EFFECTS OF EXPERIENTIAL LEARNING APPROACH ON MATHEMATICAL CREATIVITY AND ACHIEVEMENT AMONG SECONDARY SCHOOL STUDENTS OF KERICHO EAST SUB-COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

DECLARATION

This Thesis is my original work and has not been submitted for the award of any Diploma or Conferment of Degree in this or any other university.

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RECOMMENDATION

This thesis has been submitted for examination with our approval as University Supervisors.

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DEDICATION

This work is dedicated to Daniel, Hellen, Joel, Bradley, Bravian and Brenda who are a great inspiration in my life.

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I wish to thank and praise Almighty God, great things He Has done.

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ABSTRACT

Mathematics is a subject which seeks to understand patterns that permeate both the world around us and the mind within us. The knowledge of mathematics as a tool for use in everyday life is important for individual and societal development. Students' achievement in mathematics is important in Science and Technology which is important for industrial advancement of a country. There are many ways of thinking and the kind of thinking one learns in mathematics is an ability to handle abstraction and solve problems that require knowledge of mathematics. Mathematical creativity is essential for scientists. Creativity is one of the goals of teaching mathematics in schools. However, students' performance in Kenya Certificate of Secondary Education mathematics examination has been relatively poor. This has been attributed to teacher centred teaching and learning approaches among other factors that have impacted negatively on mathematical creativity and achievement. This study investigated the Effects of Experiential Learning Approach on students' mathematical creativity and achievement in Kericho East Sub-County. The topic Statistics I was taught to Form Two since it is one of the topics that is poorly performed according to Kenya National Examinations Council reports on KCSE. Solomon Four Non Equivalent Control Group Design under the quasi-experimental research was used. A random sample of four co-educational sub-county secondary schools was drawn from schools in Kericho East Sub-County. Each school provided one Form Two class. This translated to a total of 168 students. The experimental groups were taught Experiential Learning Approach (ELA) while the control groups were taught using the Conventional Teaching Methods (CTM). One experimental and one control group was pre tested. At the end of the treatment all the four groups were post tested using Mathematical Creativity Test (MCT) and Mathematics Achievement Test (MAT). The instruments were validated with the help of experts in the Department of Curriculum Instruction and Education Management of Egerton University and mathematics teachers from selected secondary schools. The MCT and MAT were pilot tested to estimate their reliability coefficient using Cronbach alpha for MCT and Kuder Richardson 21 method for MAT before they were used in the study. The reliability coefficient was 0.778 for the MCT and 0.978 for the MAT. Means, t-test and ANOVA were used in data analysis. All statistical tests were subjected to test of significance at alpha (α) level of 0.05. The results revealed that ELA had a significant effect on students' mathematical creativity and achievement in mathematics. However, the effects of treatment on mathematical creativity and achievement with regard to gender was not significant. The findings of the study may to assist mathematics teachers to adjust their instructional strategies and also teacher trainers may use the information from the study to sensitise in-service and pre-service mathematics teachers on the importance of Experiential Learning approach in enhancing Mathematical Creativity and achievement in Mathematics. The findings may also be used as a basis for future research in Mathematics Education.

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LIST OF ABBREVIATIONS AND ACRONYMS

ACO	African Curriculum Organisation
ANOVA	Analysis of Variance
CSEE	Certificate of Secondary Education Examinations
CTM	Conventional Teaching Methods
DEO	District Education Office
ELA	Experiential Learning Approach
ELT	Experiential Learning Theory
FAWE	Forum for African Women Educationalists
IEA	International Education Assessment
KCPE	Kenya Certificate of Primary Education
KCSE	Kenya Certificate of Secondary Education
KIE	Kenya Institute of Education
KNEC	Kenya National Examinations Council
MAT	Mathematics Achievement Test
MCT	Mathematical Creativity Test
MoEST	Ministry of Education Science and Technology
NACOSTI	National Commission for Science, Technology and Innovation
NECTA	National Examinations Council of Tanzania
NCTM	National Council of Teachers of Mathematics
SMASSE	Strengthening Mathematics and Science in Secondary Education
SPSS	Statistical Package for Social Science
TIMSS	Trends in International Mathematics and Science Study

