subjects from different groups, intact classes two from different schools in each zone constituted experimental and control groups. Besides, two schools from each zone were used in the study to ensure each zone was represented in the sample. Twelve co-educational public primary schools were used in this study. Figure 3.1 shows the operationalizing of the research design.

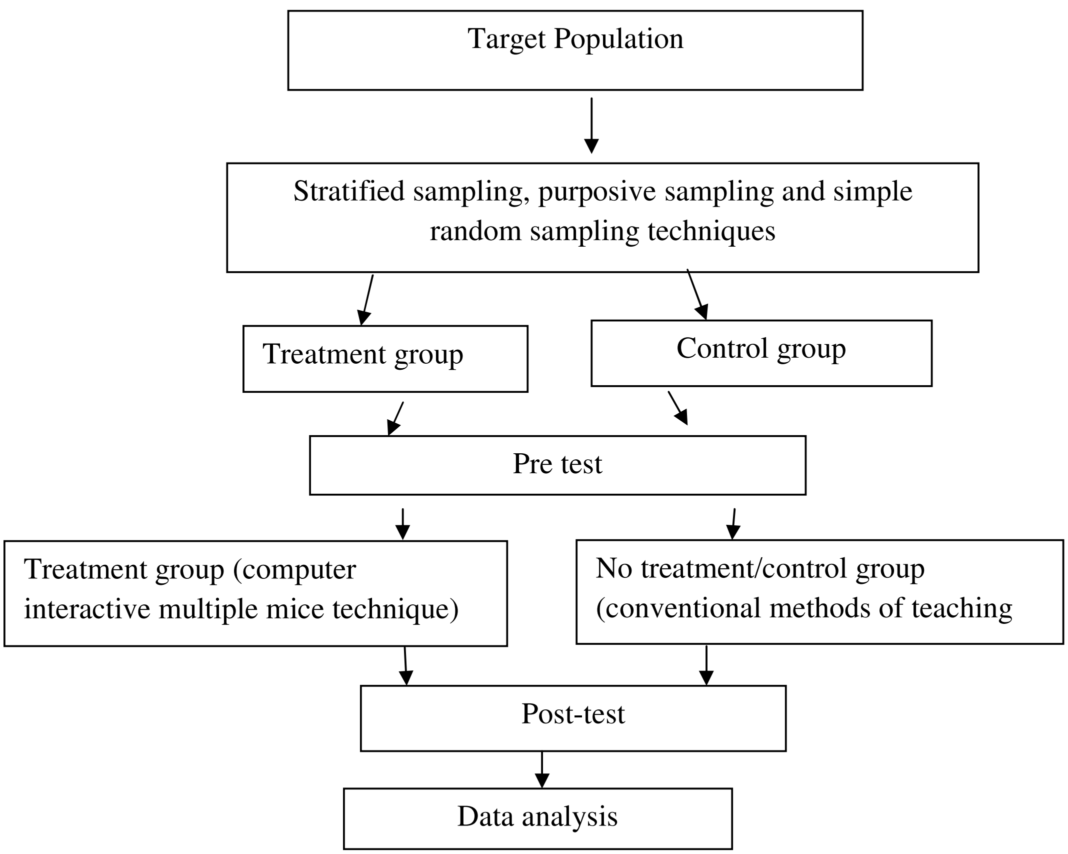


Figure 3.1: Operationalizing the Reseach Design

3.3 The Study Location

The study area was Hamisi Sub-county of Vihiga County, Kenya. Vihiga County is along the Equator between 34º 30 mins E and 35º 0mins E and 0º 15 mins N and 0º 5mins S in the western part of Kenya. It boarders Nandi County to the East, Kisumu County to the South, Siaya County to the West and Kakamega County to the North. The County urbanization rate is 31 % with the Major Towns being; Luanda, Maseno, Chavakali, Mudete, Majengo, Mbale, Serem, Jeptulu, Jebrock and Kilingili.

The County has 392 Primary Schools. It draws its advice from the County Government's Vision: To create a free, secure, just and prosperous County with a strong and highly skilled human resource that will spur industrial growth for economic empowerment. Hamisi Sub-county was selected because learner performance in KCPE mathematics has been poor (Sub County Office, 2013). Available statistics in Hamisi Sub-County showed a performance index of 48.6 % in 2009; 49.8 % in 2010; 49.4 % in 2011 and 48.7 % in 2012 respectively. In 2013, 2014 and 2015 the Sub County registered a mean of 48.8 %, 49.8 % and 48.8 % respectively (Hamisi Sub-County Office, 2015). This performance was far much below compared to other Sub Counties in Vihiga County. It could be inferred from the results that fractions was one of the topics that was poorly done since KNEC reports indicated fractions to be among the difficulty topics for learners to comprehend. It is not known the cause of the poor performance in KCPE mathematics despite the rich natural resources and varied economic activities in the area. The current study strove to find out the effects of computer interactive multiple mice technique on achievement, motivation and classroom interactions in learning fractions in public primary schools in the Sub County.

3.4 Study Population

Hamisi Sub-County has 105 public primary schools of which 102 are public co-educational primary schools (Sub-County Education Office, Hamisi 2013). All the 5,487 Standard 6 learners in these schools formed the target population.

3.5 Sampling Procedures and Sample Size

This section highlights the sampling techniques and sample that were employed during the study.

3.5.1 Sampling Procedures

The Sub County was stratified into six existing educational zones namely: Shaviringa, Shamakhokho, Banja, Nyangori, Gisambai and Tambua. The Sub County was selected because of poor KCPE mathematics performance as compared to other Sub Counties in Vihiga County (Table 1.2). In each of the zones, simple random sampling was used to pick two schools to participate in the study. The selected schools from each zone were then randomly sampled into experimental and control groups using simple random sampling. Some schools had more than one stream of Standard 6. In such cases, simple random sampling technique was used to select one stream that participated in the study. This technique was considered appropriate since it ensured that all the streams had an equal chance of being included in the study sample. According to Borg (1987) and Mugenda and Mugenda (1999), simple random sampling gives samples, which yield data that can be generalized. Purposive sampling was used to identify public primary co-educational schools and those that have at least a computer. The experimental and control groups were drawn from different schools to reduce the chance of interaction and bias.

3.5.2 Sample Size

Twelve co-educational public primary schools were used in the study. Six schools formed the experimental groups that used computer interactive multiple mice technique in learning fractions. The other six schools constituted the control groups which were treated to conventional instructional methods of learning fractions. The actual sample size that participated in the study was 518 learners drawn from Standard six. Krejcie and Morgan (1970) argue that if the target population is finite, the following formula may be used to determine the required sample size:

$S = \frac{X^2 NP(1-P)}{d^2(N-1)+X^2P(1-P)}$ where, S = Required Sample size, X= Z value (e.g. 1.96 for 95% confidence level), N= Population Size, P= Population proportion (expressed as decimal) (assumed to be 0.5(50%) and D = Decree of accuracy (5%) expressed as a proportion (.05). It is the margin of error.

Based on the above formula, the required sample was

$$S = \frac{1.96x1.96x5487x.5(1-.5)}{.05x.05(5486)+1.96x1.96x.5(1-.5)} = \frac{5269.7148}{14.6757} = 359$$

However, the sample was 518 because intact classes were chosen for the study. Furthermore, large samples increased external validity and accuracy of the results. Conclusions were confidently drawn since both the sub groups were large. These subjects were used in their twelve intact classes that were randomly assigned to Experimental and Control groups as shown in the Table 3.2.

Table 3.2: Sample Size Distribution By Zone and Group

Type of Zone	Experimental Group	Control Group	Total number of Learners
Zone 1	30	45	75
Zone 2	54	46	100
Zone 3	52	34	86
Zone 4	62	32	94
Zone 5	34	38	72
Zone 6	34	57	91
Total	**266**	**252**	**518**

Fraenkel and Wallen (2000) recommend at least 30 subjects per group (i.e. experimental or control group). Hence this number was deemed adequate for the study.

3.6 Research Instruments

Four research instruments were used to collect data for this study. These were: Mathematics Achievement Test 1 (MAT 1); Mathematics Achievement Test 2 (MAT 2); Learner Motivation Questionnaire (LMQ) and Mathematics Lesson Observation Checklist (MLOC).

3.6.1 Mathematics Achievement Test 1 (MAT 1)

Mathematics Achievement Test 1(MAT 1) assessed learners' achievement in the topic fractions which was taught in standard five. The purpose of MAT 1 was to ascertain the entry behaviour of the two groups in order to determine if the two groups have comparable characteristics. The contents were drawn from the former K.I.C.D mathematics syllabus for Standard five. It consisted of questions on addition and subtraction of fractions, simplification of fractions, converting mixed numbers to improper fractions and converting improper fractions to mixed numbers. It was administered to all learners in both experimental and control groups in the sample. MAT 1 was marked out of 100 marks. Each of the items in MAT 1 were analyzed for difficulty and discrimination indices. After item analysis, it was found that all the MAT 1 items had a difficulty level of between 0.32 and 0.41 which necessitated revising and some retained. The discrimination index was found to lie between 0.31 and 0.45. These indices were found acceptable according to Ebel and Fresbie (2004).

3.6.2 Mathematics Achievement Test 2 (MAT 2)

Mathematics Achievement Test 2 (MAT 2) acted as a post test for all the groups. It comprised of 30 items developed from term one work on the topic fractions in Standard six. It consisted of the following sub-topics: multiplication of fractions, squares of fractions, square root of fractions, reciprocals, division of fractions and number sequencing involving fractions. MAT 2 was marked out of 100 marks. Each of the items in MAT 2 was analyzed for difficulty and discrimination indices. After item analysis, it was found that all the MAT 2 items had a difficulty level of between 0.35 and 0.56. The discrimination index was found to lie between 0.33 and 0.67. These indices were found acceptable according to Ebel and Fresbie (2004). They recommend that if the discrimination index is greater or equal to .40 then the item is functioning satisfactorily and if it's $.30 \leq DI \leq .39$ then little or no revision is required. For item analysis if the range of difficulty is .26 - .71 the item is of right difficulty and should be retained. If it's .76 and above then the question is easy and should either be revised or discarded.

3.6.3 Learners' Motivation Questionnaire (LMQ)

The LMQ was a 5-point Likert-type of tool ranging from Strongly agree (SA) to Strongly Disagree (SD). It consisted of twenty structured items which measured learners' motivation towards learning fractions. The twenty items were divided into four categories: Attention, Relevance, Confidence, and Satisfaction (ARCS). Survey items in the attention category measured the extent to which the interest of learners' was captured and their curiosity to learn fractions was stimulated by the lesson. The attention mentioned in this theory referred to the interest displayed by learners' in acquiring the concepts being taught (items 5, 6, 7, 8, 10 and 20 in appendix VI). Items in the relevance category served to measure the extent to which the personal needs and goals of the learner were met in such a way as to affect a positive attitude (items 1, 12, 13, 14, 16 in appendix VI). Items related to confidence evaluated the perception of learners about whether they were able to succeed and control their success. The confidence aspect of the ARCS model focused on establishing positive expectations for achieving success among learners (items 3, 4, 15 and 17 in appendix VI). Finally, the items in the category of satisfaction measured the extent to which learners' accomplishments were reinforced. When the outcome of the learners' effort is consistent with their expectations and they feel relatively good about those outcomes, they will remain motivated. This satisfaction can be from a sense of achievement, praise or mere entertainment (items 2, 9, 18 and 19 in appendix VI).

3.6.4 Mathematics Lesson Observation Checklist (MLOC)

A Fractions Lesson Observation Checklist (MLOC) was adapted by the researcher from the Marzano (2007) Classroom Observation Indicators Model (COIM). The MLOC was used to observe lessons on the topic fractions. The purpose of this observation was to collect data on classroom interactions during learners' learning of fractions namely: teacher-learner, learner-learner and learner-teacher interactions from each of the groups in the two modes of teaching during the mathematics lessons. The researcher made a list of various aspects to be observed during the mathematics lesson. This allowed the researcher to gauge presence of these aspects during the lesson and also compared the two methods to see which one was more effective.

The MLOC consisted of the following: eight teacher-learner activity related items, six learner-learner activities and six teacher's learner related activity items giving a total of 20 items. The learner-teacher activities focused on seeking clarifications, questioning and responding. The teacher-learner related activities focused on facilitation, giving hints, reinforcement, and supervision of learning activities, correcting learners' errors, questioning and explanation of concepts.

3.7 Piloting

This section provided the rationale for piloting. It also checked for the validity and reliability of the research instruments.

3.7.1 Rationale for Piloting

The purpose of the pilot was to ensure the research instruments were relevant and accurate, the level of language used was appropriate, the adequacy of space in providing answers to questions and time allocated was consumerate with task at hand. The MAT 1, MAT 2, LMQ and MLOC were piloted in two public primary co-educational schools of Hamisi Sub-County that were not used in the actual study but had similar characteristics as the sampled schools. One item in MAT 1 was deleted because it was not measuring the variables under study. MAT 2 was too long and learners took long to answer it. Hence the numbers of questions were reduced. The whole LMQ (Learner Motivation Questionnaire) was re-structured because the language used was not clear to the Learners. The researcher used four teachers of English to act as experts in English language. The teachers were asked to check for clarity, simplicity in language and replace the complex words with those similar in meaning.

3.7.2 Validity of the Research Instruments

To ensure that the research tools were valid, the instruments were given to the experts for validation (experts, mathematics teachers and teachers of English). Two aspects of validity were determined for the instruments. Face validity were established by assessing the items for relevance, meaningfulness and appropriateness to the respondents. To measure content validity there was critical and careful examination of the items on the research instrument. To further check content validity of MAT 1 and MAT 2, the two instruments were given to mathematics teachers who had experience in teaching fractions in Standard six. . The teachers were asked to check the items for clarity and in completeness in covering concepts on fractions in Standard six syllabus. This ascertained that the instrument contained adequate coverage of the topic under study based on the KICD primary school mathematics syllabus and Standard 6 primary mathematics text books for learners. LMQ was given to four teachers of English who were asked to check for clarity, simplicity in language and replace the words with those similar in meaning. The average rating ranged from a score of 1 (extremely invalid), 2 (fairly valid), 3(valid) and 4 (highly valid) . The overall average mean rating was 3.5 on a scale of 1 to 5 (see Appendix III). The validation was done as shown in Table 3.3.

Table 3.3: Validation of Research Instruments

Experts	Research Instruments	Face Validity	Content Validity	Average	Verdict
Expert A	LMQ (5)	4	3	3.5	Valid
	MLOC (5)	3	4	3.5	Valid
	MAT 1 (5)	3	5	4	Valid
	MAT 2 (5)	2	4	3	Valid
Expert B	LMQ (5)	3	4	3.5	Valid
	MLOC (5)	3	3	3	Valid
	MAT 1(5)	3	4	3.5	Valid
	MAT 2 (5)	4	4	4	Valid
Expert C	LMQ (5)	3	4	3.5	Valid
	MLOC (5)	3	3	3	Valid
	MAT 1(5)	4	2	3	Valid
	MAT 2 (5)	4	4	4	Valid
Total					

The raters found the instruments to be valid. The experts indicated that question 2 in MAT 1 was irrelevant hence was deleted. The following words in questions 2 (engagement), 3 (positive interaction), 4 (immediate feedback), 7 (stimulated), 8 (humor), 14 (knowledge learned applied), 16 (simplified and 17 (boosted) in the LMQ were difficulty for learners to infer meaning. The difficult words were replaced as follows: questions 2 (engagement replaced with participation), 3 (positive interaction replaced with 'i was involved more in activities with other learners'), 4 (immediate feedback replaced with instant or quick answers to questions), 7 (stimulated replaced with interest), 8 (humor replaced with lively), 14 (knowledge learned applied replaced with able to solve word problems), 16 (simplified replaced with easy) and 17 (boosted replaced with confident).

3.7.3 Reliability of Research Instruments

The MAT 1, MAT 2, LMQ and MLOC were tested for reliability using Pearson Product Moment of Correlation statistic. The test-retest technique was employed on two independent occasions within two weeks' period under similar conditions. The test data was correlated using the Pearson Product Moment of Correlation (r_{xy}) which were as follows .698 for MAT 1, .891 for MAT 2, .941 for LMQ and .813 for MLOC (see appendix VIII - XII). The results show a correlation of above 0.7 between the first score and the second score implying the instruments were reliable. A reliability coefficient (r_{xy}) of 0.7 and above is considered suitable to make inferences based on the findings (Fraenkel and Wallen, 2000).

3.8 Operationalizing The Study

A guiding manual was developed for the mathematics teachers in the experimental groups. The content was based on the Kenya Institute of Curriculum Development and approved syllabus (2003), primary mathematics teacher's guide and the learners' primary mathematics text books. The manual created interactive multiple mice presentations that allowed the learners in small groups to draw and answer multiple choice questions on a shared screen.

The researcher recruited 12 research assistants who had taught Standard six mathematics atleast for a minimum of 3 years. The research assistants were taken through the instruments to know what data to collect and how to record it. In addition, the researcher trained the mathematics teachers in the experimental group on how to use the manual. During training teachers were taught how to help learners draw and to answer the multiple choice questions. They also learned how to develop polling slides to guide class discussions and how to ensure all learners were actively participating. These content areas were presented in 10 lessons of 35 minutes each covering 2 weeks in all the 12 schools. They were taught to Standard six learners. To master the skills of using computer interactive multiple mice technique after training, the teachers practiced how to use it on a different topic other than fractions.

After training, each teacher in the experimental groups was provided with a starter set of equipment for their classrooms consisting of 15 wired mice, four seven-port and six four-port USB hubs, six USB cables, one power-strip extension cord and projector. Teachers were then charged with implementing the use of the computer interactive multiple mice technique or conventional instructional methods in the teaching of fractions in their classrooms. All the mathematics teachers involved in the study were also informed about ethical issues among them confidentiality, informed consent and acceptance. After the two week practice, the researcher then embarked on administering the research instruments. A pretest was done then after two weeks the post test was done.

Permission to carry out the research was then sought starting from the School of Graduate Studies of Masinde Muliro University of Science and Technology. This was done after the research proposal was approved by the School of Graduate Studies of Masinde Muliro University of Science and Technology. The researcher then obtained a research permit from the National Council of Science, Technology and Innovation (NACOSTI) to carry out the research in the selected schools. Consent was also given by the Vihiga County government, Hamisi Sub-County Education Office and the head teachers of the selected schools.

Several visits were made to the sampled schools. During the first visit to each school the researcher explained purpose of the study and discussed details of the study with the school administration and the Standard six mathematics teachers. In the second visit, the researcher trained the teachers handling the experimental groups on how to use the computer interactive multiple mice technique in teaching fractions in readiness for their roles in the study. Those mathematics teachers in the conventional groups were also given instructions on what was expected of them during this period. The induction for those involved in experimental group took a period of two weeks. Thereafter they practiced together with their learners to build confidence. During the practice period, the researcher supervised, discussed and addressed any technical issues that arose. This was to ensure uniformity in procedures followed in the six experimental groups. The researcher then pre-tested the instruments in two schools of Hamisi Sub-County which were not used in the actual study.

On the third visit, the researcher administered and collected MAT 1 in all the twelve schools. During implementation, the researcher also made two visits to each school for discussions on the progress and challenges encountered in use computer interactive multiple mice technique. These visits enabled harmonization of the implementation of the new technique in all the sampled schools. Standard six mathematics teachers participated in the study as research assistants. They taught their learners using computer interactive multiple mice and conventional instructional methods. They also took charge of MAT 2, LMQ and MLOC before researcher collected them.

3.8.1 Physical Setting and Classroom Environment

At first, in classroom observations, the researcher watched for details describing the physical setting and classroom learning environment in both the experimental and control schools as shown.

Experimental schools

It was observed that all the 6 experimental schools used similar system requirements; all the computers ran Windows 7 operating system and Microsoft Office PowerPoint 2007. These provided tools that had slides created to support computer interactive multiple mice learner interaction. The teacher's computer screen was shown using a projector that was projected on a clean wall. This was large enough for all the learners to see. The teachers used mice to set up and control the multiple mice presentation. Due to large classes, learners shared available mice in small cohesive groups. To connect many mice to one computer, USB hubs and USB cables were used. All the co-educational schools chosen had at least one computer which was the minimum requirement to participate in the study. Most computers available in the schools did not have more than four USB ports. A USB hub was the device that was plugged into a USB port on a computer to provide more USB ports into which teachers plugged in mice to enable all learners participate in the activities. Figure 3.2 shows the USB hub.

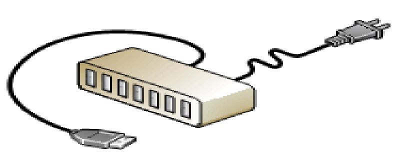


Figure 3.2: USB Hub

After the set up for computer multiple mice was complete, a general classroom layout was as shown in Figure 3.3.