UNESCO United Nations Educational, Scientific and Cultural Organisation

URT United Republic of Tanzania

CHAPTER ONE
INTRODUCTION

1.1 Background Information of the Study

Mathematics is a science of deductive reasoning. It is much more than algebra, geometry, statistics and calculus. Primarily mathematics is a way of thinking and a way of organising a logical proof. As a way of thinking, it gives insight into the power of the human mind and forms a crucial discipline of learning programmes in school subjects everywhere in the world (Johnson & Rising, 1972;Wojciech, 2009). Mathematics introduces learners to concepts, skills and ways of thinking that are important in their everyday lives. It helps them understand the sense of numbers, patterns and shapes they see around them. As their mathematical confidence grows they look for patterns, use logical thinking and discover new connections, new solutions and different approaches to problems. According to Breakel and Mutunga (1992) mathematics is a way of thinking in which a person determines the validity of an idea or information.

Mathematics is also a tool for understanding other subjects. It is said that mathematics is the gate and key to science. According to the famous philosopher Immanuel Kant; "Science is exact only in so far as it employs mathematics" therefore, all scientific education that do not begin with mathematics is said to be defective at its foundation (Wojciech, 2009). Mathematics plays a very important role in building up modern civilisation by perfecting all science (African Curricullum Organisation, [ACO] 1979; Riley 2000). Mathematical thinking is important for all members of a modern society as a habit of mind for its use in the workplace, business and finance and for personal decision making. Mathematics is fundamental to national development by providing tools for understanding science, engineering, technology and economics. It is essential in public decision making and for participation in the knowledge economy (Buschang, Chung & Kim 2011). Mathematics is a tool for use in all spheres of life and it is important for the existence of any individual and society (Aguele & Agwagah, 2007).

According to Baber (2011) Mathematics equips pupils with uniquely powerful ways to describe, analyse and change the world. It can stimulate moments of pleasure and wonder for all learners when they solve a problem for the first time, discover a more elegant solution or notice hidden connections. Learners who are functional in mathematics are able to think independently in applied and abstract ways and can reason, solve problems and assess risks.

Creativity has been proposed as one of the major components to be included in the education of the 21st century (Mann, 2005). Therefore, the contemporary curricula should emphasize the development of students creative thinking (Lamon, 2003). There is no commonly accepted definition of mathematical creativity (Mann, 2006). However a commonly agreed upon definition is that mathematical creativity is a novel way of thinking characterised by fluency, flexibility, originality and elaboration (Gill, Ben-Zvi & Apel, 2007; Leikin, Berman & Koichu, 2010; Kim, Cho & Ahn, 2003; Imai, 2000; Runco, 2008). Fluency is the number of responses a learner can give to a mathematical question, flexibility is the shift in categories in the responses to a given mathematical task, originality is the degree of uniqueness of responses and elaboration is the ability of a person to produce detailed steps (Leikin, 2009).

Mathematical creativity is an essential aspect in the development of mathematical talent (Mann, 2005). Mathematical creativity is also important for constructing mathematical knowledge in a more central way than merely producing learnt knowledge thus teaching of mathematics must focus on seeking solutions creatively, exploring patterns uniquely and formulating hypothesis (Jha, 2012). Despite its importance, mathematical creativity is often neglected in mathematics education. There is need therefore, to improve upon the instructional methods to produce creative thinkers thus the use of ELA.

Learners' performance in mathematics at the national examinations in many countries has remained low (Colwell, 2000). According to Colwell (2000) performance of American students in International Mathematical Tests was low in comparison to other countries. However some countries like Singapore, Taiwan, South Korea and Japan were doing better in mathematics. In Kenyamathematics is a compulsory subject at the primary and secondary school level and it is a basic requirement for many careers and trainings (Aguele & Agwagah, 2007; Githua, 2002). However students' examination results in mathematics in Kenya Certificate of Secondary Education (KCSE) have been relatively low. The trend of performance of candidates in paper I and II of mathematics between the years 2010 and 2014 are shown in Table 1.

Table 1

Candidates National Performance in Mathematics at KCSE Level from 2010 - 2014

Year	Paper	Max. Score	Mean Score
2010	1	100	26.21
	2	100	19.92
	Overall	200	46.07
2011	1	100	21.36
	2	100	28.22
	Overall	200	49.57
2012	1	100	29.46
	2	100	27.86
	Overall	200	57.31
2013	1	100	28.12
	2	100	27.03
	Overall	200	55.15
2014	1	100	24.54
	2	100	23.50
	Overall	200	48.04

Source: Kenya National Examinations Council (KNEC) Report, 2015

Table 1 indicates that the overall performance has a decreasing trend. The mean score is below average of 50% for each paper. It is evident that the overall performance has been quite low, perhaps due to the students' lack of motivation to learn the subject, inadequate coverage of syllabus or the teacher centred methods used by most teachers among others (Miheso, 2012; Amadalo, Shikuku & Wasike, 2012). Some of the topics that have been noted to give learners difficulties to solve problems hence achieve low marks at KCSE include Calculus, Three Dimensional Geometry, Vectors, Statistics, Probability, Loci and Navigation amongst others (KNEC, 2015).

Further, a variation exists in mathematics performance when learners are grouped according to gender. Disparity in mathematics achievement at secondary school level exists between boys and girls. Table 2 indicates the national KCSE performance by gender in mathematics as from the year 2011 to 2014

Table 2

Mathematics KCSE Performance and Candidature by Gender for the Years 2011-2014

Year	Candidature					
	All		Female		Male	
	No. Sat	Mean%	No. Sat	Mean %	No.Sat	Mean %
2011	335014	21.10	151915	18.1	183099	23.60
2012	357446	21.80	159403	18.7	198043	24.30
2013	409887	24.79	181770	21.00	228117	27.80
2014	433014	28.66	195093	25.30	241233	31.38

Source; KNEC Report 2015

From Table 2 it can be noted that the enrolment of girls is lower than that of boys. Analysis of results over this period of time also indicates that the performance of girls is lower compared to that of boys nationally.

The performance of students in mathematics in KCSE in Kericho East Sub County has also been low. Table 3 shows the students performance in mathematicsKericho East by their mean scores.

Table 3

Candidates' Performance in Mathematics in Kericho East Sub County for the Years 2010-2014

Year	Candidature	Meanscore	Meangrade	Deviation
2010	1966	3.9514	D+	+0.5014
2011	2035	4.1540	D+	+0.2026
2012	1978	4.3464	D+	+1.0705
2013	2315	5.4586	C-	+1.1122
2014	2221	5.3336	C-	- 0.1250

Source: Kericho District Education Office, 2015

Although the deviation in the mean scores is positive over the selected period except in 2014 the mean score for all the years is still low. The maximum grade that can be attained is A which has a meanscore of 12 points thus the performance in mathematics in the national examinations by the students of kericho East sub county below average.

Learning in mathematics is not solely a cognitive affair. A better understanding of the relationship between teaching and learning strategy and outcomes in the cognitive and affective domains is imperative. There is need therefore, to improve upon the instructional strategies and develop curriculum that will produce better learners and creative thinkers (Ajogbeje & Omirin, 2013). Karega (2008) argues that one way of addressing the difficulties students experience in Kenyan classrooms is through appropriate teaching interventions that can be realised through professional development of teachers. It is with this in mind that the Ministry of Education in Kenya with assistance from the Government of Japan hoped to strengthen the teaching and learning of mathematics and science education in public schools through a project known as Strengthening Mathematics and Science in Secondary Education (SMASSE) (Kibe, Odhiambo & Ogwel, 2008). SMASSE project has made mathematics and science subjects to become more relevant to learners, more practical and therefore more interesting and less expensive.