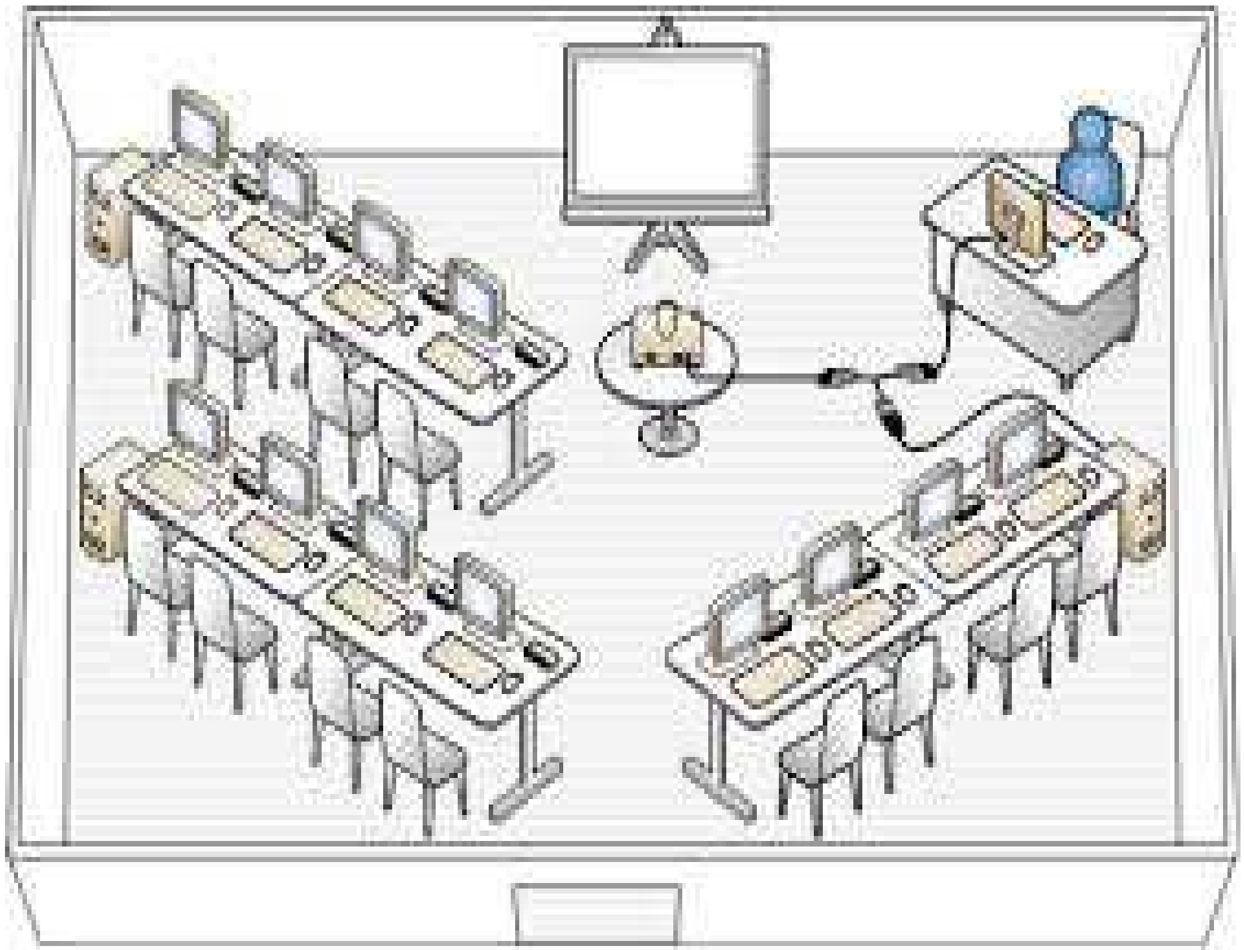


Figure 3.3: General Design of the Classroom Layout

Figure 3.3 shows the general classroom layout that incorporates a projector as the display device, three USB hubs, and both wired and wireless mice. However, the wireless mice could not be used because they were expensive for the schools to purchase. In addition, most schools had few mice or faulty mice. Due to this, the researcher provided a starter set of equipment consisting of the following: 15 wired mice, four seven-port and six four- port USB hubs, six USB cables, one power-strip extension cord and projector for each experimental school. A clean wall was used as the projector screens.

It was observed in some schools with large number of learners in the classrooms and lack of wireless mice, the layout above was modified. In most cases, the space was limited and there were a lot of connection of wires around, because of the wired mice and USB hubs. Due to this challenge, the "U distribution" was used as shown in Figure 3.4. In this distribution, tables and chairs were arranged in the classroom in the form of a U, with all the wires facing inside the U and the computer and projector placed in the middle of the U, letting the learners move around the classroom outside the U without risk of tripping with wires as recommended by Arturo (2012). Figure 3.4 shows the modified "U" distribution layout in one of the experimental schools.

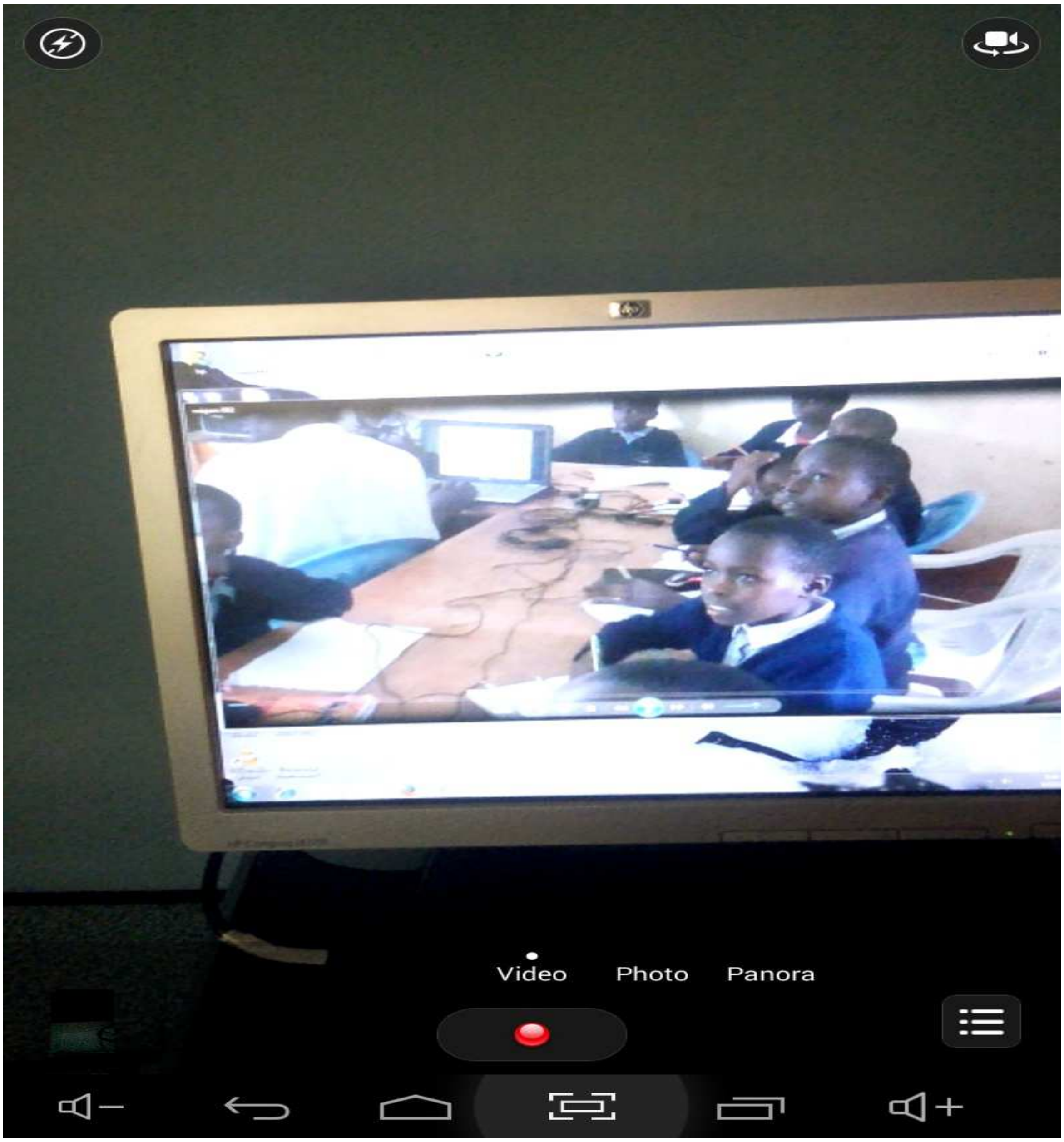


Figure 3.4: Classroom 'U' Distribution Layout in an Experimental School

However, in schools where the space available in a classroom was not enough for making a U distribution or in some cases tables not available; in those cases, learners sat in rows as shown in Figure 3.5.

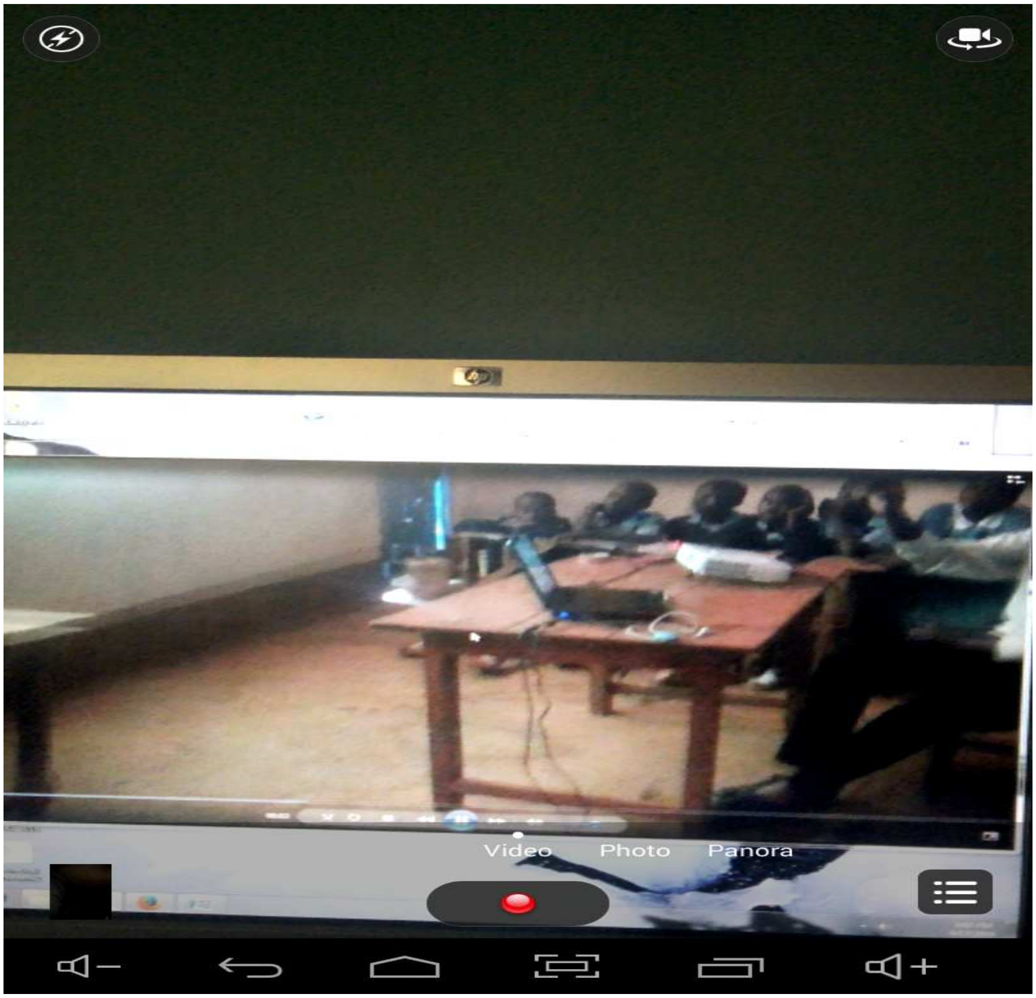


Figure 3.5: Learners Sitting in Rows in a Classroom Layout of an Experimental School

All the experimental schools used a large clean wall to serve as projection screen. At the beginning of each lesson that is start of a multiple mice presentation, the researcher observed that the system had recognized multiple mice presence and asked the teacher whether they wanted to use multiple mice to start the slide show. The next step, teachers were asked to identify their mouse as the teacher mouse. After teacher identifying which mouse pointer was the teacher mouse pointer, it changed to an orange arrow. They now had control of the presentation. Next step they specified whether learners were to participate in teams or as individuals. During this study team mode was used. Learners specified use of teams, they clicked a team picture to join a team that was composed of some of their classmates. If learners did not join a team, it was observed that their mouse pointers disappeared from the screen when teacher advanced the presentation to begin the lesson. As learners joined teams, their mouse pointers changed to resemble the team picture that they selected.

The number at the top of each team picture changed to indicate how many learners were on that team, and the players count in the upper right corner of the screen kept track of how many of the available learner mice had joined a team. Figure 3.6 shows slide for learners joining in the learning activities as teams.

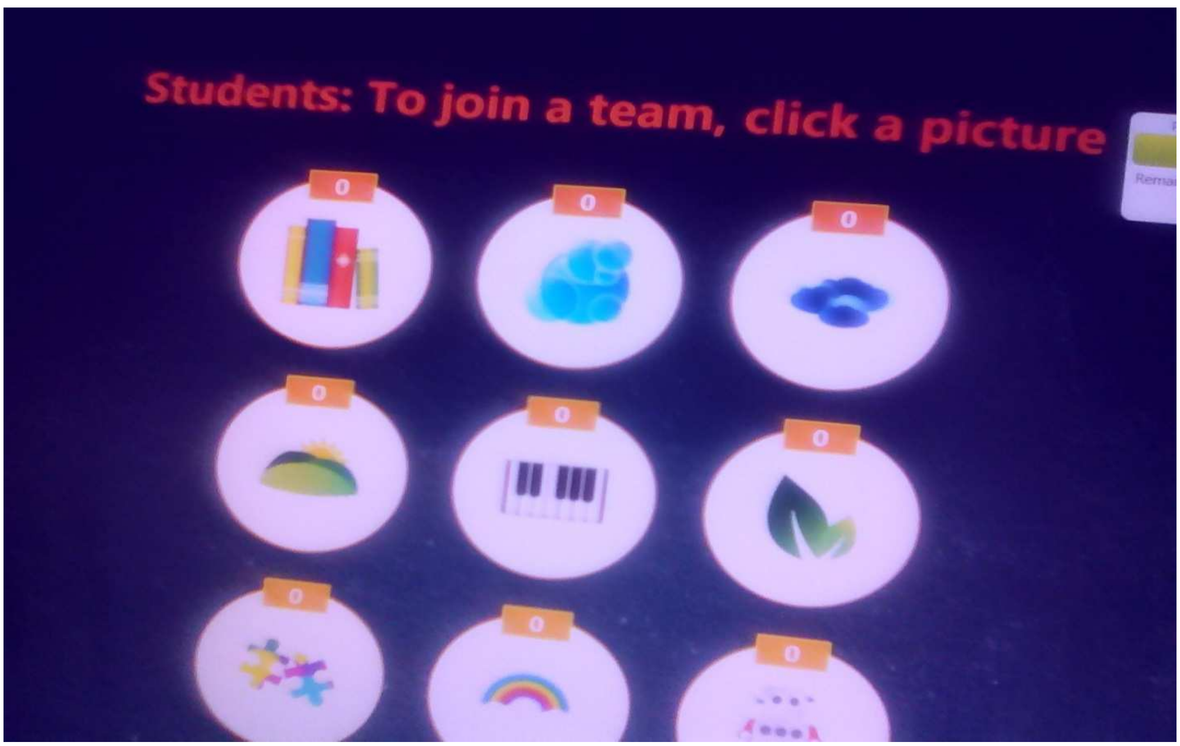


Figure 3.6: Slide for Learners to Join a Team, Pictures Used as Names of The Teams

Due to large classes, the starter equipment was not enough, hence the study adopted the team mode only. In all the six experimental groups, it was observed that number of members in a team ranged from 2-5 members. The purpose was to ensure maximum effectiveness in active team participation. The groups consisted of mixed gender, varying mathematical abilities. Figures 3.2 to 3.6 involved preparation process which together with classroom set up made teachers to spend approximately 10 minutes for preparation. Due to this challenge there was need for re adjustment on the school time table so that mathematics classes came as the last lesson to tea break or lunch break. This was to curb interference with the other subjects.

Mouse Cursors and Group Identity

Each team of participants were represented on the projector screen by a unique cursor that enabled them to participate in team activities. Once the team chose an icon that could represent them, they clicked the picture and their cursor changed to take that picture. This was used as unique identity of each team. The cursor was visible on the screen for all to see. When a teams cursor is visible and clicks on a particular picture, that picture is displayed. This was done to increase feelings of connectedness to the lesson and to reinforce the learners. They also helped mediate conversation between learner-learner, learner-teacher and teacher-learner, supported gestures, and communicate focus of attention between members in a team. The teacher's cursor was a special mouse that controlled all activities on the screen using the presentation controls. Figure 3.7 shows the presentation control panel.

Figure 3.7: Presentation Control panel
Source: www.microsoft.com/mousemischief/inbuiltinsystem

Each of the buttons on the presentation control panel had a specific purpose to accomplish. Figure 3.8 shows the functions of the buttons on the presentation panel.

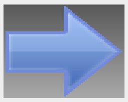
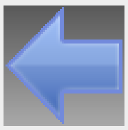
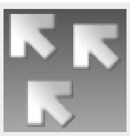
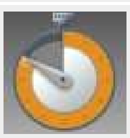
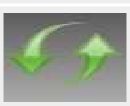
Control	Purpose of use
	**Continue timer.** The button was clicked to continue the countdown of the timer when the timer has been paused. When the timer countdown continued, this button changed appearance to the pause timer button.
	**Hide results.** Clicked when the teacher wanted to dismiss` the results pane. When the results pane was hidden, this button changed appearance to the show results button.
	**Next.** Clicked to advance the presentation to the next slide.
	**Previous.** Clicked to back up the presentation to the previous slide incase the teacher wanted to clarify a point, lead a class discussion, ask learners how they got the answer and encourage them to explain to others. This encouraged both learner and teacher to do reflective thinking on their learning and teaching processes
	**Pause.** Clicked to temporarily stop multiple mice activity on the presentation. While the presentation was paused, learner mouse pointers disappeared, and this button changed appearance to the play button. The purpose was to draw learner attention to a particular concept or a class discussion, correction of errors.
	**Pause timer.** Clicked to temporarily stop the timer. When the timer was paused, this button changed appearance to the continue timer button.
	**Play.** Clicked to continue a paused presentation and make learner mouse pointers reappear. When the presentation was running, this button changed appearance to the pause button.
	**Show results.** Clicked to end activity on the slide and display learners' results. The button was clicked when a Yes/No slide or Multiple Choice slide is visible. This button was unavailable on drawing slides.
	**Start timer.** Clicked to limit the time learners have to perform an activity. The timer counted down from 60 seconds. When the timer finished, learner mouse pointers disappeared from the screen and (if the slide is a Yes/No or a Multiple Choice slide) the results appear. When the timer has started, this button changed appearance to the pause timer button.
	**Reset slide to clear learner activity.** Clicked when they wanted to erase learner drawings from a drawing slide.

Figure 3.8: Functions of the Presentation Control Buttons
Source: www.microsoft.com/mousemischief/inbuiltinsystem

It was observed that until the teacher started the multiple mice presentation, all of the mice attached to the computer controlled the single mouse pointer that was visible on the computer screen. It was therefore important that the teacher started the presentation before they invited learners to join. Furthermore, the teacher was able to recognize patterns of student interaction. For example "the 'rainbow' or 'keyboard' was the first to answer correctly. This could improve teacher awareness of the class, follow up of learner activities. They were also able to monitor team activities. The activities included clicking the mouse on correct response of multiple choice questions, drawing on slides, matching activities in teams and as whole class discussions using polling slides.

All the teachers in the experimental groups reported that they spend quite considerable time to help familiarize learners on how to hold mice, click, use of right and left buttons as part of preliminary training of learners especially on a drawing slide. Teachers also practiced how to use the presentation control panel in Figure 3.8. This is because 5 out of the 6 experimental schools, learners had never used a computer in their lives. It was also observed that one teacher had never used technology while those who had been exposed to use of technology, computer interactive multiple mice technique was something new to them. They therefore, indicated that the two weeks of practice helped both teachers and learners to familiarize with the technique and harmonize the activities in the 6 experimental groups. These helped improve reliability of the results. It was also observed that one school had an ICT technician with an ordinary classroom converted into a laboratory with three computers, 2 schools had a computer laboratory fully furnished with projector, another 2 were attached to a secondary school and youth polytechnic respectively. The last school had a computer that was not working hence the teacher resorted to using his lab top.