According to Wambugu (2006) the teaching approach that a teacher adopts is a factor that may affect students' achievement. The Conventional Teaching Methods (CTM), which are often used to teach mathematics are expository in nature. These methods leave little room for the students to think and be creative (Ndekei, 2011). There is a possibility that less mathematical creativity and low achievement could be due to students' lack of hands on activities in learning mathematics.
Research has shown that learners of all ages tend to learn much more effectively if they are actively involved in the learning process rather than simply being receivers of instruction. Thus in recent years there has been a progressive move away from traditional teacher centred expository instruction towards student centred approaches. Experiential Learning Approach (ELA) is one of the student focused approach to teaching and learning.

This study addressed the effects of ELA on students' mathematical creativity and achievement in mathematics. According to Kolb (1984) Experiential Learning involves four stages as illustrated in figure 1

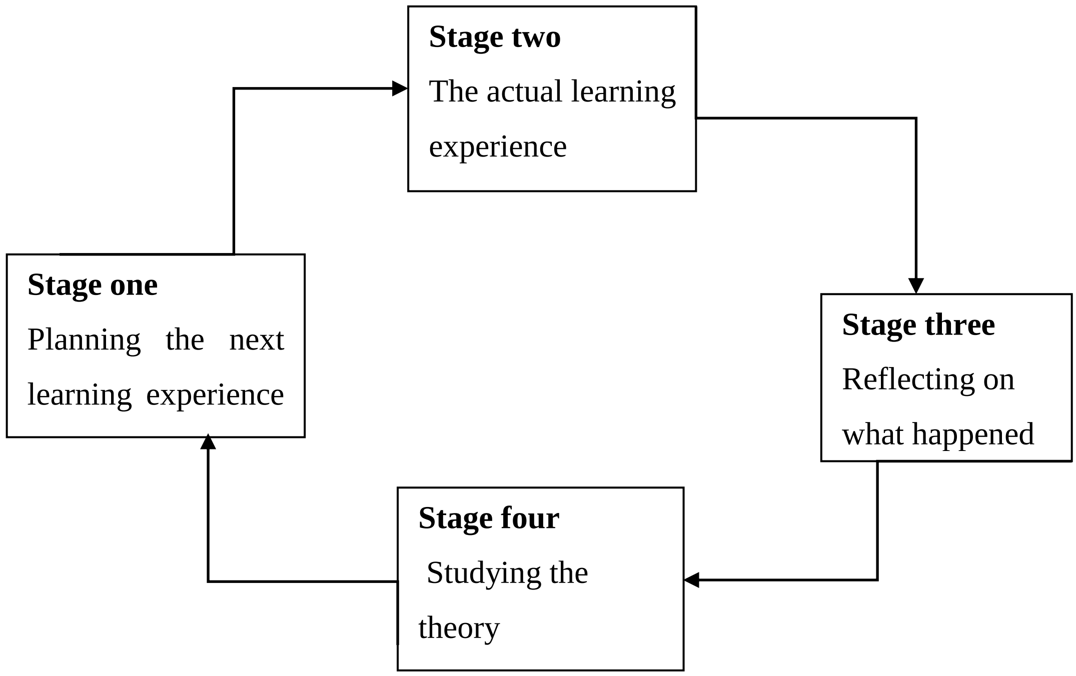


Figure 1: Kolb's Experiential Cycle

Figure 1 illustrates the stages of ELA. Stage one is the planning phase whereby the teacher and learners set the learning activities and objectives. The learner must be involved in the planning of the learning experience if ELA is to be fully effective. This can be done through action planning or preparing a learning contract. Action planning may involve nothing more than putting down a set of things to do, or discussing the proposed procedure with the teacher. It's useful for individual learners to set their own objectives for inclusion in the action plan (Kolb, 1984)

Stage two is where the actual learning occurs and students are actively involved in the learning activities and exploration of the learning experience. This stage involves drawing up a checklist of things that the learner should try to do, for example active observation of what is going on, and producing a log or record of some sort and formulating appropriate questions (Kolb, 1984). Some activities undertaken at this point in a mathematics class include working on examples, problem sets, mathematical games and data collection.