Conventional Classrooms

Physical Setting and Classroom Environment

There was no modification made on the physical setting and classroom environment in conventional schools. In the conventional classes, learners sat in rows and columns as shown in Figure 3.9.

Figure 3.9 : Learners in a Conventional Classroom Sitting Arrangement in Rows

3.9 Data Collection Procedures

MAT 1 was administered and collected at the beginning of the study. MAT 1 was administered to both the experimental (E) and control groups (C). The purpose was to ascertain their entry behavior and to find out if they had comparable characteristics (homogeneity). Groups E was then exposed to ten (10) lessons of 35 minutes each in the topic fractions taught to randomly selected streams of Standard six using the computer interactive multiple mice technique while groups C were exposed to the same content and same number of lessons using conventional instructional methods.

Research assistants observed the mathematics lessons on fractions and filled the MLOC to assess learner classroom interactions during the two weeks when fractions were taught. Besides, during the two weeks of practice the researcher observed both the participating teachers and learners for atleast 5 lessons of 35 minutes each to give them enough time to adjust to her presence in their classroom and be assured of consistency in the findings.

During all observations, the researcher took photographs and recorded descriptive notes of teachers, learners, and classroom activities. In addition, the researcher kept a record of own perceptions, questions, and reactions throughout the study and which were referred to during analysis of the findings (Merriam, 1998). As a non participant observer in the classroom, the researcher watched and recorded notes without becoming involved in the teaching and learning process. By not actively participating in the dynamics of the lesson, it made teachers and learners feel more comfortable with researcher presence in their classroom.

As researcher became familiar with the settings, the observations were narrowed to specific aspects of teaching and learning. The focus was on how the teacher used presentation controls to control the learning, teacher-learner interactions, learner-learner interactions and learner-teacher interactions. The purpose was to seek a deeper understanding and insight on aspects that made the use of computer interactive multiple mice technique different from the conventional instructional methods. At the end of two weeks, all the concepts on fractions taught in Standard six were covered in both the experimental and control groups. The researcher then administered and collected FAT 2 and LMQ assisted by the research assistants. The filled FLOC was collected during this visit.

3.10. Data Analysis Techniques

Data from the study was analyzed both descriptively and inferentially. Quantitative data collected from the respondents were coded, entered and analyzed using Statistical Package for Social Sciences (SPPS) version 20. Raw data from Fractions Lesson Observation Checklist (MLOC) was both quantitative and qualitative while MAT 1, MAT 2 and LMQ generated quantitative data only. Objective one generated quantitative data from learners' scores. Objective two generated quantitative data too. The research question generated both quantitative and qualitative data. Quantitative data was analyzed using descriptive statistics percentages, means and standard deviation and inferential statistics was an independent sample t-test. More specifically: Quantitative data for objective one was analyzed using means, standard deviations and independent sample t-test. Quantitative data in objective two was analyzed using percentages and an independent sample t-test and summarized using tables. Quantitative data in the research question was analyzed using percentages and qualitative data was summarized and reported using verbatim reports and presented using tables and figures.

Multiple post hoc comparison tests using an independent samples t-test were performed to confirm possible differences and the direction of differences in achievement and motivation between learners taught using computer interactive multiple mice technique and those taught using conventional methods. An independent t-test was calculated to find out if there was any relationship in achievement and motivation between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods. Each of the objectives were analyzed and presented as shown in Table 3.4.

Table 3.4: Summary of Data Analysis and Statistical Techniques

Objectives	Indicators	Instruments	Statistical Tools	Type of Data generated
To determine any difference in achievement in fractions between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods.	Gains in mathematical scores - difference between the pre test scores and post test scores	Mathematics Achievement Tests (MAT 1, MAT 2)	Independent sample t-test, means and standard deviation	Interval
To find out any difference in motivation between learners' taught using computer interactive multiple mice and those using conventional instructional methods.	Attention factor-Learner attention gained and maintained, inquiry arousal, maintain learner interest Relevance factor-familiarity, goal orientation, motive matching, use strategies that take care of varied learning styles Confidence factor- learning requirements, success opportunities and personal control Satisfaction factor- intrinsic reinforcement, extrinsic rewards and equity	Learner Motivation Questionnaire (LMQ)	Percentages, Independent sample t-test	Ordinal
To establish any difference in classroom interaction between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods	Learner answering yes or no, multiple choice questions, drawing on screen, small group or whole class simultaneously accessing the information, each learner controlling their own mice, teacher cursor freely moving on the entire screen to intervene in learner work where necessary, display on each team actions, feedback for each team, class discussions	Mathematics Lesson Observation Checklist (MLOC)	Percentages and verbatim reports	Ordinal

3.11 Ethical Considerations

There are several ethical issues that arise when research is being carried out and they include access and acceptance, informed consent, privacy (anonymity and confidentiality), misrepresentation of data or deception and selection of subjects. Access and acceptance involves gaining official permission to undertake one's research in a target community. Access and acceptance in this study was attained by the researcher getting permission from the Masinde Muliro University of Science and Technology, securing a research permit from the National Council of Science and Technology and thereafter seeking permission from the Vihiga County government, Sub-County Education Office and headteachers of the 12 schools that participated in the study. After identifying the research area, meetings were held with the school head teachers and mathematics teachers to negotiate access into the school and informed consent to participate in the study. The head teacher of each respective school gave their verbal approval and helped set up the meeting with the standard six mathematics teachers.

Informed consent was ascertained by informing the participants of the nature and purpose of the study and assuring them that there were no risks involved in the study. Their participation was voluntary and they were informed of this at the beginning of the study when the researcher sought the consent of the head teachers of participating schools. Each head teacher and mathematics teacher were informed about the tests and experimental procedures to be used. This explanation satisfied the subject that participation was important, desirable and it was to the subject's advantage to cooperate.

On privacy (anonymity and confidentiality), the information provided by the participants were not to be traced back to them under any circumstance. In selecting the minors, in a school where there were more than one standard six streams randomization was used to ensure each stream had equal chance to participate in the study.

CHAPTER FOUR

DATA PRESENTATION, INTERPRETATION AND DISCUSSION OF FINDINGS

4.1 Introduction

This chapter deals with data analysis, presentation, interpretation and discussion of findings. The chapter is divided into four sections namely: demographic information and themes based on the two objectives and one research question of the study. Data is presented, interpreted and discussed for each objective.

The study was guided by the following objectives:

i) To determine any difference in achievement in fractions between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods.

ii) To find out any difference in motivation between learners' taught using computer interactive multiple mice and those using conventional methods.

iii) To establish any difference in classroom interaction between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods

Objective one was guided by Hypothesis H01, while objective two was guided by hypothesis H02 as follows:

H01 There is no difference in achievement between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods.

H02 There is no difference in motivation between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods.

In addition, objective three was guided by the following research question:

i) What is the difference in classroom interaction between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods.

4.2 Demographic Information

This section gives an overview of the response rate per school in each zone and per group category. Also shows the gender of the respondents in the schools (Appendix XIV) shows field data for gender. The above characteristics have a bearing on use of computer interactive multiple mice versus conventional methods by respondents and hence could influence learners' performance in fractions.

4.2.1 Response Rate

The average response rate of the study stood at 89.1 % which is representative enough to give findings that can be generalized. Respondents from different zones and groups exhibited different response rates as shown in Table 4.1.

Table 4.1: Response Rate in Percentages

Zone	Experimental Group			Control Group		
	No. Issued	No. Returned	Response Rate	No. Issue	No. Returned	Response Rate
1	30	24	80	45	43	96
2	54	50	93	46	44	91
3	52	48	92	34	32	88
4	62	55	89	32	30	89
5	34	34	100	38	35	92
6	34	32	94	57	49	86
Total	266	243	91	252	233	90

From the results in Table 4.1, experimental group had the highest response rate (91 %) while the control group had the lowest (90 %) but the difference was insignificant. This can be attributed to the use of computer interactive multiple mice technique that was used in the experimental group was new and exciting to learners.

4.2.2 Gender of Respondents

The gender of the respondents was tabulated and the results were as shown in Table 4.2.

Table 4.2: Gender of Respondents

Respondents by Zone	Experimental Group			Control Group		
	Boys	Girls	Total	Boys	Girls	Total
1	15(62 %)	9(38 %)	24(100 %)	14(33 %)	29(67 %)	43(100 %)
2	26(52 %)	.24(48 %)	50(100 %)	23(52 %)	21(48 %)	44(100 %)
3	20(59 %)	14(41 %)	34 (100 %)	15(47 %)	. 17(53 `%)	32(100 %)
4	34(62 %)	21(38 %)	55(100 %)	18(51 %)	17(49 %)	35(100 %)
5	15(47 %)	17(53 %)	32(100 %)	14(47 %)	16(53 %)	30(100 %)
6	28(58 %)	20(42 %)	48(100 %)	29(59 %)	20(41 %)	49(100 %)
Total	138(57%)	105(43%)	243(100%)	113(49%).	120(52%)	233(100%)

The findings in Table 4.2 show that most respondents in the experimental group were boys 138 (57 %) while only 105 (43 %) were girls. However, in the control group most of the respondents were girls120 (52 %) while only 113 (45 %) were boys. This is an indication that in most public primary schools in Hamisi Sub-county is generally of balanced gender. This could be attributed to Free Primary Education (FPE) policy by the Kenyan government.

4.3 Computer Interactive Multiple Mice Technique and Learner Achievement

The first objective was to determine any difference in achievement between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods. The null hypothesis stated that there is no difference in achievement between learners taught using computer interactive multiple mice and those taught using conventional instructional methods.

The instruments used for this objective were Mathematics Achievement Test 1(MAT 1) and Mathematics Achievement Test 2 (MAT 2). Mathematics Achievement Test 1(MAT 1) assessed learners' achievement in the topic fractions which was taught in Standard five. The purpose of MAT 1 was to ascertain the entry behaviour of both the experimental and control groups. MAT 2 was used to measure any gain in learners' scores in fractions. In order to find out whether the two groups had comparable characteristics, the results of the two groups were analyzed. Comparing the pre-test results reveal that the difference in the pre-test mean of the two groups was extremely small for learners taught using computer interactive multiple mice (M= 46.09, SD =15.38) as compared to those taught using the conventional instructional methods (M =45.86, SD =13.03). The mean difference between the two groups was .23 which was quite small interpreted to mean the two groups were similar in entry characteristics. Furthermore, there was a slight difference in their standard deviation meaning the spread of scores of learners in both experimental and control groups was similar. In order to find out any significant difference on the pre test using computer interactive multiple mice technique as compared to conventional instructional methods on learners' achievement in fractions, an analysis of the learners' pre-test scores was carried out. The results the of Independent Sample t-test based on these means are shown in Table 4.3.

Table 4.3: Results of Independent Sample t-test of the Pre-test Scores of MAT 1

	t –test for Equality of Means		
	t-value	df	Sig (2-tailed)
Experimental versus control group	.178	474	.859

From the findings in Table 4.3, comparing the pre-test results reveal that the pre-test mean of the two groups did not differ significantly for learners taught using computer interactive multiple mice as compared to those taught using the conventional instructional methods (t_{474} =.178, p=.86). This is attested to by the probability value of .859 which is higher than the .05 level of significance. Therefore there is no significant difference between the levels of performance between the control and experimental groups of participants in the pre-test. It means the groups were not varied in achievement at the start of the study. This means the experimental group is comparable to the control group in terms of entry characteristics. This made the groups suitable for the study. Hence the random distribution of the participants in the control and experimental groups was of equal chance.

In order to find out the effects of computer interactive multiple mice technique on learners achievement in the topic "Fractions" an analysis of the learners' pre-test and post-test scores was carried out. Table 4.4 shows the MAT 1 and MAT 2 pre-test and post-test mean scores obtained by the learners.

Table 4.4: Comparison of MAT 1 and MAT 2 Pre- test and Post- test Mean Scores

Type of Groups	N	Pre-test Mean Score	Post-test Mean Score	Mean Gain
Experimental	243	46.09	72.56	26.47
Control	233	45.85	54.05	8.2
Total	476			

The results show that learners in the experimental group considerably improved in mean on their pretest results, whereas there was very little improvement in the control group. The performance of post-test mean for the experimental group was outstanding with a mean of 72.56 with a mean gain of 26.47 while control had a mean gain of 8.2. Further, the mean gain of the experimental group was significantly higher by 26.27 than that of the control group. This suggests that the experimental group gained more than the control group while the post test mean of the control group was below average of 46.05. This was interpreted to mean the computer interactive multiple mice technique was more superior compared to conventional instructional methods.

In order to determine whether the mean scores were significant, further analysis of the results of Independent sample t-test based on these means were shown in Table 4.5.

Table 4.5: Results of Independent Sample t-test of the Post-test Scores of MAT 2

	t –test for Equality of Means		
	T	df	Sig (2-tailed)
Experimental versus control group	21.925	474	.000

From the results in Table 4.5, comparing the post-test results reveal that the post-test mean of the two groups differ significantly. Learners taught using computer interactive multiple mice as compared to those taught using the conventional instructional methods (t_{474} =21.925, p=.000). The probability value of .000 which is lower than the .05 level of significance further proves that there was a significant difference in the posttest performance of the learners of the experimental and control groups. Therefore, the hypothesis that there was no difference in achievement between learners' taught using computer interactive multiple mice and those taught using conventional methods is rejected. Therefore, it can be concluded that there was better performance among learners who used multiple mice technique in learning fractions than those who used the conventional instructional methods. This is interpreted to mean computer interactive multiple mice technique is a more superior technique as compared to conventional instructional technique.

Further analysis was done to find out the level of significance per zone and across the six zones. The data for each zone is in appendix XIII. An independent sample t-test was performed and the results obtained are reported in Table 4.6.

Table 4.6 Post Hoc Comparison Tests of MAT 2 Post Test Mean Scores Per Zone

Type of Group	Post-test Means						
	E mean	C mean	N(E)	N(C)	df	Cal t-val	Cri t-value
E_1vsC_1	74	55	48	32	78	5.782*	1.9908
E_2vsC_2	80	48	32	55	85	13.074*	1.9883
E_3vsC_3	68	50	61	35	94	6.638*	1.9855
E_4vsC_4	64	46	54	45	97	7.1643*	1.9847
E_5vsC_5	79	41	24	45	67	14.056*	1.9955
E_6vsC_6	82	39	34	34	66	14.217*	1.9966
E_3vsE_4	68	64	61	54	113	1.5334	1.9840
E_5vsE_6	79	82	24	34	56	1.4064	2.0032
C_2vsC_3	48	50	55	35	88	.6880	1.9873
C_3vsC_4	50	46	35	45	78	1.3513	1.9908
C_5vsC_6	41	39	45	34	77	.8451	1.9913

E=Experimental, C= Control, N=total number of learners in the group, DF=Degrees of Freedom,* denotes significance at .05 level of significance

Table 4.6 shows the results of post hoc comparisons for MAT 2 post test mean scores. The results reveal that the mean scores obtained by the learners within the treatment groups (E_3vsE_4, E_5vsE_6) for (t_{113} = 1.5334, t_{56} = 1.4064) and control groups (C_2vsC_3, C_3vsC_4 and C_5 vsC_6) for (t_{88} =.6880, t_{78} = 1.3513 and t_{77} =.8451, p<.05) respectively were not statistically different. However, there were significant differences between the mean scores of the experimental groups and control groups: E_1vsC_1 for (t_{78} =5.782, p<.05, E_2vsC_2 for t_{85} = 13.074, p<.05, E_3vsC_3 for t_{94} =6.638, p<.05, E_4vsC_4 for t_{97} = 7.1643, p<.05, E_5vsC_5 for t_{68} = 14.056, p<.05 and E_6vsC_6 for t_{66} =14.217, p<.05) such that the mean scores obtained by the treatment groups were significantly higher than those in the control groups.

These suggest that the learners exposed to computer interactive multiple mice technique significantly gained more than those who were not exposed to it. Interpreted to mean computer interactive multiple mice technique is more superior than the conventional instructional methods in enhancing learner achievement in fractions. Independent sample t-test was preferred over others since the groups were independent of each other and they could best establish whether there was a statistically significant difference in achievement between learners taught using computer interactive multiple mice technique and those taught using the conventional methods as required by objective one of this study and the source of the difference. In view of this results, the null hypothesis that there was no difference in achievement between learners' taught using computer interactive multiple mice and those taught using conventional methods is rejected.

Boyraz (2008) found out that computers created a dynamic learning environment that supported learners' development and meaningful learning. This is in agreement with the findings of the current study. Hamilton (2007), Alejandro *et al.*, (2009) and Alcoholado *et al.*, (2012) also concur with the findings of current research. They established statistically relevant results when multiple mice was used and observed that the technology proved most beneficial for the below average students. The findings are also in line with those of Ochanda and Indoshi (2011) who established that scientific calculators had great potential in developing learners' conceptual understanding of mathematics. Wenglinsky (1998) assessed the effects of simulation and higher order thinking in mathematics achievement on the National Assessment of Educational Progress (NAEP). Wenglinsky found out that the eighth grade learners who used simulation and higher order thinking software showed gains in math scores of up to 15 weeks above grade level as compared to fourth grade learners.

Kenneth (2004) wanted to find out if second grade learners could learn to transform visual, aural, and kinesthetic rhythm experiences into mathematical symbols in order to equate and add fractions with unlike denominators. Results showed that the experimental group's gain scores ranked significantly higher than the gain scores for the control group. Mofeed (2005) determined the effect of computer-aided instruction on student achievement in mathematics using the 'I CAN Learn' computer aided instructional system. The results from the statistical analysis showed differences between Missouri Assessment Program (MAP) scores. The findings established that those learners who received instruction using the I CAN Learn computer program scored higher than those who did not. Dissanayake *et al*., (2007) on "use of computer technology for the teaching of primary school mathematics, the findings revealed that learners showed significant gains in their performance after using the computer package. Numerous academic studies have shown the significant positive correlation between technology, student learning, and mathematics achievement. Computer interactive multiple mice technique has also significant correlation between the technology and learner achievement in fractions. This is because the technology enabled learners to be actively and simultaneously involved in learning activities, provided immediate feedback to assigned tasks. This multiplied its effect on learning achievement.

Mendicino and Heffernan (2007) focused on paper-pencil and wed based homework conditions. The Web-based homework condition provided immediate feedback in the form of hints on demand and step-by-step scaffolding. Analyzed results indicated that learners in the web-based conditions learned significantly more when given computer feedback than when doing traditional paper-and-pencil homework. Furthermore, Stewart (2010) in his findings indicated that computer interactive multiple mice technique helped students who were unsuccessful at mathematics, who could not focus and had trouble understanding. When they did multiplication lessons results indicated they moved from lower achieving to higher achieving students.

Rosen and Beck-hill (2012) established consistent and highly positive findings of the efficacy of a constructivist one-to-one computing program in terms of learner mathematics achievement. Rochmad (2015) used the application of Think Pair and Share (TPS) based on the use of the of Multiple mice and found out it improved the ability to solve mathematical problems for high school learners and improve Senior High School (SHS) students in learning activities. Remalyn (2013) found significant difference in use of scaffolding strategy in teaching mathematics. It was concluded that there was a greater retention of the topics learned among the participants in experimental group which meant the scaffolding techniques were much superior compared to the traditional methods of learning mathematics. Alcoholado et al (2012) established statistically relevant results and observed that the technology proved most beneficial for the below average learners. There was also greater improvement on percentage of correct answers (20.96 %) for learners who had the lowest initial results.

Siswa (2012), Jennie (2012) and Rosen and Beck-hill (2012) also found a significant increase in learners' mathematics test scores from pre-test post-test in the experimental groups. The results are also consistent with Lee and Chwen (2016) in their study who aimed at evaluating effects of different response systems (SRSs) interaction mode. These included: SRS individual, SRS collaborative and classroom were examined on the posttest scores for higher order thinking (HOT) and lower order thinking questions. The results showed that SRS collaborative mode had significant positive effects on science posttest scores of HOT questions. The study points to the potential of using SRS in collaborative tasks to solve problems that require HOT skills. All the findings above indicate that learners learn better using computer interactive multiple mice technique as compared to those taught using conventional techniques of learning mathematics. Therefore, computer interactive multiple mice technique proves to be more superior than conventional methods in improving achievement in fractions in public schools of Hamisi Sub County.

The results above contrast with the results of several researches. In contrast, What Works Clearinghouse examined Kerstyn‘s (2001) research conducted on the use of the ‘I CAN Learn’ computer system in teaching and reported their findings. The WWC reported that students who received I CAN Learn classroom instruction did not score significantly higher than their counterparts in traditional math classrooms (What Works Clearinghouse, 2004). Again, inconsistent with the results, Ziegler (2002) conducted a study to determine the impact of potential changes in students’ behaviors when instructional technology (Interactive White Board (IWB); Liquid Crystal Display (LCD) projector, document camera and classroom response system) was present. The results indicated there was not statistically significant improvement found regarding student achievement in 4th, 5th, and 6th grades. Furthermore, Beeland (2002) did not find any correlation between engagement and achievement. There was no data collected to determine if there was any impact on achievement in this study. Organization for Economic Cooperation and Development (OECD, 2015), tracked educational outcome among students based on their use of technology in the classroom. The results also contradicted the current results. They found that technology in classrooms doesn't always boost education results and overexposure to computers and the Internet causes educational outcomes to drop. The results of the OECD study show negative correlations between mathematics performance and computer use in mathematics lessons and lead to the conclusion that there is little evidence for a positive effect on student achievement in mathematics.

Two subsequent large-scale experimental studies by Dynarski *et al.,* (2007) and Campuzano et al (2009), however, concluded that the effects of the use of digital tools in grade 9 algebra courses were not significantly different. The overall image is that the use of technology in mathematics education can have a significant positive effect, but with a small effect size. Given that any innovative educational intervention usually has a positive effect, these studies do not provide overwhelming evidence for the effectiveness of the use of digital tools in mathematics education (Higgins, Xiao, & Katsipataki, 2012). The results reported above are mixed, and interpretations reported by authors seem ambiguous.

Baker *et al.*, (1994) assessed the impact of interactive technology called the Apple Classroom of Tomorrow (ACOT). On standardized tests in mathematical concepts ACOT students performed no better than comparison group who did not have access to computers or to the teaching and learning reforms of ACOT schools. Besides, Wenglinsky's (1998) national study on technology impact on mathematics achievement to determine effect of simulation on higher order thinking technologies. The results showed that 4^{th} and 8^{th} grade who used drill and practice performed worse in National Assessment of Education Progress (NAEP) than students who did not use drill and practice technology. Given the contrast with research findings of several scholars above, there is need to conduct further research on the same to find out if similar results will be found.

4.4. Computer Interactive Multiple Mice Technique and Learner Motivation

The second objective was to find out any difference in motivation between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods. Learners were asked to indicate their level of motivation using the likert scale and the results are summarized in Table 4.7.

Table 4.7: Post test Results for the Motivation of Learners in Percentages

Statement	Experimental Group Post-test Results (%)					Control Group Post-test Results (%)				
	SD	D	U	A	SA	SD	D	U	A	SA
Active involvement	0.8	2.5	3.7	26.3	66.7	30.0	30.0	16.7	15.9	7.3
Participation in the lesson increased	0.8	2.1	7.0	77.9	56.8	13.3	21.5	22.7	32.2	10.3
Involved more in activities	1.2	4.9	5.8	35.4	52.7	38.6	42.9	16.7	1.3	0.4
Instant answers to the questions	2.9	6.2	7.8	31.3	51.9	21.5	33.5	14.6	20.2	10.3
My attention in the lesson improved	1.6	1.6	5.8	30.9	60.1	30.5	45.1	19.3	3.4	1.7
I became more attentive	0.8	2.1	4.1	27.6	65.4	29.2	45.5	18.9	3.0	3.4
Interest in learning improved	1.8	1.2	1.9	35.7	59.4	36.9	38.3	20.5	1.8	2.5
The lesson was lively	0.8	2.1	4.5	27.9	64.6	38.2	39.1	20.2	1.3	1.3
Involved more in activities than listening to teacher	4.1	4.1	8.6	31.7	51.4	33.9	27.9	14.2	13.3	10.3
Different activities increased interest	2.5	0.4	6.2	35.0	55.6	8.6	7.7	15.0	42.9	25.8
I understood fractions	1.2	3.3	4.5	28.4	62.6	15.0	33.9	19.7	18.5	12.9
Used examples that i have come across	4.9	2.5	4.1	27.6	60.9	17.6	7.7	10.7	42.9	21.0
Activities used is useful to me	0.4	1.6	6.6	32.1	59.3	6.0	10.7	13.3	33.0	36.9
Knowledge learned enabled me to solve word problems in fractions	1.6	3.3	9.5	28.8	56.8	7.7	12.9	14.2	40.8	24.5
Getting correct answers increased my confidence in doing sums	1.6	1.2	4.9	29.2	63.0	5.6	7.7	12.9	46.8	27.0
Solving sums became easy	1.2	4.1	11.9	27.6	55.1	27.5	40.8	12.9	1.7	2.1
I became more confident	0.4	4.5	9.5	27.6	58.0	36.5	35.2	21.5	3.0	1.3
I was satisfied when i learned fractions	1.6	4.9	14.0	30.9	48.6	26.6	39.1	24.9	6.0	3.4
I was praised by teacher	2.9	2.9	2.5	35.0	56.8	11.2	9.9	10.7	37.8	30.5
Teacher praise made me want to learn fractions	2.5	1.6	6.2	28.8	60.9	9.0	8.6	12.9	34.3	35.2

The findings in Table 4.7 reveal that motivation of most learners in the experimental group was enhanced after being exposed to the treatment as compared to those in the control groups. On particular items, it revealed that in experimental group, most (68 %) learners strongly agreed that they were actively involved in learning process after treatment as compared to those learners (7%) in the control group. Asked whether their participation in the mathematics lesson increased, most (57 %) subject in experimental group strongly agreed as compared learners (10 %) to the control group. On whether learners were involved more in activities with other learners, majority (95 %) of the experimental group strongly agreed while 4 % of the control strongly agreed. They also strongly agreed (53 %) that they received instant and quick answers to the questions as compared to their counter parts (0.4 %) in the control group.

Furthermore, most (60 %) learners in the experimental group strongly agreed that their attention in the lesson improved as compared to (2%) in the control group. Majority of subjects in the experimental group (65 %) strongly agreed that they become more attentive as compared to (3 %) in the control group who strongly agreed. Learners were also asked whether the lesson was lively. Most learners (65 %) in the experimental group strongly agreed that the lesson was lively while only (1 %) in the control group strongly agreed after the experiment. Asked if they were involved more in doing the activities than listening to teacher. Majority (51 %) of the experimental group strongly agreed while a palstry (10%) of the control group strongly agreed. Majority (56 %) of the respondents in the experimental group strongly agreed that the teacher used different activities which increased their interest in learning fractions while only (26 %) in the control control group strongly agreed on the same item.

On whether learners understood fractions, most (67 %) learners in the experiental group strongly agreed while only (13 %) strongly agreed in the control group. There was need to find out from learners if the teacher used examples that they had come across. Those who strongly agreed in the experimental group were (61 %) while (21 %) in the control group. Besides, majority (59 %) in the experimental group strongly agreed that activities used in learning fractions were useful to them while only (37 %) strongly agreed in the control group. Most (59 %) subjects in the experimental group strongly agreed that knowledge learned enabled them to solve word problems in fractions and only (25 %) in the control group strongly agreed. The results also revealed that a majority (63 %) of the experimental group strongly agreed that getting correct answers increased their confidence in doing sums in fractions while only (27 %) in the control group also strongly agreed. Most (55 %) subjects in the experimental group alluded that solving sums in fractions became easy for them as compared to a palstry (2 %) in the control group. It also became necessary to find out if they became more confident in working out sums in fractions. Most (58 %) in the experimental group strongly agreed as compared to a palstry (1 %) in the control group.

Asked if they were satisfied with teaching method when they learned fractions, most (49 %) in the experimental group strongly agreed while only (3 %) strongly agreed in the control group. On whether learners were praised by teacher for the correct answers they gave. Findings revealed that most (57 %) in the experimental group strongly agreed while (31 %) strongly agreed in the control group. Finally, most (61 %) respondents in the experimental group strongly agreed that praises from teacher made them want to learn fractions while (35 %) strongly agreed in the control group. It can be inferred from the findings in Table 4.7 that computer interactive multiple mice technique enhanced motivation of most learners in the experimental group as compared to the conventional technique of teaching and learning of the topic fractions.

Further analysis was done using independent sample t-test to establish if there were any statistical differences in motivation between the two groups during the pre test. Table 4.8 show the pre test findings of independent sample t-test.

Table 4.8: Independent Sample t-test Pre-test Results on Learners Motivation

Type of Group	Pre-test Means						
	E mean	C mean	N(E)	N(C)	df	Cal t-val	Cri t-value
E_1vsC_1	39	41	48	32	78	1.7870	1.990
E_2vsC_2	45	44	35	55	88	1.1424	1.984
E_3vsC_3	45	46	61	35	94	1.1968	1.984
E_4vsC_4	46	45	54	45	97	1.4409	1.984
E_5vsC_5	46	47	24	45	67	1.7563	1.990
E_6vsC_6	45	46	34	34	66	1.1595	1.990

E=Experimental, C= Control, N=total number of learners in the group, DF=Degrees of Freedom,* denotes significance at .05 level of significance

Table 4.8 shows the results of the pre test post hoc comparisons for independent sample t-test. The results reveal that there were no significant differences between the mean scores of the experimental groups and control groups: E_1vsC_1 for (t_{78} =1.7870, p<.05, E_2vsC_2 for t_{88} = 1.1424, p<.05, E_3vsC_3 for t_{94} =1.1968, p<.05, E_4vsC_4 for t_{97} = 1.4409, p<.05, E_5vsC_5 for t_{67} = 1.7563, p<.05 and E_6vsC_6 for t_{66} =1.1595, p<.05). These shows that there was no difference in motivation between experimental and control groups at pre test. Both groups had similar or comparable characteristics hence they are equivalent groups. The results can be interpreted to mean that there was no significant difference in motivation between subjects in the control and experimental groups at the beginning of this study.

The researcher then wanted to find out any significant difference in motivation between the experimental and control groups after the exposure to the treatment. A comparison in motivation was therefore made between learners taught using the computer interactive multiple mice and those taught using conventional techniques. Table 4.9 shows the post test results.

Table 4.9: Independent Sample t-test Post-test Results on Learners Motivation

Type of Group	Post-test Means						
	E mean	C mean	N(E)	N(C)	df	Cal t-val	Cri t-value
E_1vsC_1	79	57	48	32	78	9.5244*	1.9900
E_2vsC_2	80	57	35	55	88	11.9125*	1.9840
E_3vsC_3	82	50	61	35	94	13.1808*	1.9840
E_4vsC_4	78	50	54	45	97	12.4263*	1.9840
E_5vsC_5	87	50	24	45	67	21.8160*	2.0000
E_6vsC_6	92	50	34	34	66	22.8594*	2.0000

E=Experimental, C= Control, N=total number of learners in the group, df=Degrees of Freedom,* denotes significance at .05 level of significance

Table 4.9 shows the results of post hoc comparisons for independent sample t-test. The results reveal that there were significant differences in motivation between the mean scores of the experimental groups and control groups: E_1vsC_1 for (t_{78} =9.5244, p<.05, E_2vsC_2 for t_{88} = 11.9125, p<.05, E_3vsC_3 for t_{94} =13.1808, p<.05, E_4vsC_4 for t_{97} = 12.4263, p<.05, E_5vsC_5 for t_{67} = 21.8160, p<.05 and E_6vsC_6 for t_{66} =22.8594, p<.05) such that the mean scores obtained by the treatment groups were significantly higher than those in the control groups. These suggests that the learners who were exposed to computer interactive multiple technique significantly improved in motivation more than those who were not exposed to it. These means computer interactive multiple mice technique is more superior than the conventional technique in enhancing learner motivation in learning fractions. Independent sample t-test was preferred over others since the groups were independent of each other and they could best establish whether there was a statistically significant difference in motivation between learners taught using computer interactive multiple mice technique and those taught using the conventional instructional methods as required by objective two of this study and the source of the difference. In view of these results, the null hypothesis that there was no difference in motivation between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods is rejected. The results mean that computer interactive multiple mice technique is a more superior technique of teaching fractions as compared to the conventional technique.

The findings above are in agreement with studies by several scholars who underscore the effect of technology to the learner motivation. Keller (1993) asserts that there are many factors that contribute to learners' motivation in the classroom during teaching and learning, which indicates interest, attention, relevance, confidence and satisfaction. Heinich et al (2002) report that various emotional factors have been found to influence the direction of attention, duration of paying attention, effort invested in learning and how feeling may interfere with learning. They point out that many learners do not perform well in school subjects due to lack of interest. The argument provided is that learners who are motivated will work harder to learn more because of their personal interest in the materials. That learning arises out of direct interest in the materials to be learnt.

Microsoft (2008) on a study on use of “The Multiple mice,” teacher and learner interviews revealed that learners paid more attention and they were eager to participate in the learning activities. The study by Baytak *et al.*, (2011) also agrees with the findings.’ They established that most learners believe that their learning mathematics is fun, interesting and enjoyable. Wilson and Corpus (2005) emphasize that motivation is essential in determining academic success. Microsoft (2008) also indicated the following: learners felt their answers had greater impact since they were projected on a screen; feedback on group scores with highest scores were satisfied in their scores; they argued that the technique was able to offer a more engaging classroom experience than the conventional methods. Besides, in a study by Bruce and Tirotta (2009), they sought to determine the extent to which use of Interactive White Board technology (IWB) was correlated with level of motivation in mathematics. Learners in the treatment group reported elevated levels of motivation relative to control group. Learners with teachers who were more supportive of IWB technology reported higher motivation levels. Allessi and Trollip (1991) suggest a number of ways that could enhance motivation. This include: use of game technique; use of audio, visual and audio visual technique. These increase learner intensity of work, attention and encourage deeper cognitive processing.

These results also concur with Moraveji *et al.*, (2010) who argue that Single Display Groupware (SDG) model in particular, multiple mice have been shown to lead to higher engagement, better task performance, and a positive impact on collaboration and motivation. The use of technology in mathematics teaching can capture children’s attention, motivate them and help them construct mathematics concepts in meaningful ways (Smith, Gentry, and Blake, 2011). Murat (2010) his study, the results on the Satisfaction scale, revealed that satisfaction differs in learners' grade level statistically significantly. The highest loaded item for this category was item 15: "I'd be proud of being the outstanding student in the use of technology," (M=2.36; SD=1.182). The mean values with respect to grade level were as follows: 9th grade (M=2.21; SD=1.127), 10th grade (M=2.48; SD=1.341), and 11th grade (M=2.62; SD=1.173). Thus, learners at lower grades tended to have more satisfaction in using technology compared to the higher graders.

Stewart (2010) results established that the attention of students enhanced learning. Lower achieving students were more involved because there was no embarrassment in giving the wrong answer and use of computer interactive multiple mice helped more content to be reviewed and faster than the conventional methods. Immediate feedback was received to gauge understanding of content taught. Marks et al (2013) in their study, "Does use of touch screen computer technology improve classroom engagement in children?" It was observed that engagement was higher in lessons based on apple's ipad than those not. On particular significance was increase in engagement seen in boys, which resulted in their engagement levels increasing compared to those seen in girls.

In the study of Jeng-Chung (2013), measurements of learning motivation comprised the subscales of attention, relevance, confidence, and satisfaction. The results established that learners' responses regarding the ARCS motivation scale, for which the mean of the relevance subscale was the highest (6.37) and that of the attention subscale was the lowest (5.77). The means of the confidence and satisfaction subscales were 5.90 and 6.05, respectively. In addition, all of the motivational subscales attained standard deviations ranging from .67 to .78. The mean of overall learning motivation was 6.02. They concluded that although game characteristics, such as fun, fantasy, curiosity, and role-playing can attract learners' attention, they are not necessarily directly relevant to learning. Regarding the lack of corresponding game characteristics for the relevance subscale, this game involved adopting the following two design strategies namely: familiarity with product model examples, and realistic simulation. Furthermore, the relevance of learning environments can be increased by integrating learners' previous experiences. This is consistent with the current study.

According to Kimberle *et al.*, (2010) in their study, teacher interview results indicated the following; Teachers unanimously reported that learners were motivated to use the tablets to try activities normally completed with paper and pencil. The teachers felt that tablet use changed the way the teaching and learning occurred in their classrooms making learning relevant and real. All teachers felt that it increased learner engagement, focus, questioning, and work completion as a result of tablet use directly led to increased active learner participation in the learning process, which they felt, if continued, would result in improved outcomes. Several teachers identified ways they saw the tablets providing options for teaching a lesson, providing a variety of entry points for different kinds of learners, for example, those who: like technology, like communicating, didn't like writing but liked drawing, were shy, were slower, or who typically didn't complete assignments.

In contrast, Beeland (2002) conducted a study to determine if IWBs increased the level of student engagement. The research results showed no correlation was found between student engagement and the amount of time the students were allowed to interact with the board. A thorough review of the literature, however, indicated that computer based instruction use alone does not necessarily lead to an improvement in intrinsic motivation (House, 2003; Wang & Yang, 2002). It is, therefore, important to examine the effects of student-centered instruction in conjunction with technology-based instruction on intrinsic motivation. Instructional design is crucial to linking these methods in an effective manner. Other studies that contradict the current results indicate the fact that computers do not always lead to positive results in terms of student motivation, not all computer related activities lead to the same outcomes. Deaney, Ruthven, and Hennessy (2003) reported that students did not indicate equal motivation or enjoyment from all computer-based lessons.

4.5 Computer Interactive Multiple Mice Technique and Learners Interaction

The third objective sought to establish any difference in classroom interaction between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods. The following are the results.

4.5.1. Results on Percentages showing Classroom Interactions

Independent Standard six mathematics teachers who did not teach the learners but observed the lessons were asked to give their independent evaluation of the lessons. First, the respondents were asked to indicate whether lessons were taught using small groups, individual and whole class discussions. The experimental group used small groups (42 %), individual (50 %) and whole class discussions (8 %) while the control group, only a paltry (8 %) used small groups and (92 %) for whole class discussions implying enhanced interactions were observed in the experimental as compared to the control groups.

It can be concluded from the results that the control group used teacher centred approach which offered limited interactions amongst the learners. It was therefore necessary to find out from respondents their opinion based on their observations on teacher- learner interactions between the control and experimental groups. Table 4.10 reported the results.

Table 4.10: Percentages for Post test Results On Teacher - Learner Interactions

Statement	Experimental Group (%)					Control Group (%)				
	SD	D	U	A	SA	SD	D	U	A	SA
Accepts feeling tone of learners in non threatening manner	0.0	8.3	0.0	75.0	18.7	16.7	25.0	8.3	33.3	16.7
Did not give facts about procedure	16.7	58.3	0.0	16.7	8.3	33.3	25.1	8.3	25.0	8.3
Clarifies ideas by learners	0.0.	41.7	0.0	25.0	33.3	16.7	41.7	0.0	16.7	25.0
Builds ideas by learners	25.0	0.0	0.0	41.7	33.3	33.3	41.7	0.0	16.7	8.3
Didnt solicit learners statement	25.0	66.7	0.0	8.3	0.0	0.0	25.0	0.0	58.3	16.7
Didn't correct errors in lesson	33.3	41.7	0.0	25.0	0.0	8.3	66.7	0.0	16.7	8.3
Praised learner behavior	0.0	8.3	0.0	50.0	41.7	0.0	8.3	8.3	66.7	16.7
Probed follow-up questions based on learners	0.0	16.7	0.0	33.3	50.0	16.7	33.3	0.0	25.0	25.0

LEGEND: SA-Strongly Agree, A-Agree, U-Undecided, D-Disagree, SD- Strongly Disagree

For analysis of generated data from the Mathematics Lesson Observation Checklist (MLOC) "Strongly Disagree" and "Disagree" were merged to mean "Disagree" while "Agree" and "Strongly Agree" were merged to mean "Agree". This merging is supported by Donald and Pamela (2006) who argue that to ensure consistent results, the highest and lowest score are selected. The middle is excluded from subsequent analysis.

The findings in Table 4.10 reveal the following: teachers were asked whether they accepted feeling tone of learners in non threatening manner. Most (94 %) teachers in the experimental group agreed while (50 %) of the control group agreed. It was necessary to find out if teachers did not give facts about procedure. 75 % of the experimental group disagreed while paltry 33 % of the control did disagree. The researcher then wanted to find out if the teachers clarified ideas suggested by learners. Majority (58 %) of experimental group strongly agreed while only 42 % of control strongly agreed. Furthermore, teachers were asked if they build ideas suggested by learners. Most (75 %) experimental group agreed with only (25 %) of control group did agree with the statement. Asked if they did not solicit learner statement, majority (92 %) of teachers in the experimental group disagreed compared to only (25 %) of the control group.