Stage three is where the teacher and learner reflect on the effectiveness of the learning experience. This stage is probably the most crucial of all in the cycle though it may seem the most difficult. The teacher and the students should reflect on what the learners learnt, how they learned it, whether the learning experience could have been more effective and so on. Discussions of these reflections with the teacher can prove extremely helpful as can discussions with one's peers – either informally or at a formal debriefing session of some sort (Zilbert & Leske, 1989). The reflective observation phase is accomplished through discussion, brainstorming and thought questions.

Stage four is where the teacher and learners link the actual learning experiences and the theories of learning it was meant to illustrate. Discussions with the instructor can prove extremely helpful during this stage of the Kolb cycle as can discussion with ones fellow learners. This is the active experimentation phase where the learner applies what has been learnt to new situations through field work, projects and assignments. In this study form II secondary school students were taught the mathematics topic "Statistics" which has been found challenging at the KCSE (KNEC,2012) using ELA.

1.2 Statement of the problem

Secondary school mathematics aims at producing a learner who is numerate, orderly, logical, accurate, precise and critical in thought. It is also designed to enable the learner to acquire knowledge and skills relevant for meaningful contribution to society. Mathematical creativity is considered as an important aspect in mathematics learning. However it is often neglected despite the fact that mathematics is a subject which seeks to understand patterns that permeate both the world around us and the mind within us. Students' performance in Mathematics at KCSE has been poor. Research studies indicate that the conventional teaching methods that teachers use which are mainly expository in naturemay be contributing to the poor performance among other factors. These teaching methods have been blamed for students' inability to acquire relevant mathematical creativity hence low achievement. Research on effect of experiential learning in science and agriculture in Kenya's secondary schools showed that there was better learners' performance in the subject when this method was used. However there is scanty information on its effects on learners performance in Mathematics. This study thus sought to investigate the effects of Experiential Learning Approach on secondary school students' Mathematical Creativity and Achievement in Kericho East Sub County, Kenya.

1.3 Purpose of the Study

The purpose of this study was to investigate the effects of Experiential LearningApproach on students'mathematical creativity and achievement inKericho Sub-County Secondary Schools.

1.4 Objectives of the Study

The study was guided by the following objectives;

i) To compare Students' Mathematical Creativity between those taught using ELA and those taught using Conventional Teaching Methods (CTM).

ii) To find out whether there are gender differences in Mathematical Creativity of students taught through Experiential Learning Approach.

iii) To compare Students' achievement in Mathematics between those taught using ELA and those taught using Conventional Teaching Methods (CTM).

iv) To find out whether there are gender differences in Mathematics Achievement of students taught through Experiential Learning Approach.

1.5 Hypotheses of the Study

To examine the effect of experiential learning approach on students'mathematical creativity and achievement the following null hypotheses were tested.

H_o1: There is no statistically significant difference in students' mathematical creativity between those taught through Experiential Learning Approach and those taught through conventional methods.

H_o2: There is no statistically significant difference in mathematical creativity of students taught through Experiential Learning Approach by gender.

H_o3: There is no statistically significant difference in students' mathematics achievement between those taught through Experiential Learning Approach and those taught through conventional methods.

H_o4: There is no statistically significant difference in mathematics achievement of students taught through Experiential Learning Approach by gender.

1.6 Significance of the Study

The findings of this study may provide information that would be used to develop policy recommendation for improved mathematical Instructional approaches. It is expected to provide information on students' mathematical creativity and achievement when taught using ELA as compared to when they are taught through CTM. The findings of the study may also assist mathematics teachers to adjust their instructional strategies to benefit learners better. They may also be useful to the Ministry of Education in the making of policies pertaining to production of Mathematics teaching materials that embrace student centred approaches such as ELA. The findings from this study may also be used as a basis for further research in mathematics education.

1.7 Scope of the Study

The study focused on Form Two Students drawn from four sub-county co-educational secondary schools in Kericho East Sub-County, Kenya. The mathematics topic taught was Statistics I as presented in the approved Kenya's secondary school syllabus (KIE, 2002). The study explored the effects of experiential learning approach on students' mathematical creativity and achievement in secondary school mathematics.