Besides, the researcher wanted to find out if the teachers did not correct learners errors during the lesson. Respondents in both the experimental and control groups each tallied with (75 %) disagreement. They were then asked if they praised learner behavior. Most (92 %) of the experimental agreed while (83 %) of the control also agreed with the statement. On whether teachers asked probing follow-up questions based on learners' understanding a majority (83 %) of the experimental did agreed while only (50 %) for control group did agree with the statement. It became necessary to find out respondents opinion based on their observations on learner- learner interactions between the control and experimental groups. Table 4.11 reported the results.

Table 4.11: Percentages for Post test Results On Learner-Learner Interactions

Statement	Experimental Group (%)					Control Group (%)				
	SD	D	U	A	SA	SD	D	U	A	SA
Worked in small groups	15.4	18.5	0.0	41.7	24.4	41.7	33.3	0.0	16.7	8.3
Consult each other in teams	23.3	6.7	0.0	13.3	56.7	46.2	28.8	0.0	16.7	8.3
Thinking time not given to discuss questions	33.3	50.0	0.0	16.7	0.0	50.1	16.6	0.0	33.3	0.0
Incorrect answers stimulated debate	16.7	33.3	0.0	16.7	33.3	30.8	19.2	0.0	16.7	33.3
Asked questions to each other	8.3	16.7	0.0	41.7	33.3	41.7	41.7	0.0	8.3	8.3
Self evaluated their work	12.9	27.2	0.0	25.0	34.9	41.7	41.7	0.0	16.6	0.0
Discussed other ways to solve problems	8.3	10.7	0.0	66.7	14.3	41.7	41.7	0.0	8.3	8.3

LEGEND: SA-Strongly Agree, A-Agree, U-Undecided. D-Disagree, SD-Strongly Disagree

The findings in Table 4.11 on learner-learner interaction reveals the following: the respondents were asked the following questions: first they were asked if they worked in small groups, most (66 %) in the experimental group agreed that they worked in small groups while only 25 % did in the control group. They were also asked if learners were allowed to consult each other while working in teams most (70 %) of the experimental did agree with only 25 % in the control.

There was also need to find out if thinking time was not given to learners to discuss before answering questions. As indicated a majority 83 % of the subjects in the experimental group disagreed as only 33 % of the control did disagree. Asked whether incorrect answers given stimulated debate among learners. Subjects in both groups (50 %) agreed. The researcher again sought to find out if learners were encouraged to ask questions to each other. 75 % of the experimental agreed while only 17 % in the control group agreed. Teachers were then asked if they encouraged learners to self evaluate their work. Majority (60 %) of the experimental strongly agreed while 17 % of the control also agreed with the statement. Lastly, teachers were asked if they allowed learners to discuss other ways to solve problem. 81 % of the subjects in the experimental group agreed while a paltry 17 % of the control did agree with the statement.

Morever, it was necessary to also find out respondents opinion based on their observations on learner-teacher interactions between the control and experimental groups. Table 4.12 reported the results.

Table 4.12: Percentages for Post test Results on Learner-Teacher Interactions

Statement	Experimental Group (%)					Control Group (%)				
	SD	**D**	**U**	**A**	**SA**	**SD**	**D**	**U**	**A**	**SA**
Gauged understanding using questioning techniques	0.0	0.0	0.0	66.7	33.3	16.7	0.0	8.3	58.3	16.7
Asked adequate time for task	16.7	50.0	0.0	16.7	16	66.7	25.0	0.0	8.3	0.0
Learners initiated the discussion	25.0	16.7	0.0	50.0	8.3	50.0	33.3	0.0	16.7	0.0
Questions did not stimulate broad learners responses	8.3	58.4	8.3	25.0	0.0	0.0	41.7	8.3	41.7	8.3
Followed teachers instructions	0.0	25.0	8.3	25.0	41.7	0.0	25.0	8.3	41.7	25.0
Individual needs were met	8.3	25.0	0.0	16.7	50.0	25.0	66.7	0.0	8.3	0.0

LEGEND: SA-Strongly Agree, A-Agree, U-Undecided. D-Disagree, SD-Strongly Disagree

The findings in Table 4.12 on learner-teacher interaction, the following is revealed: Teachers were asked if they gauged learner understanding of mathematical concepts using questioning techniques. All subjects (100 %) of the experimental group agreed while 75 % of the control did agree. They were then asked to state if learners asked for adequate time for task. 33 % of the experimental group agreed while a paltry 8 % of the control did agree with the statement. In addition, were asked if learners initiated the discussion by responding to teachers statement. Majority (58 %) of the experimental did agree while only 17 % from the control group agreed.

There was also need to find out if questions asked did not stimulate broad learner responses. Majority (66 %) of the subjects in the experimental group disagreed with the statement as compared to (50 %) in the control group. They were then asked if the learners followed teachers instructions. 67% of the experimental strongly agreed while the same (67 %) in the control group did agree. Lastly, it was necessary to find out if learners individual learning needs were met. Majority (67 %) in the experimental group agreed with the statement as compared with only 8 % of the control group.

It can therefore be inferred from the results in Table 4.10 to 4.12 that there was enhanced learner-learner interactions, learner-teacher interactions and teacher-learner interactions among learners in the experimental group as compared to those in the control group. These means computer interactive multiple mice is a better method of teaching as compared to the conventional methods as highlighted by teachers in Hamisi Sub County public primary schools.

4.5.2. Verbatim Reports Results on Classroom Interactions

A comparison of the two methods of teaching was done by the researcher. The following observations were noted: In classrooms that used the conventional method the number of exercises were fixed wheareas for those using the computer interactive technology, the number was variable and depended on the learner performance. This is because the computer interactive multiple mice technique kept on generating new questions to enable the team to follow up on mathematical concepts taught in that particular lesson.

The main difference between the two groups was in the immediacy of the feedback. Learners in groups using the computer interactive multiple mice received immediate feedback. However, the group using the conventional methods of teaching had to complete the exercises given before finding out which ones were answered correctly, and did not necessarily have to redo the wrong answers since the teacher did not always supervise them directly. These were especially noted in large classes. Only a few learners got a chance for individualized instruction. However, in the computer interactive multiple mice technique, they worked in small groups, teacher was able to supervise and each group worked simultaneously on task given. These ensured learners in treatment group were not idle but actively constructed new knowledge.

Furthermore, learners in the experimental group focused on their team activities while teachers kept an eye on ranking, teams encountering problems, display of correct answer and overall control of the presentation panel. The results were as summarized in Table 4.13.

Table 4.13: Summary Of Verbatim Reports Observations

Question	Experimental group	Conventional group
State type of feedback	Immediate, had opportunity to revise work and reflected on their answers	Upon completion of the exercise given
How was information displayed	Public-working out answer to questions was to the view of entire class	Private-answer to questions only seen by individual unless working out on chalkboard
How were learners involved	Individual, cooperative, whole class discussions, small groups	Whole class discussions
Can you gauge learners participation	Active participation	Passive paticipation
Did technique increase learner activities	Increased learners activities	Increased teacher activities
Were all learners involved at same time	Worked simultaneously on the screen	One learner at a time worked on chalkboard or answered questions
State level of engagement	More engaged	less engaged
Which type of interactions	Unlimited and competitive interactions	Limited interactions and less competitive

Based on the results in Table 4.13 it became necessary to further find out additional indepth observations noted on various aspects in both the experimental and control groups based on the research question on classroom interaction. Analysis was done and the results were summarized as follows:

Use of chalkboard

On the research question to find any difference in classroom interaction between the two groups the following was noted on use of chalkboards: There was extensive use of chalkboards in the conventional classrooms. Teacher-class interaction was evident, a less frequent but important use for chalkboards for working out questions by both teacher and learner was also evident in conventional classrooms. In most conventional classrooms a teacher asked individual learners to “come up to the chalkboard” to work out their answer to a question and encouraged them to explain to others. This was used as means of working out questions by both teacher and learner. From the worked out questions, learners were reinforced for the responses either positive or negative reinforcement by the teacher. Figure 4.1 shows a learner working out questions on the chalkboard in a conventional classroom on multiplication of fractions.

Figure 4.1. Working out Questions on Chalkboard

There was no use of chalkboard in the experimental groups instead their display was the projector screen and used their team mice to work out questions after team members had consulted and agreed on a particular answer. Figure 4.2 shows the display of information projected on the screen in one of the experimental schools.

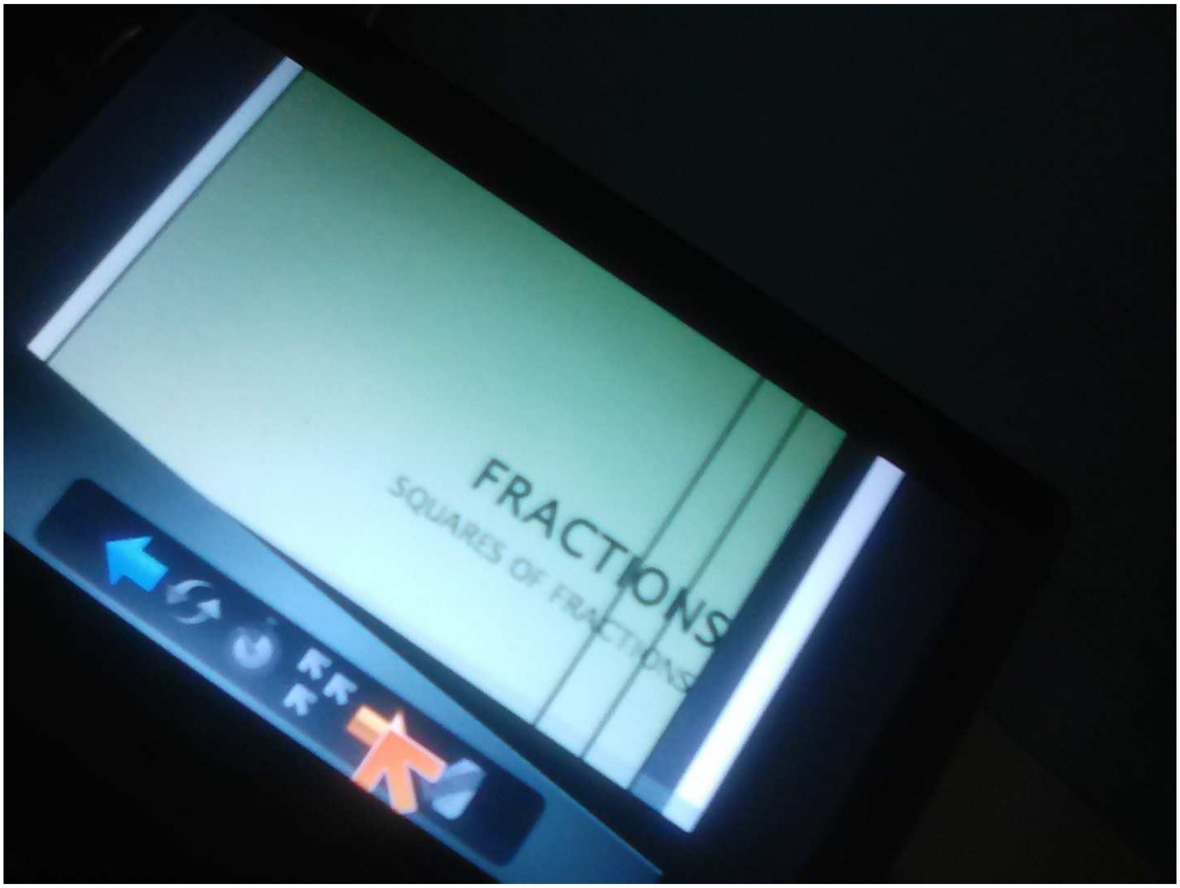


Figure 4.2: Public Display of the Information in an Experimental School

Experimental schools displayed information on a classroom wall to act as a projector screen. Figure 4.3 displays one of the power point slides part on squares of fractions in an experimental school during the learning. This is one of the slides that the teacher prepared and used to teach in one of the experimental schools. This picture was taken as the teacher progressed with his lesson. The teacher was explaining this concept to learners before group tasks were given.

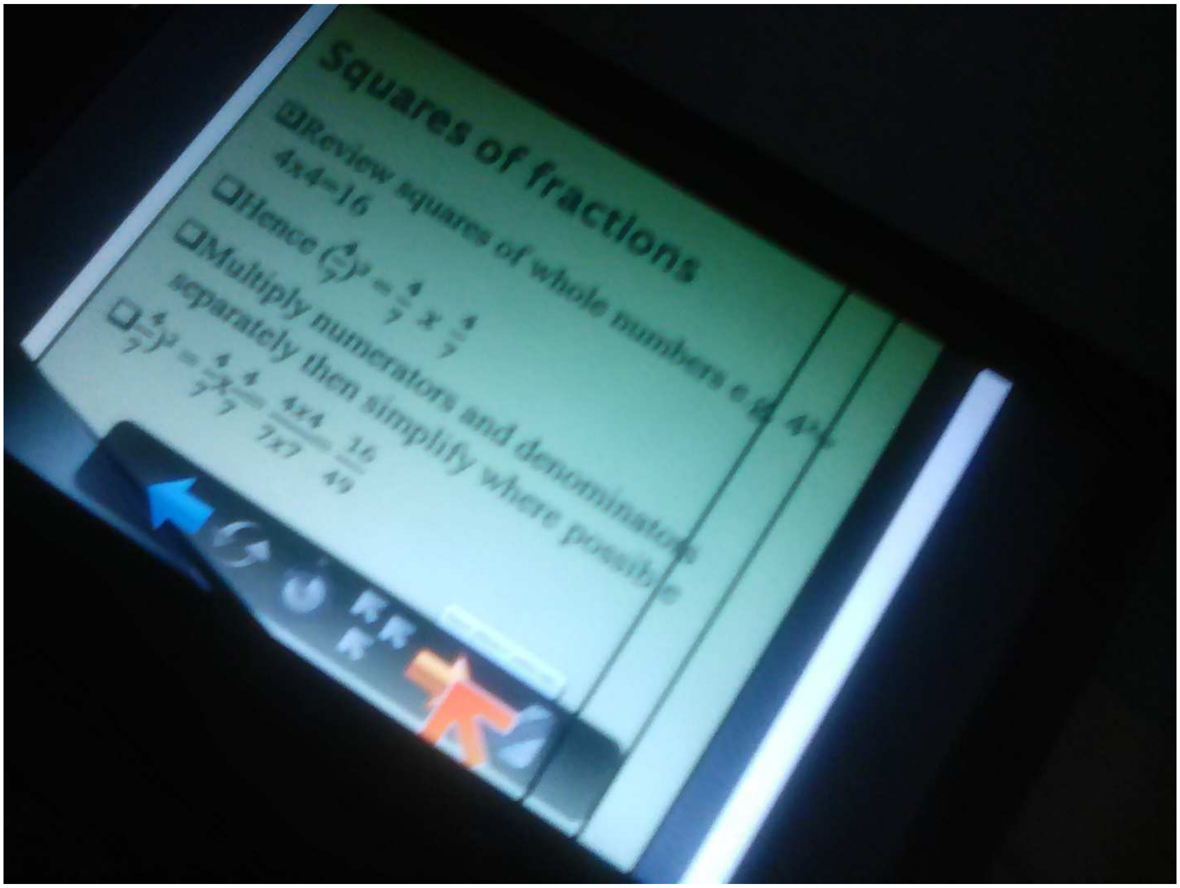


Figure 4.3 Displays Content Prepared by a Teacher on Multiplication of Fractions

Personal and Team Identity

In the conventional classroom the teacher addressed the learners by name, to maintain class control issues and gave them both oral and written questions to gauge mathematical concept acquisition. In computer interactive multiple mice techinique, learners were identified either by use of letters as team A, B, C, D or picture of the team used as their identity. For example, the following were the teams observed: the keyboard, hat, flower, water melon, gun, book and rainbow. The names were derived from the icons for team cursors. These enabled teachers to quickly gauge group activities. Identity also helped control for classroom management issues and created a healthy competitive learning environment.

Individual and Team Attention

Teachers in the conventional classrooms, kept individual attention by pointing or making eye contact, the teacher transfered the class' attention to individual learners. Figure 4.4 shows a teacher giving attention to particular learner who answered oral questions on multiplication of fractions. The teacher gave the learner attention because she was explaining to others how to multiply a whole number and a fraction 2x $\frac{3}{4}$ as multiplying 2x3 to get the numerator over the denominator 4 to get $\frac{6}{4}$ and converted into a mixed number as $1\frac{1}{2}$.

Figure 4.4 Teacher Giving Attention to Learner in a Conventional Classroom

In the experimental group, the teacher used the presentation controls to control the whole process of learning because the teacher mouse accessed features that the learner mouse could not. For example: advance to the next slide, moving backward to the previous slide, stop multiple-mouse activity on the current slide, resume activity, display or hide the results, start, pause and resume the timer and erase information on the drawing slide (refer to Figure 3.8). In addition, gauged which team was the first to get the correct answer, how many failed, how many got it right. The wrong and correct answers helped stimulate class discusion.

Morever, in experimental group individual and team attention served three purpose namely: correct error patterns of individual learner or teams, give them an opportunity for public response to a question and allow team to explain their answers to other teams. The teachers could click on an answer in the multiple-choice activity or yes and answer activity to see which teams chose that answer. It was also observed that the teacher could click *on top* a team's cursor to see that team's answer for the current activity displayed next to their cursor while keeping an eye on that team and asking them their answer or how they worked it out. The teacher could also choose one learner from a certain team to correct the work of another team's by deactivating the active team cursor and activating the new team, whose answer will be displayed on the screen.

Positive Reinforcement

In conventional classrooms, individual and varied reinforcement was used for all the learners to hear. For example, a teacher awarded learners by saying well done, good trial, clap for him when those learners answered a question correctly. Most often, in the experimental groups it was noted that higher level questions were asked and reinforced as well either teachers simply rewarded verbally 'well done', clap for team A members, that was good work members of the hat team. For example, the keyboard team can you explain to the class how you got your answer to question 'square of $5\frac{7}{8}$'?.... Let us clap for the keyboard team. Yes Tom, what did your team find out as the correct answer to the following question: A rectangular sheet of metal is $1\frac{3}{4}$ M long and $1\frac{5}{7}$ M wide. The area of the sheet of metal is 3 M^2. Learners were expected to either click yes or no as displayed on the screen in Figure 4.5. Figure 4.5 shows one of the questions generated from the system on word problems in multiplication which read as

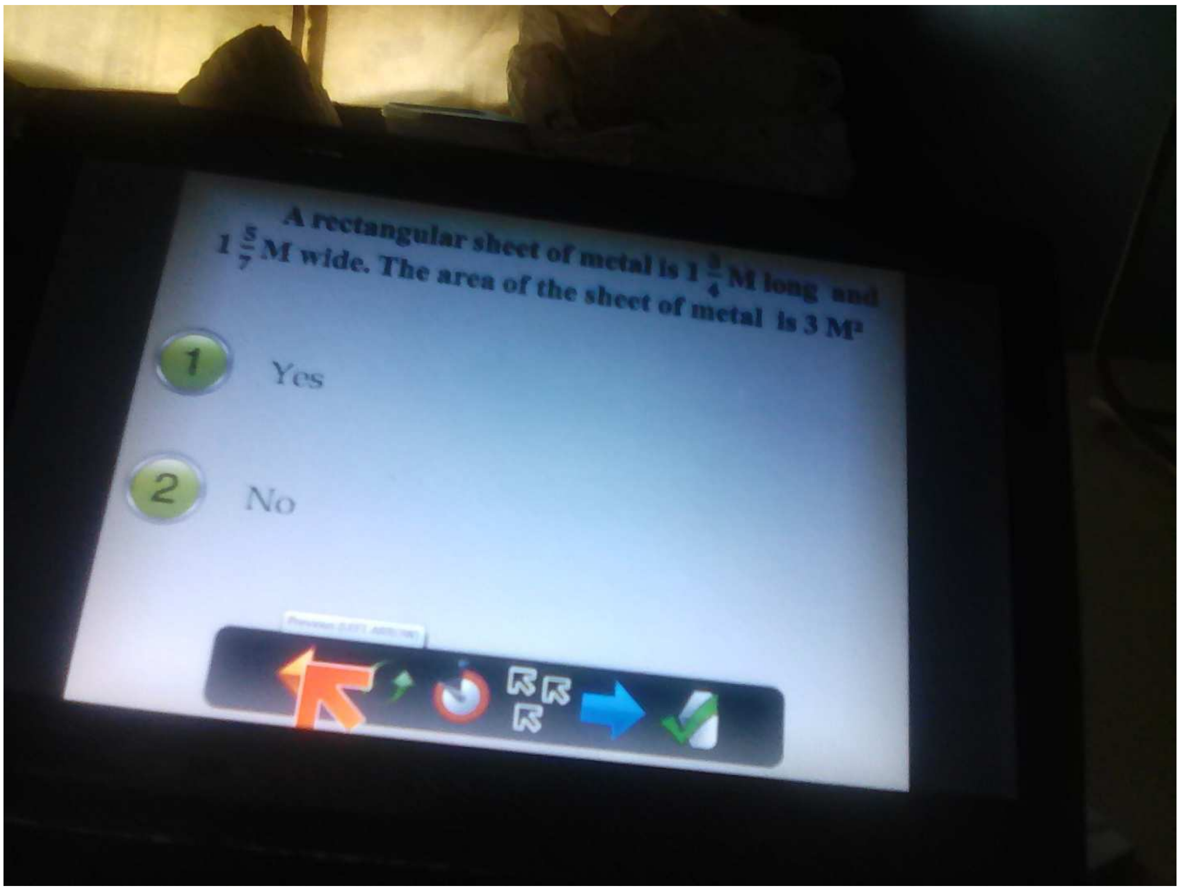


Figure 4.5: Word Problem on Multiplication of Fractions

Tom: Says ..yes its 3 M^2. Is this answer correct? Any member from the book team? Yes Ann...well done Ann. Do you think there is another method we can use to arrive at the answer...yes the rainbow team...

Raising Hands

Raising of hands was exhibited especially in the teacher-learner interaction where a teacher asked a learner or team a particular question or explaining to others how they worked out a question. The practice of raising hands to answer questions was common in both groups but mostly the control schools. However, it was noted that learners in the control group rarely raised their hands to ask questions and majority dependent on their teacher to give them the correct answer. In the experimental groups learners raised hands as part of learner- teacher interactions for the following reasons: their mice could not move; their mice had disappeared; had already finished working our the answer to question and were waiting for feedback; wanted to show how they worked out their answer to other teams. Figure 4.6 shows a learner raising up their hands as a way of responding to oral questions from their teacher in the conventional group.

Figure 4.6: Learners Raising up Hands to Answer Questions In Conventional Classrooms

Responses by Individuals or Teams

In the experimental groups, the teacher deactivated the mice in order to allow for discussion on use of polling slides. This enhanced interaction between the teacher and the class, learner-learner and learner-teacher interactions through oral questions, hands-on experiences on both drawing slides and normal slides and questions from the system helped to maintain confidence, satisfaction, interest and attention among teams. This was often done with quick, questions like “That’s what we saw earlier, right?”, “Are you understanding?”, and “Raise your hand if you dont understand or your team is stuck.” A team was asked “What is the reciprocal of $\frac{1}{2}$? Multiple Choices given were $\frac{3}{4}$, $\frac{1}{2}$ or $\frac{2}{1}$. Figure 4.7 shows a learner in an experimental group moving mice to answer question on reciprocal of $\frac{1}{2}$ by picking one of the choices above. The child picked $\frac{2}{1}$ and was asked to explain to the class how she arrived at the answer.

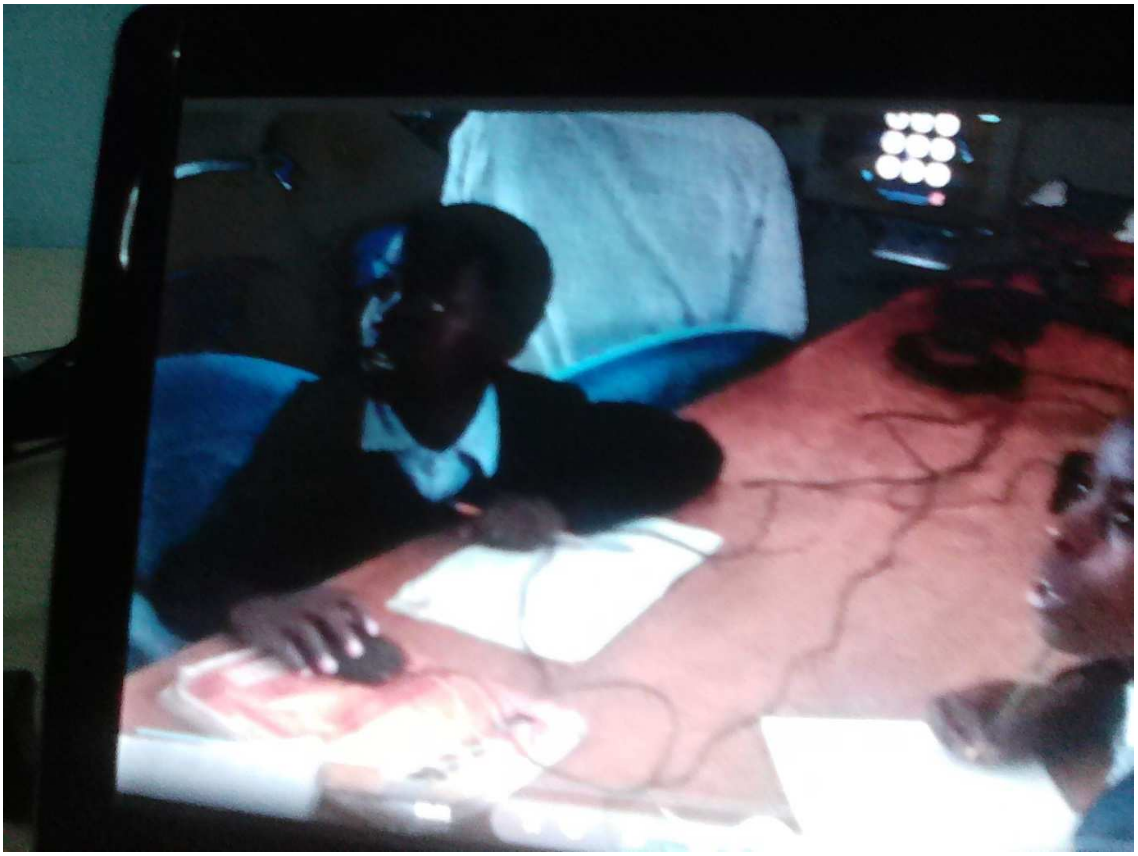


Figure 4.7: Learner Answering Question on Reciproclas of Fractions in an Experimental School

Moreover, in experimental classrooms, multiple teams were able to give answers simultaneously during an activity and the teacher was able to inspect those answers in an efficient manner by going through answer panel. Figure 4.8 shows mice of three teams on a working screen answering the question on reciprocals of fractions.

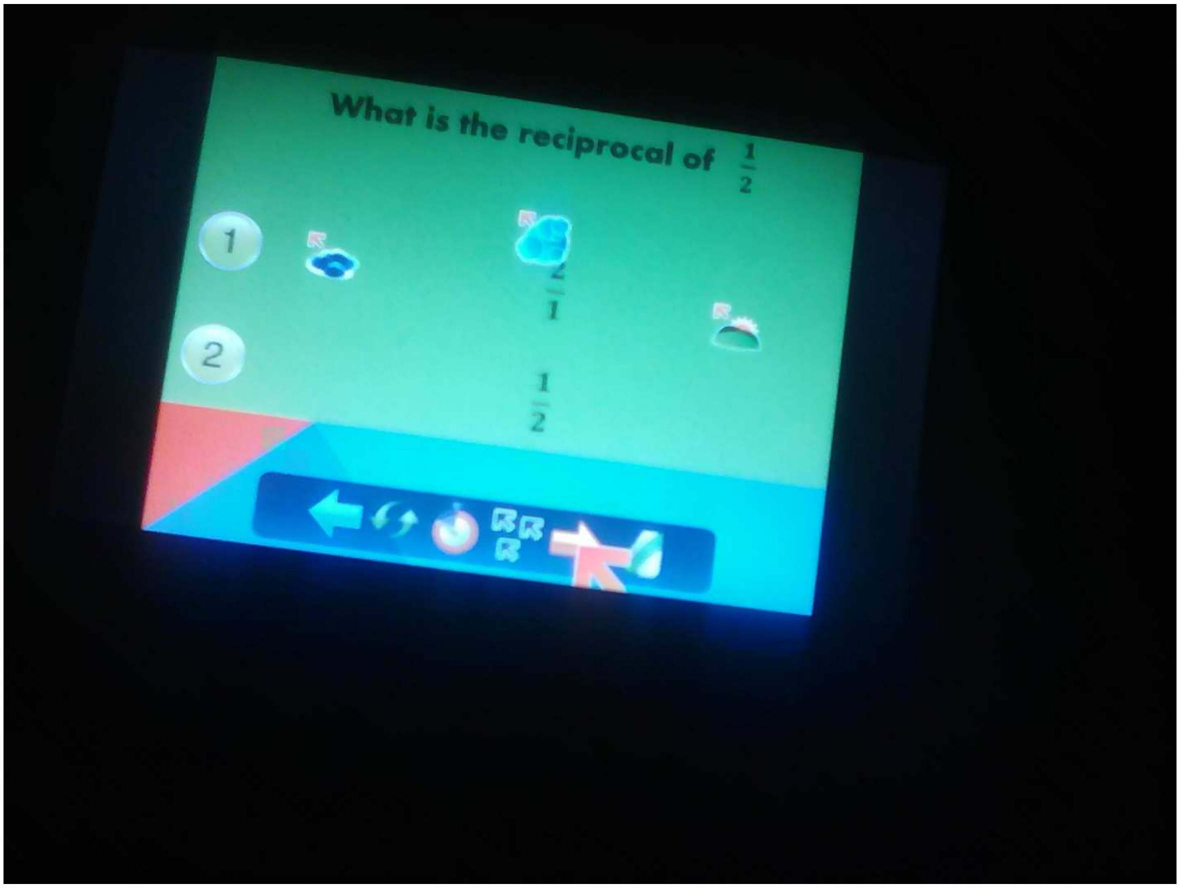


Figure 4.8: Displaying Mice of the Hat team, Flower Team and the Water Melon Team

After learners had discussed and written their answers on the screen. The computer interactive multiple mice system continuously generated new questions, teams answered the questions and also displayed the answers to the teams. One of the displayed information showed whcich was the first team to answer correctly, which team was the first to answer and how many learners choose a particular multiple choice. These enabled the teacher to give feedback to the class. Figure 4.9 shows display of the results in the answer panel.

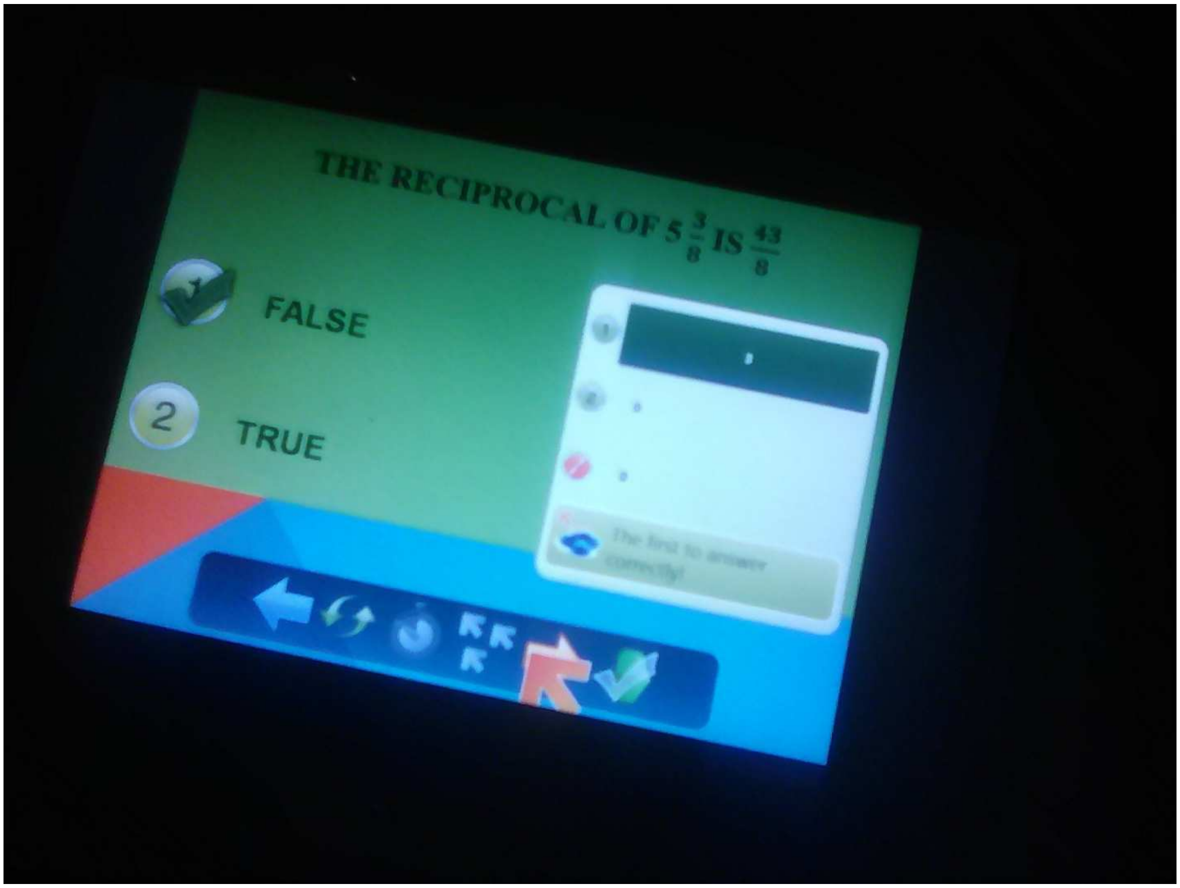


Figure 4.9: Display of answers to Teams on the Answer Panel

However, in the control groups most learners were shy to say they had not understood. Most teachers assumed that keeping quite meant a learner had understood.

Gauging Class, Team and Individual Growth in Mathematical Concepts

In the conventional groups the teacher continually and quickly gauged whole class and individual status on mathematical concept acquisition through oral questions, marking learners books, supervising learner activities and often asking a child to work out a question on chalkboard. Figure 4.10 shows teacher marking learners exercise books and correcting errors.

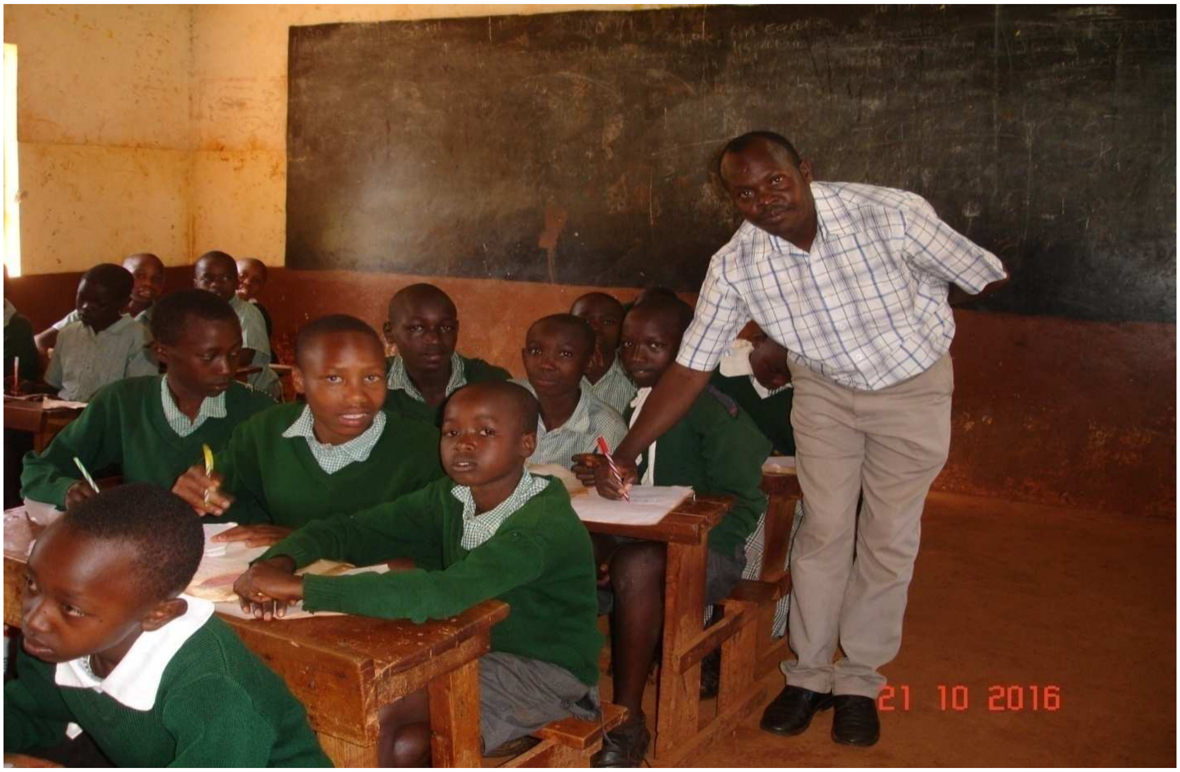


Figure 4.10: Teacher in a Conventional Classroom Marking Learners Books on Sequences of Fractions

However, in the experimental groups status of the teams were gauged by working out questions in teams by first discussing, then posting group answer on screen (refer to Figure 4.9), used polling slides to gauge both recall questions and higher order thinking skills. Polling slides were made possible when teacher switched off all learner mice to gain their attention and drew them to a particular slide for further class discussion. For example, on questions that required further class discussions questions like the examples below were used:

Example 1: a) Write the next number in the sequence $\frac{1}{2}$, $\frac{1}{4}$,$\frac{1}{8}$ $\frac{1}{16}$, $\frac{1}{32}$,...........

b) What is $\sqrt{\{\frac{196}{576}\}}$?

"Why do you think your answer is correct members of team A?"

Show us how you worked out

"Can you find another way to solve the problem, yes team C?"

"Are there other opinions from the individual teams or whole class?".... What do you think?

These questions helped enhance learner understanding of the various concepts on fractions.

Example 2

Teacher: "Get into teams and work out the answer the following question: *how can we find the square root of fractions using the example* $\frac{49}{100}$*?*

It was observed that learners in the control team did individual work and teacher supervised and marked. In the experimental group, in teams learners discussed the answer to the question and agreed on the answer then posted the answer on the screen. Answers to the question from different teams were posted simultaneuosly and immediate feedback was evident.

Example 3

Teacher: "So, given a sequence of fractions for example, *What is the next fraction in the sequence* $2\frac{1}{4}$, $1\frac{3}{4}$, $1\frac{1}{4}$.......... , can you please explain what I should do to get the next number, anybody from the rainbow team?".

Example 4

Teacher: Teacher Sarah bought $\frac{1}{2}$ Kg of beef. She divided it into 2 equal portions. What fraction of a kilogram was each portion**?** What shall we do to arrive at the correct answer?. Explain to the class how it should be worked out, yes Kedogo's team?

Example 5

Explain to the members in your group how you think you are going to go about working out the question. Then ask if they conceptualize what you are talking about and let them ask you questions. Remember in the end you all need to be able to explain how you worked out the question. Finally post the group thinking and working on the screen. In the conventional classrooms, most explanations were teacher centred and learner passively involved. The teacher felt learners required a particular way of reasoning that could better be done by the teacher to avoid errors done by learners. Figure 4.11 shows a teacher explaining a point to learners.