1.8 Limitations of the study

The study did not cover all the categories of schools. Characteristics of chosen schools may not be applicable to all other schools therefore the findings may not be generalized to the rest of the schools in the sub county.The content covered is limited to subject matter of one topic statistics Form II component of the KCSE mathematics syllabus thus implementation to other topics should be done cautiously.

1.9 Assumptions of the Study

In this study it was assumed that:

i) The teachers who were involved conformed to all the conditions set for the study and thus ensured successful implementation on testing of the effect of the proposed teaching approach on the variables selected.

ii) The learners used in this study were of comparable academic ability.

1.10 Definition of Terms

The terms used in this study are defined constitutively and operationally as follows

Co-educational Schools: schools that admit both boys and girls. This study focused on co-educational schools where boys and girls learn in the same classrooms.

Conventional Teaching Methods: A teaching learning arrangement in which teachers maintain control of the subject matter to be learned and the learners are passive recipients. In this study the teachers in control schools teaching mathematics in form two were assumed to be using conventional teaching methods as opposed to use of experiential learning approach.

Experiential Learning Approach: A teaching learning arrangement in which the learners are actively involved in the planning of learning activities and in the gathering, analyzing and use of the subject matter and have to undergo the four stages of (i) concrete experience (ii) reflective observation (iii) abstract conceptualization (iv) active experimentation

Gender: This refers to the socially constructed roles, behaviours and attributes that a given society considers appropriate for men and women. In this study gender refer to the difference between boys and girls in socio-cultural aspects rather than biological differences only.

Mathematics Achievement: This is a measure of the degree of success in performing specific tasks in a subject or area of study after a teaching/learning experience. In this study the measure is in the form of mathematics test scores from the Mathematics Achievement Test.

Mathematical Creativity: A novel way of seeing or doing things that is characterised by four components. Fluency (generating many ideas), flexibility (shifting perspectives easily), originality (conceiving of something new) and elaboration (building on other ideas). In this study the measure of Mathematical Creativity is in the form of scores from Mathematical Creativity Test.

Statistics: This is the study of the collection, analysis, interpretation, presentation, and organization of data. In this study Statistics is a topic in the mathematics syllabus that is done in Form Two.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This section presents the relevant literature review on global perspective of mathematics, mathematics curriculum in Kenya, objectives of teaching mathematics, instructional methods used in mathematics and gender differences and academic achievement in mathematics. The chapter also reviews experiential learning instruction approach, research on experiential learning, mathematical creativity and its role in enhancing achievement. Finally the Theoretical and Conceptual framework guiding this study are discussed.

2.2 Global perspective of Mathematics

Mathematics is a powerful way of communication. The language of mathematics is international and exceeds national or cultural boundaries (Baber, 2011; Githua, 2002). Learners explore and explain their ideas using universal symbols, common diagrams, spoken and written language. They also start to discover how mathematics has developed over time and how it affects the worlds economy, societies and their cultures. It is an international language expressed clearly and with precision. Mathematics uses an internationally accepted symbol system that has condensed meaning and is understood by all (Gasca, 2011; Githua, 2001). Thus it facilitates trade transactions across borders as units of quantification are understood universally. The International Association for the Evaluation of Education (IEA) has been conducting comparative studies of education achievement in a number of curriculum areas including mathematics and science. Trends in International Mathematics and Science Study (TIMMS) was conducted by IEA and its main objective is to compare the achievement of various countries in Mathematics and Science.

According to TIMMS (2011) results in mathematics evaluation in 22 countries out of 63 which participated had an average scale score of below 500 which is the TIMSS scale centre point at the fourth grade examinations. However at the eighth grade only 14 countries out of 42 got an average of above 500. The maximum score for the assessment was 1000. East Asian countries continue to lead in mathematics achievement. Singapore, Korea, Chinese Taipei and Japan were top performing countries at the fourth grade. Similarly at the eighth grade Korea, Singapore and Chinese Taipei outperformed all other countries followed by Hong Kong and Japan.Thus the percentage of countries below the average score was 67. Botswana, South Africa and Honduras participated in the TIMMS 2011. Despite their participants being at the ninth grade their scale scores were below average.