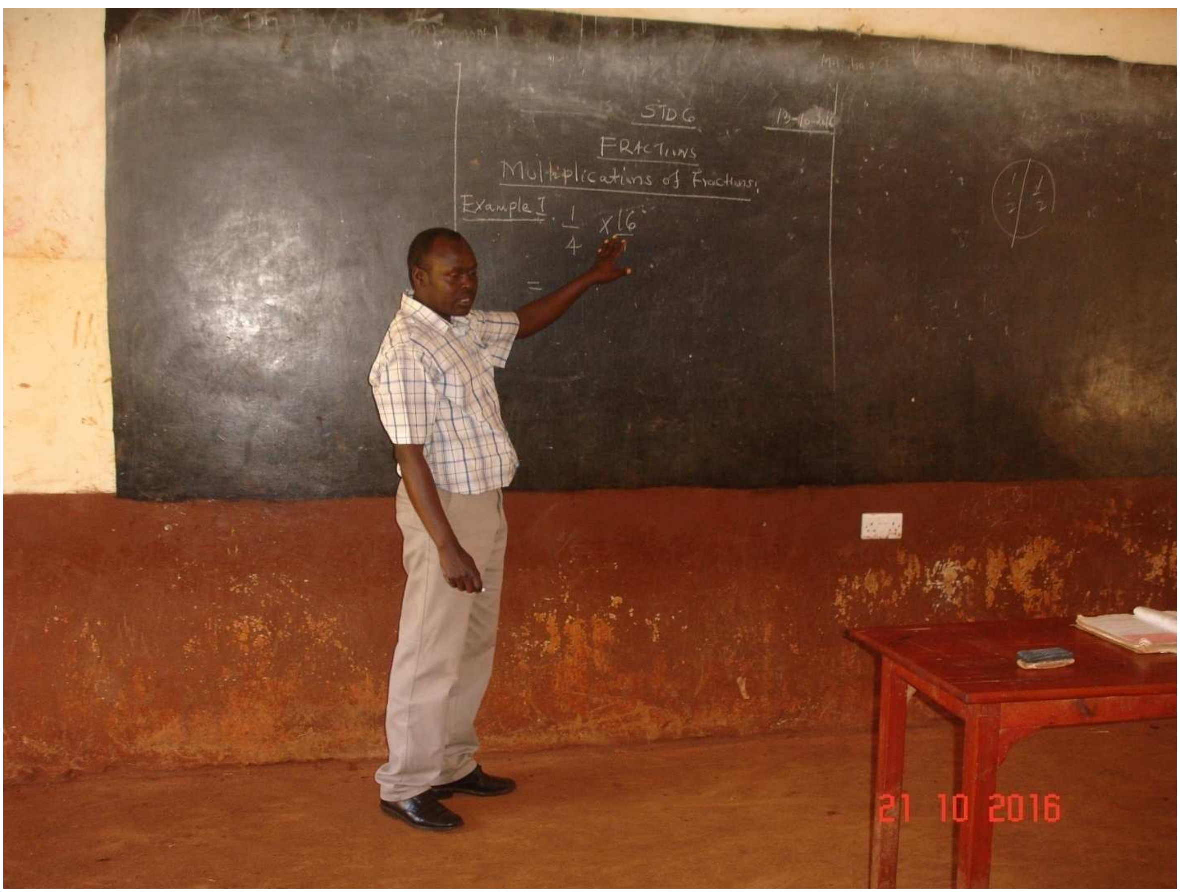


Figure 4.11: Teacher Explaining Procedure of Working out Problems on Multiplication of Fractions

It was important that the opinion of mathematics teachers involved in teaching both the control and experimental groups be sought. The researcher read through the teacher opinions, identified statements or phrases, sentences, and paragraphs that were based on the research objectives and those repeating themselves. These similarities and differences were used to summarize the data in themes as shown in Table 4.14.

Table 4.14: Comparison of Mathematics Teacher Classoom Observations

Statement	Experimental group	Control group
Participation	Learners actively involved. In group discussions activities supervised, listened to their conversations, encouraged them to talk and challenged each other's opinions. One learner in the group worked out problem while others closely observed and asked questions. Every team was involved in tasks simultaneously.	Learners quietly worked on their tasks. Teacher lead whole-class discussion as the primary resource to nurture patterns of mathematical reasoning, monitored participation and emphasized efficient ways of doing it. Learners passive.
Feedback	Immediate feedback helped detect error patterns of learners especially in concepts like reciprocals and division of fractions and enabled them to identify and correct their mistakes.	Teacher gives feedback after all the learners have worked out questions, marked and difficulty problems corrected to the attention of whole class.
Learner evaluation	Formative evaluation gauged understanding of fractions. All levels of Blooms taxonomy possible. Presentation controls enabled to remain in control, oversee working processes, review areas not understood, time learners actions, activate and deactivate mice to facilitate class discussions. Intervention of teacher offered divergent views and ways of answering the same question	Oral questions gauged understanding followed by questions like, "have all understood" ...and silence means they have understood. 90% of time spend on computation. Learners showed step by step how to solve problems and expected them to do the same. One learner works out problems on the chalkboard while others watched. Homework given to learners to be handed in the following day
Motivation of learners	Intrinsically motivated to learn. Curiosity stimulated and encouraged them to investigate further by asking questions like, "What would happen if.... Learners eagerly waited for the next lesson. Team icons used as names helped avoid stigmatization and demoralization. Struggling ones monitored closely. Good rapport with learners. Frequent power black outs caused boredom and frustration.	To keep them interested in fractions, teacher worked out problems for his learners and "magically" came up with answers and occasionally rewards those who get correct answers. The bright learners were singled out to work out questions on the chalkboard to help the struggling ones boosting their confidence and self-esteem. The weak ones did not receive individualized instruction. Used praise and rewards like pens, exercise books.
Learner interactions	More interaction between learners. Interacting with learners increased significantly, they asked and answered questions from their peers.	All learners got the same instruction at the same time hence whole class instruction. Limited learner interaction limited.
Classroom management issues	Presentation controls enabled teachers remain in control, oversaw working processes and made large classes look smaller. Trouble shooting tips inbuilt in the software helped solve technical problems.	Mastering learners names helped discourage disruptive behaviours. Rules written on the wall of the classroom, learners reminded constantly and whoever broke any of them was punished as stipulated in the rules and they agreed on verdict incase violation of the rule.
Challenges encountered	Some mouse pointers disappeared from the presentation. This reduced the number of participating mice. Use of virtual pen challenging to some. Faulty power transformer delayed start of study. On two occasions, a learner stepped on cables interrupting learning. Initially learners struggled with tasks due to lack of competence in holding the mice. In such cases they showed signs of frustration.	Use of complex language made comprehension. Only a few exercise books were marked. Sometimes teacher found it difficult to capture learner attention due to large classes. Truant learners were punished by kneeling in class the whole lesson. This served as a lesson to other disruptive learners.
Learner involvement	Given tasks in small groups. Individuals had own mice but answered questions using team icon. This enhanced development of social skills. Often was need to negotiate and resolve conflicts on the answer and method used. This encouraged healthy competition with other groups which made learning more interesting.	Teacher covered a lot of content within a short time. This was a convenient way of instruction especially in classes with many learners. Due to large classes learners could not be put in groups hence whole class discussions were used. Individual learners asked to answer questions orally or work out on chalkboard

On teacher- learner interactions the findings are consistent with several studies that showed that computer interactive multiple mice technique influences teacher-learner interaction.

Rimm-Kaufman et al (2009) in Daniel (2015) states that the quality of teacher-learner interactions is an example of an influence external to the learner that has been shown to contribute to engagement. However, Ruzek et al (2014) asserts that teacher-learner interaction quality is highly variable across the United States with some classrooms offering more support for learning than others. They concluded that teacher-learner interaction quality is multi-dimensional, in that teachers can provide support that is emotional, organizational, or instructional in nature. Teachers provide emotional support by being sensitive, responsive, warm, and aware of learners interests and needs. Teachers facilitate organizational support by creating non-chaotic classroom environments characterized by clear expectations and productive learning. Teachers offer instructional support by giving clear feedback to learners, creating opportunities for conceptual thinking, and modeling new vocabulary. In the current study, the mathematics teacher in the experimental groups being the mediator of the learning process, in advance made decisions on the specific objectives and developed varied learning activities and experiences that ensured learners were actively involved in the lesson. This was accomplished through providing clear and efficient pedagogical stragegies .

The findings of teacher-learner interactions, learner-learner interaction and learner-teacher interactions are also in agreement with (Stewart *et al.*, 1998; Pal *et al.*, 2006; Pawar *et al.*, 2007; Coa *et al.*, 2008; Kaplan *et al.*, 2009) in their study where they compared the Single Display Groupware (SDG) model and the traditional collaboration. The results indicated that SDG allows multiple learners to share the same space and interact simultaneously over a single display, on the same machine, each with his own input device. It provides each learner with a mouse and cursor that controls his own objects on the screen, thus effectively multiplying the amount of interaction per learner. These results are also in agreement with with Stewart (2010) who argued that every student is engaged and participate simultaneously. In addition, Roberts (2011) established that use of mouse mischief students got involved in interactive learning that increased their participation and helped them learn from their mistakes. These results are also consistent with Siswa (2012) in learners experience with triangles, an analysis of behaviour patterns showed that students in experimental group found different ways of collaborating. Group discussion were held after to stimulate students to gain deeper understanding of material and concepts taught.

The results on classroom interactions are also in line with Kimberle *et al.*, (2010) results that indicated that tablets were particularly successful in facilitating learners' creation of drawings and other mathematical and scientific representations, and providing teachers with tools to promote classroom discussions and enhancing teacher interacting with learner in the learning process. Basing on the findings and the literature reviewed on learner-teacher interactions, it is clear computer interactive multiple mice enhance learner-teacher interactions in the classroom. This is because the results are in agreement with previous studies. Microsoft (2008) in a pilot study found out the following: results of teacher interviews and classroom observations established that compared to the traditional method of teaching, using multiple mice was totally different because learners have the ability to interact with teachers, interaction with each other increased and learners worked well in small groups, developed teamwork skills and the whole class was involved. They continue to assert that in the results, one teacher said, ‘a small group of learners had to discuss among themselves more than usual to get a final answer because the system only allowed one answer and it was visible to everyone. In traditional classes, the teacher would just point to an individual learner and the answer is only visible that learner.

Pamela (2012) established that use of clickers in the classroom increased participation and mental engagement. That clickers help to provide instant feedback on what is known. Survey data also revealed that both groups agreed that clickers increase participation in class. Fifteen of the 22 teachers surveyed (68%) felt that clickers allowed them to design questions at either all levels or at least application and above. In the current study learners in all groups were involved in activities simultaneously and immediate feedback gave teacher opportunity to engage learners in a class discussion using polling slides. Examples of activities included: drawing on the slide, circle, cross, match and deactivating active mice to draw attention of learner to a particular task. Infante *et al.*, (2010) also agrees by arguing that computer interactive multiple mice technique is fundamental in favoring learner-learner interactions during the learning process. The activity will make each learner work with objects that are closely his. Each learner controls his own input device, which forces him to participate and become the protagonist of his own learning process. They indicate that learners' focus their attention on the common screen where individual resources are shared. The findings are also consistent with Siu (2011) whose results of a time allocation analysis showed that the use of computer supported cognitive tool (CT) in a one-to-one classroom enhanced learner engagement in terms of time on task for learning exploration during class time. Moreover, the questionnaire survey results reveal the potential of the use of CT in a one-to-one classroom to promote classroom-based dialogic interaction in mathematics lessons. The findings indicate that use of computer interactive multiple mice technique enhances learner-learner interactions, learner-teacher interactions and teacher-learner interactions. These means that it is a more superior method of enhancing classroom interactions as compared to conventional methods in public primary schools of Hamisi Sub County.

Several studies done on influence of computer technology on learner classroom interactions contradict the above results. Although there are many benefits to the integration of Interactive White Board in mathematics classrooms in primary schools(IWB), the board is used as a glorified whiteboard and not used interactively (Knight, Pennant, & Piggott, 2007). On the contrary, computer interactive multiple mice is more interactive that the IWB because all learners answer questions simultaneously whereas the IWB allows one learner at a time. Researchers have debated the effects of manipulating physical materials and virtual materials on children are learning of mathematical concepts (Clements & Sarama, 2003; Zacharia, Loizou, & Papaevripidou, 2012). Moreover, promoting the development of social skills is considered one of the important developmentally appropriate practices for young children (Bredekamp & Copple, 1997). In contrast, some researchers have argued that technology may impede young children's social skills because children develop these skills through in-person interaction, and their use of various technologies keeps them from such interaction (Armstrong & Casement, 2000).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a summary of the study findings, conclusions and recommendations. These are presented under the themes derived from the objectives of the study as follows:

i) To determine any difference in achievement between learners' taught using computer interactive multiple mice and those using conventional instructional methods.
ii) To find out if there is any difference in motivation between learners' taught using computer interactive multiple mice and those using conventional instructional methods.
iii) To establish any difference in classroom interaction between learners' taught using computer interactive multiple mice and those using conventional instructional methods.

5.2 Summary of Findings

The summary of findings established in chapter four is presented in this sub-section.

5.2.1 Computer Interactive Multiple Mice Technique and Learner Achievement

The first objective was to determine any difference in achievement between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods. Comparing the pre-test results reveal that the pre-test mean of the two groups were similar on means for learners taught using computer interactive multiple mice as compared to those taught using the conventional instructional methods.

The independent sample's t-test analysis on post-test results showed that participants in the experimental group considerably improved their pretest results, whereas there was very little improvement in the control group. The performance of post-test mean for the experimental group was outstanding with a higher mean while the control group had a low mean. From the results, comparing the post-test results revealed that the post-test mean of the two groups differ significantly. The results meant computer interactive multiple mice is a superior technique of learning fractions as compared to conventional technique.

The results of post hoc comparisons for independent sample t-test revealed that the mean scores obtained by the learners within the treatment groups and control groups were not statistically different. However, there were significant differences between the mean scores of the experimental groups and control groups such that the mean scores obtained by the treatment groups were significantly higher than those in the control groups. These suggested that the learners who were exposed to computer multiple interactive technique significantly gained more than those who were not exposed to it.

5.2.2 Computer Interactive Multiple Mice Technique and Learner Motivation

The second objective was to find out any difference in motivation between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods. On particular items in comparison of the learners in experimental group as compared to control group, the following was revealed in experimental group: learners were actively involved, increased participation, received instant answers to the questions, improved attention, learners more attentive, lesson lively, more involved in doing the activities than listening to teacher, different activities increased interest in learning fractions, understood fractions, teacher used examples that they had come across, activities used in learning fractions were useful to them, able to solve word problems in fractions, getting correct answers increased their confidence, learning fractions became easy, more confident in working out sums, satisfied when they learned fractions, praised by teacher for the correct answers and praises from teacher made them want to learn fractions. This was not true for learners in the control groups. Further analysis using independent sample t test indicated a statistical significant relationship in motivation between learners who were taught using computer interactive multiple mice and those taught using conventional instructional methods. These meant computer interactive multiple mice was a more superior technique in improving learners motivation as compared to conventional instructional methods.

5.2.3 Computer Interactive Multiple Mice Technique and Learner Classroom Interactions

The research question sought to establish any difference in classroom interaction between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods.

Results on Percentages Showing Classroom Interactions

The results revealed that computer interactive multiple mice technique enhanced classroom interactions among learners in the experimental group as compared to those in control groups.

Verbatim Reports on Classroom Interactions

In comparison to the conventional classrooms, computer interactive multiple mice enhanced the following: the number of exercises was varied, immediacy of the feedback, worked in small groups, actively constructed new knowledge, working out answer to questions was to the view of entire class. Learners worked sums simultaneously on the screen, maximum use of their senses, more engaged, unlimited and competitive interactions. Learners worked in teams on a common task. Teacher used the presentation controls to control the whole process of learning. Both lower and higher order questions could be evaluated using the technique. Teacher gauged concept acquisition using varied ways and the reverse was evident in conventional groups.

5.3 Conclusions

Following the objectives and research question of the study, the following conclusions were made from the findings of the study as outlined in chapter four.

5.3.1 Computer Interactive Multiple Mice Technique and Learners Achievement

Computer interactive multiple mice technique enhanced learners' achievement in fractions as compared to conventional instructional methods.

5.3.2 Computer Interactive Multiple Mice Technique and Learner Motivation

Computer interactive multiple mice technique improved learner motivation in the experimental groups as compared to those using conventional instructional methods.

5.3.3 Computer Interactive Multiple Mice Technique and Learner Interactions

Computer interactive multiple mice technique enhanced classroom interactions among learners in experimental groups as compared using conventional instructional methods.

5.4 Recommendations

Based on the findings that computer interactive multiple mice has an effect on learners performance in fractions in public primary schools of Hamisi Sub County, the following recommendations are made for the improvement of learning of fractions based on the objectives and research question of the study:

1. To determine any difference in achievement between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods.
    i) Teachers should use computer interactive multiple mice technique in teaching fractions to help improve learners achievement in fractions
    ii) Learners should use computer interactive multiple mice as a way of simplifying content that sometimes is difficult to understand
2. To find out any difference in motivation between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods.
    i) Public primary schools in Hamisi Sub County should embrace computer interactive multiple mice in improving motivation among learners in mathematics lessons especially fractions
    iii) The computer interactive multiple mice technique should be adopted in public primary schools as a teaching method. This can be achieved by in-servicing teachers on how to use the method. This will help the teacher to integrate the technology in fractions for purposes of enhancing motivation during instruction
3. To establish any difference in classroom interaction between learners' taught using computer interactive multiple mice and those taught using conventional instructional methods.

i) Computer interactive multiple mice technique should be used in writing of some mathematics content in fractions in primary mathematics books in order to enable authors show how it can be used to offer unlimited classroom interactions.

ii) Public primary schools in Hamisi Sub County should embrace computer interactive multiple mice in enhancing classroom interaction in mathematics lessons especially fractions

5.5 Suggestions for Further Study

Based on the findings of this study, the following suggestions were made for further research

i) There should be further research on computer interactive multiple mice technique and its effects on learners' performance in fractions in other counties in Kenya. A similar research could also be carried out on other topics in primary mathematics curriculum. This is because the technique allows learners to work out questions simultaneously multiplying their presence on the screen. Besides immediate feedback allows learners to correct their errors promptly.

ii) Further research can be replicated with other sources of data because this study was the first one of its kind in Kenya. This could be done on different classes other than Standard six

iii) A study should be carried out to find out why mathematics teachers are reluctant to integrate computer interactive multiple mice technique in their classroom.

iv) Research findings indicated that mathematics teachers are reluctant to use technology in the mathematics classroom. There is need for a research to be done to on relationship between Technology Pedagogical and Content Knowledge (TPACK) and its effect on teaching using technology in the classroom.

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APPENDICES

APPENDIX I: HEAD TEACHER CONSENT LETTER

Department of Science and Mathematics Education
Masinde Muliro University of Science and Technology
P.O Box 190,
Kakamega

To the Head teacher,
…………………. …...Primary school,
Dear Sir/ Madam,

RE: RESEARCH

I am a postgraduate student at MasindeMuliro University of Science and Technology in the Department of Science and Mathematics pursuing a PhD degree in Mathematics Education. I am currently conducting a research for my PhD Thesis on "Effects of computer interactive multiple mice technique on learners' performance in fractions in primary schools in Kenya." Your school has been selected in the sample and for this reason; I would appreciate if you kindly allow me to use your facilities in the teaching and learning of fractions in Standard six. I further request to observe some of the lessons conducted by the mathematics teacher in the same class to enable me answer the objectives of my study. This information will be used for this research only and will be treated with anonymity and confidentiality. Your assistance will be highly appreciated.

You are free to withdraw from this study at any time you deem fit. You may also request the researcher to inform you about the findings.

Thank you very much for accepting to assist me carry out this study. Please sign in the space provided in this letter.

Yours faithfully,

Metrine Wambani Sulungai Sign……………………………

Head teacher Sign…………………………….

APPENDIX II: PARTICIPANT CONSENT LETTER

Department of Science and Mathematics Education

Masinde Muliro University of Science and Technology

P.O Box 190,

Kakamega

To the participant,

…………………. …...Primary school,

Dear Sir/Madam,

RE: PARTICIPATION IN THE STUDY

I, ________________________, agree to take part in the research titled, "Effects of computer interactive multiple mice technique on learners' performance in fractions in primary schools in Kenya."

I do not have to take part in this study; I can stop taking part anytime without giving reason and without penalty. I can ask to have all the information returned to me, removed from the research records and destroyed.

The objectives of this study are to:

i. To determine any difference in achievement in fractions between learners taught using computer interactive multiple mice and those taught using conventional instructional methods.

ii. To find out any difference in motivation between learners taught using computer interactive multiple mice and those taught using conventional methods

The reseach question of this study is:

I understand that I will not benefit directly from this research. However, my participation in this research may lead to information that could help improve the learning of mathematics in public primary schools in Kenya.

My part in this study is to;

a) Allow the researcher to train me on how to use computer interactive multiple mice technique in the teaching of fractions in standard six

b) Participate as a research assitant by teaching the topic 'Fractions' in standard six and keep records of Mathematics Lesson Observation Checklist (MLOC), Mathematics Acheivement Tests (MATs) and Learner Motivation Questionnaire (LMQ).

The researcher has assured me of privacy and confidentiality for any information collected and no risks involved due to my learners and me participating in this study. This is subject to my permission below:

Metrine Wambani Sulungai Sign……………………………

Participant Sign…………………………….

APPENDIX III: REQUEST LETTER TO EXPERTS FOR INSTRUMENT VALIDATION

Department of Science and Mathematics Education
MasindeMuliro University of Science and Technology
P.O Box 190,
Kakamega

Dear Rater,

RE: ASSESSMENT OF CONTENT VALIDITY OF RESEARCH INSTRUMENTS

You have been identified as a resource person in matters of my educational research. I'm a PhD student in the department of Science and Mathematics of Masinde Muliro University of Science and Technology. In my research I plan to use the attached instrument called----------- to collect data about-----------. I kindly ask you to carefully read through the instrument, critique and rate each item therein, using the scale. Using the rating scale below after judging whether the items measure---My interest in the instrument is---

Rating scale:

1- Extremely invalid 2- Fairly valid 3- Valid and 4- Highly valid

Please refer to the attached instrument(s) and fill the table provided overleaf, with the appriopriate score. Mark with a tick under the selected score for each item. Feel free to add any other useful additional information that will help improve the overall validity of the instrument(i.e. Does the instrument measure what it purports to measure?).

Yours sincerely,

Metrine Wambani Sulungai
REG NO: EDM/H/01/11
MOBILE: 0791424358

APPENDIX IV: MATHEMATICS ACHIEVEMENT TEST 1 (MAT 1)

INSTRUCTIONS

i) **This test is meant to gauge your understanding of the standard 5 topic Fractions**

ii) Do not write your name anywhere in this question paper.

iii) Your answers are meant for research purposes and will be treated with utmost CONFIDENTIALITY.

iv) **Answer ALL the questions**

1. Tick the correct answer to $\frac{5}{6} + \frac{3}{8}$ **a)** $\frac{7}{14}$ **b)** $1\frac{5}{24}$

2. Circle the correct answer to $\frac{7}{8} + \frac{3}{16} + \frac{3}{4}$ **a)** $\frac{13}{28}$ **b)** $1\frac{13}{16}$

3. Which is the correct answer to $\frac{1}{3} - \frac{1}{4}$ **a)** $\frac{1}{12}$ **b)** $-\frac{0}{1}$

4.Aleso subtracted $\frac{3}{14}$ and $\frac{15}{28}$ from $\frac{6}{7}$ and got $\frac{21}{20}$ **a) True** **b) False**

5. Which is the correct answer to the question $3 + \frac{5}{8}\ -1\frac{7}{8}$ **a)** $1\frac{3}{4}$ **b)** $1\ \frac{1}{4}$

6.Which answer represents the following statement. Subtract five and five eighths and 1 and one sixteenth from eight and fifteen of sixteenth **a)** $2\frac{1}{4}$ **b)** $1\frac{1}{4}$

7. Which mixed number represents improper fraction given i) $\frac{13}{5}$ **a)** $2\frac{3}{5}$ **b)** $1\frac{8}{5}$

8. Which improper fraction represents the mixed number given $6\frac{5}{12}$ **a)** $\frac{77}{12}$ **b)** $\frac{12}{77}$

9. Tick the answer representing given fractions in simplest form i) $\frac{50}{100}$ **a)** $\frac{5}{10}$ **b)** $\frac{1}{2}$

10. Circle the fraction that is bigger **a)** $\frac{7}{8}$ **b)** $\frac{9}{10}$

11. Which is the correct answer to the following $4\frac{2}{3} + 1\frac{4}{5} + 2\frac{3}{5}$ **a)** $9\frac{1}{5}$ **b)** $7\frac{9}{13}$

12. Tick the correct answer to $5\frac{3}{4} - 2\frac{1}{4} - 1\frac{1}{8}$ **a)** $2\frac{3}{8}$ **b)** $2\frac{1}{8}$

APPENDIX V: MATHEMATICS ACHIEVEMENT TEST 2 (MAT 2)

INSTRUCTIONS

i) This test is meant to gauge your understanding of the standard 6 topic Fractions.

ii) Do not write your name anywhere in this question paper.

iii) Your answers are meant for research purposes and will be treated with utmost **CONFIDENTIALITY.** Answer ALL the questions

1. What is $\frac{3}{4}$ x $\frac{1}{3}$ x $\frac{2}{5}$ **?** Tick the correct answer **a)** $\frac{1}{10}$ **b)** $\frac{2}{10}$

2. Find the product of two and one seventh and one and five ninth **a)** $2\frac{4}{7}$ **b)** $3\frac{1}{3}$

3. What is $(4\frac{1}{5})^2$? **a)** $\frac{441}{25}$ **b)** $\frac{21}{5}$

4. What is the square of six and three quarters? **a)** $45\frac{9}{16}$ **b)** $\frac{676}{16}$

5. Circle the correct answer $\sqrt{196/576}$ **a)** $\frac{16}{26}$ **b)** $\frac{14}{24}$

6. The square root of $3\frac{6}{25}$ is $1\frac{1}{5}$ **a) True** **b) False**

7. Circle the reciprocal of 5 **a)** $\frac{5}{1}$ **b)** $\frac{1}{5}$

8. $\frac{3}{4}$ M of cloth divide by 3 persons each will get $\frac{1}{4}$m **a) True** **b) False**

9. Which is bigger $\frac{2}{5}$ divide by $\frac{2}{3}$ or $\frac{7}{12}$ divide by $\frac{9}{10}$? **a)** $\frac{2}{5} \div \frac{2}{3}$ **b)** $\frac{7}{12} \div \frac{9}{10}$

10. A rectangular sheet of metal is $1\frac{3}{4}$ M long and $1\frac{5}{7}$ M wide. What is the area of the sheet of metal in square metres? **a) $3m^2$** **b) $15m^2$**

11. Wafula's mother had $\frac{2}{5}$ Kg of sugar. She divided it into 3 equal portions. What fraction of a kilogram was each portion**?** **a)** $1\frac{1}{5}$ **b)** $\frac{2}{15}$

12. What is the next fraction in the sequence $2\frac{1}{4}$, $1\frac{3}{4}$, $1\frac{1}{4}$................ **a)** $\frac{3}{4}$ **b)** $\frac{3}{2}$

APPENDIX VI: LEARNER MOTIVATION QUESTIONNAIRE (LMQ)

Your school and class have been selected to take part in this study. You are therefore kindly requested to fill this questionnaire as honestly as possible. This study is intended to investigate effets of computer interactive multiple mice technique on learners' motivation in public primary schools of Hamisi Sub-county in Vihiga County, Kenya.

Put a tick (√) in the spaces provided or fill in as required. The information collected will be treated with utmost confidentiality and will be used for academic purposes only.

Demographic information

1. Gender: Boy ( ) Girl ( )

This questionnaire will capture information on your motivation towards learning mathematics based on the computer interactive multiple mice as compared to use of usual (conventional) methods of learning mathematics. As you read each statement, indicate your extent of your agreement or disagreement . Put a tick against

SA - If you Strongly Agree

A - If you Agree

U - If you are Undecided

D - If you Disagree

SD - **If you** Strongly Disagree

It should be noted that **ONLY ONE ANSWER** should be ticked for each of the twenty statements

NO.	STATEMENT	SA	A	N	D	SD
1	I was actively involved in learning process					
2	My participation in the mathematics lesson increased					
3	I was involved more in activities					

	with other learners					
4	I recieved instant and quick answers to the questions					
5	My attention in the lesson improved					
6	I become more attentive					
7	My interest in learning fractions improved					
8	The lesson was lively					
9	I was involved more in doing the activities than listening to teacher					
10	Teacher used different activities which increased my interest in learning fractions					
11	I understood fractions					
12	Teacher used examples that I have come across					
13	Activities used in learning fractions were useful to me					
14	Knowledge learned enabled me to solve word problems in fractions					
15	My getting correct answers increased my confidence in doing sums in fractions					
16	Solving sums in fractions became easy for me					
17	I became more confident in working out sums in fractions					
18	I was satisfied when I learned fractions					
19	I was praised by teacher for the correct answers I gave					
20	Praises from teacher made me want to learn fractions					

THANK YOU FOR YOUR COOPERATION

APPENDIX VII: MATHEMATICS LESSON OBSERVATION CHECKLIST (MLOC)

Physical Setting/Classroom Environment

A.Classroom Facility (Tick where appropriate)

Number of learners in class______________ Time__________________

Did the teacher use any of the grouping below during instruction (Put a tick in the box against the possible response you observed)

a) Small groups ( )
b) Individual ( )
c) Whole class discussion ( )

If small groups, how many pupils per group? ( )

The MLOC will capture every detail that will take place during the teaching learning process on the following aspects namely:

B. The statements below intend to get your views on classroom interactions during mathematics lesson. Please tick against either SA-Strongly Agree, A-Agree, U-Undecided, D-Disagree, SD-Strongly Disagree

	STATEMENT	**SA**	**A**	**U**	**D**	**SD**
TEACHER -LEARNER INTERACTION						
1	Teacher accepts feeling tone of learners in non threatening manner					
2	Teacher did not give facts about procedure					
3	Teacher clarifies ideas suggested by learners					
4	Teacher builds ideas suggested by learners					
5	Teacher did not solicit leaner statement					
6	Teacher did not correct learners errors during the lesson					
7	Teacher provided praise for learner behavior					
8	Teacher asked probing follow-up questions based on learners' understanding					

LEARNER- LEARNER INTERACTION						
1	Learners worked in small groups					
2	Learners were allowed to consult each other while working in teams					
3	Thinking time not given to pupils to discuss before answering questions					
4	Incorrect answers given stimulated debate among learners					
5	Learners are encouraged to ask questions to each other					
6	Learners encouraged to self evaluate their work					
7	Learners asked to discuss other ways to solve problem					
	LEARNER - TEACHER INTERACTION					
1	Learner understanding of mathematical concepts gauged by using questioning techniques					
2	Learners asked for adequate time for task					
3	Learners initiate the discussion by responding to teachers statement					
4	Questions did not stimulate broad learner responses					
5	Learners follow teachers instructions					
6	Learners individual needs were met					

C. Provide any other relevant information on classroom interactions or any other that you observed during the lesson that may have influenced your teaching

……………………………………………………………………………………………………

……………………………………………………………………………………………………

………………………………………………………………………………………

THANK YOU FOR YOUR CO-OPERATION

APPENDIX VIII: SOURCES FOR PILOT STUDY OUTPUTS

CODE	MAT 1		MAT 2		LMQ		MLOC	
	X	*Y*	X	Y	X	Y	X	Y
1	7	17	11	30	40	43	44	47
2	10	17	21	33	80	82	42	41
3	17	27	5	9	77	92	39	42
4	10	14	12	25	89	85	60	63
5	16	30	5	8	84	96	67	68
6	10	10	11	12	76	95	46	47
7	10	17	6	10	84	88	42	43
8	20	23	5	10	74	91	52	55
9	10	13	6	14	86	85	58	60
10	10	17	35	43	74	83	65	65
11	7	17	12	16	84	87	62	63
12	0	13	6	9	79	87	51	54
13	10	17	6	7	76	86		
14	0	17	5	6	67	81		
15	0	10	8	9	85	94		
16	10	33	6	10	84	93		
17	7	20	15	17	80	89		
18	7	13	8	9	51	75		
19	7	10	7	10	88	96		
20	7	7	9	10	87	89		
21	13	37	9	9	85	85		
22	0	10	8	15	75	80		
23	0	13	14	21	81	86		
24	7	17	7	10	78	85		
25	10	23	16	21	83	92		

APPENDIX IX: OUTPUT FOR MAT 1 PILOT STUDY

Correlations

		X (MAT 1)	Y(MAT 1)
	Pearson Correlation	1	.698**
X(MAT 1)	Sig(2-tailed)		.000
	N	25	25
Y(MAT 1)	Pearson Correlation	.698**	1
	Sig.(2-tailed)	.000	
	N	25	25

*****Correlation is significant at the .05 level (2-tailed)***

APPENDIX X: OUTPUT FOR MAT 2 PILOT STUDY

Correlations

		X (MAT 2)	Y(MAT 2)
	Pearson Correlation	1	.891**
X(MAT 2)	Sig(2-tailed)		.000
	N	25	25
Y(MAT 2)	Pearson Correlation	.891**	1
	Sig.(2-tailed)	.000	
	N	25	25

*****Correlation is significant at the .05 level (2-tailed)*

APPENDIX XI: OUTPUT FOR LMQ PILOT STUDY

Correlations

		X (LMQ)	Y(LMQ)
	Pearson Correlation	1	.941**
X(LMQ)	Sig(2-tailed)		.000
	N	25	25
Y(LMQ)	Pearson Correlation	.941**	1
	Sig.(2-tailed)	.000	
	N	25	25

** *Correlation is significant at the .05 level (2-tailed)*

APPENDIX XII: OUTPUT FOR MLOC PILOT STUDY

Correlations

		X (MLOC)	Y(MLOC)
	Pearson Correlation	1	.896**
X(MLOC)	Sig(2-tailed)		.000
	N	24	24
Y(MLOC)	Pearson Correlation	.896**	1
	Sig.(2-tailed)	.000	
	N	24	24

***Correlation is significant at the .05 level (2-tailed)*

APPENDIX XIII: DATA OF PARTICIPANTS FROM 6 ZONES

ZONE 1		ZONE 2		ZONE 3		ZONE 4		ZONE 5		ZONE 6	
E	C	E	C	E	C	E	C	E	C	E	C
67	33	67	42	100	42	83	25	75	42	83	42
83	67	92	25	75	75	83	50	83	42	92	50
92	33	92	42	83	67	75	42	67	50	100	33
50	75	83	67	100	50	58	50	92	42	92	42
58	67	83	50	67	58	83	58	83	42	92	50
83	58	75	25	92	58	67	42	58	42	92	42
75	83	75	50	83	67	92	58	67	50	100	33
75	50	75	75	75	58	67	75	75	42	92	33
75	50	67	33	83	67	83	33	58	42	100	42
75	42	75	50	75	58	50	58	83	42	92	25
58	50	67	42	67	25	67	50	67	33	83	33
83	42	83	50	75	67	83	58	92	58	75	33
75	42	83	42	75	42	58	58	92	25	58	58
58	75	75	58	75	50	67	58	92	58	83	42
75	67	67	33	83	33	83	58	83	58	58	42
58	75	83	50	58	50	67	58	83	50	67	67
83	75	75	58	75	33	75	50	75	50	83	42
83	50	75	25	75	50	50	17	75	50	67	42
67	67	83	50	75	50	58	67	83	50	75	33
67	50	75	42	75	25	58	33	67	58	75	33
92	42	75	58	75	50	75	42	92	17	75	42
92	50	75	42	75	50	75	33	92	42	67	25
83	67	67	33	83	25	58	33	75	33	58	25
75	33	75	42	58	58	75	42	83	50	75	42
67	33	83	33	50	33	50	58		50	67	17
67	25	75	42	58	33	50	33		42	75	25
100	67	75	58	75	50	50	58		25	67	42
67	67	58	58	67	50	58	58		58	50	42
83	58	75	50	75	67	75	50		50	75	42
67	75	67	42	67	25	50	67		33	67	33
75	58	83	25	58	58	42	33		42	92	50
		58	58	83	42	67	58		50	92	
		75	42	75	25	50	42		42	92	
		92		67	42	58	50		42	92	
		83		75	50	75	25		25		
		50		83		67	58		42		
		58		58		50	50		58		
		75		75		67	67		42		
		83		75		58	33		67		

		67		75		42	42		50		
		75		75		58	25		67		
		83		75		67	33		67		
		92		75		67	58		25		
		75		83		42	50				
		58		58		75					
		100		50		50					
		58		58		33					
		67		75		58					
		58		100		58					
				75		67					
				83		75					
				100		58					
				67		83					
				92							
				83							
				75							
				83							
				75							
				67							
				75							
				75							

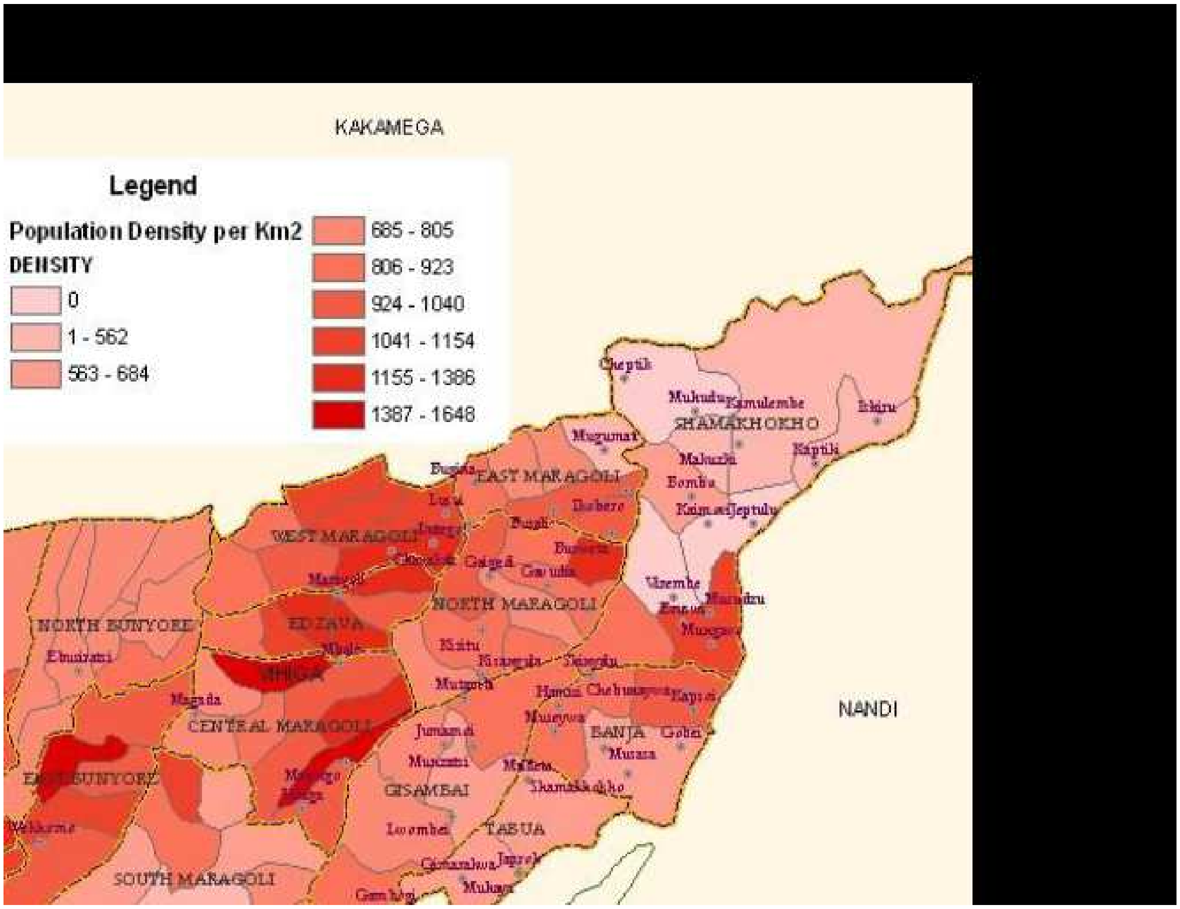
E= Experimental group, C= Control group

APPENDIX XIV: DATA OF BOYS AND GIRLS IN THE SCHOOLS

	ZONE 1		ZONE 2		ZONE 3		ZONE 4		ZONE 5		ZONE 6	
Gender	B	G	B	G	B	G	B	G	B	G	B	G
Experimental	15	9	26	24	20	14	34	21	15	17	28	20
Control	14	29	23	21	15	17	18	17	14	16	29	20
Total gender per zone	29	38	49	45	35	31	52	38	29	33	57	40

B= Boys , G= Girls, E= Experimental group, C= Control group

APPENDIX XV: MAP OF VIHIGA COUNTY



APPENDIX XVI: RESEARCH PERMIT

THIS IS TO CERTIFY THAT:
MS. METRINE WAMBANI SULUNGAI
of MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY, 0-30100 mOSORIOT,has been permitted to conduct research in *Vihiga County*

on the topic: *COMPUTER INTERACTIVE MULTIPLE MICE TECHNIQUE AND ITS EFFECT ON PUPILS' PERFORMANCE IN FRACTIONS IN PUBLIC PRIMARY SCHOOLS IN VIHIGA COUNTY,KENYA*

for the period ending:
24th October,2017

Permit No : NACOSTI/P/16/25657/13473
Date Of Issue : 24th October,2016
Fee Recieved :Ksh 2000

....
Applicant's Signature

....
Director General
National Commission for Science, Technology & Innovation

APPENDIX XVII: LETTER FROM NACOSTI

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471,
2241349,3310571,2219420
Fax:+254-20-318245,318249
Email:dg@nacosti.go.ke
Website: www.nacosti.go.ke
when replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref. No. **NACOSTI/P/16/25657/13473**

Date: **24th October, 2016**

Metrine Wambani Sulungai
Masinde Muliro University of
Science and Technology
P.O. Box 190-50100
KAKAMEGA.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on "***Computer Interactive Multiple Mice Technique and its effect on pupils' performance in fractions in public primary schools in Vihiga County, Kenya,***" I am pleased to inform you that you have been authorized to undertake research in **Vihiga County** for the period ending **24th October, 2017.**

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

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

BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Vihiga County.

The County Director of Education
Vihiga County.

National Commission for Science, Technology and Innovation is ISO 9001:2008 Certified