In Tanzania statistics released by the National Examinations Council of Tanzania (NECTA) show that the trend of massive failure in mathematics is in actual fact getting worse by the day at the secondary school level (URT, 2008). In 2009 about 82% of students who sat for Certificate of Secondary Education Examination (CSEE) failed in mathematics. In Kenya mathematics is a compulsory subject both at primary and secondary school level however learners have been performing dismally (KNEC, 2013). In Kericho East Sub County of Kenya students performance at KCSE mathematics has shown an upward trend from a mean score of 3.95 in 2010 to a mean score of 5.33 in 2014 out of possible score of 12 points though the mean scores are still below average (Kericho District Education Office, 2015)

2.3 Mathematics Curriculum in Kenya

There have been three main phases in mathematics curriculum in Kenya since the colonial time. The first phase was that between 1960 and 1963 in which Traditional mathematics was taught in Kenyan secondary schools (Eshiwani, 1993; Ondiek, 1986). This stage was also known as the adoption stage because the mathematics taught at the Kenyan secondary schools was that which had been adopted from the colonial government. The mathematics courses were adopted without any alteration and they remained fairly static. Traditional mathematics was teacher centred thus easier to teach, required less or no materials at all, encouraged rote learning, learning materials had no local relevance, had deeper content coverage and it emphasised on academic certification. Few students did mathematics at secondary school level because it was highly selective.

The second phase was that between 1964 and 1980 in which The Modern/New mathematics was taught in Kenyas schools. This stage was also known as adaptation stage (Eshiwani, 1993). The changes in school mathematics courses during this period were in response to both changes else where in the world and also the local demands. Several factors played a significant part in influencing the change from traditional to modern mathematics, this included, technological advancement, lack of success in traditional mathematics content and methodologies, new development on how children learn mathematics and greater expansion of student population (Ondiek, 1986). Some changes that were effected from the traditional matematcs to modern mathematics included: some topics taught in the university were brought down to the secondary school level, reorganization of the mathematics subject matter and new approaches to teaching of mathematics. Criticisms of modern mathematics included; difficult and overloaded syllabuses and textbooks, failure to apply mathematics, overdone symbolism and conceptual emphasis as opposed to computation.

By the end of 1980 modern mathematics was replaced by the appropriate/utilitarian mathematics (Eshiwani, 1984). The aim of appropriate mathematics was to meet different needs of adult life in Kenya, employment and need for further education for a limited few. The 8-4-4 system of Education was introduced in January 1985 following the Mackay Report of 1982. The Mackay Report emphasized recommendations made by GoK (1964) as well as streamlined Education System of eight years in primary, four years in secondary and four years in the university (8-4-4) (Wanjohi, 2011). Mathematics plays a pivotal role in the realisation of the prime objective of the 8-4-4 system of education: to produce a person who is numerate, orderly, logical, accurate and precise in thought. The current secondary school mathematics curriculum was released in 1986, revised first in 1992 and later on in 2002. In 2006 mathematics alternative B was introduced for learners who preferred the physical sciences to pure science. This move was unpopular and very few schools chose to implement mathematics alternative B as reflected in the number of candidates who sat for mathematics alternative B KCSE examination in the years 2010-2014 (KNEC, 2015). The current syllabus is academic and driven by requirements of Kenya National Examinations Council. The teaching learning methods used should therefore aim at achieving the requirements of KNEC and hence the use of ELA in this study.

2.4 Objectives of Teaching Secondary School Mathematics

The goals of teaching mathematics have been classified into four namely utilitarian, personal, social and cultural (Yara & Otieno, 2010; Xia et al., 2008; Scopes, 1973). According to MoEST, (2006) the general objectives of secondary school mathematics in Kenya include the following;

i. Develop a positive attitude towards learning mathematics.
ii. Perform mathematical operations and manipulation with confidence, speed and accuracy.
iii. Think and reason precisely, logically and critically in any given situation.
iv. Develop investigative skills in mathematics.
v. Identify, concretise, symbolise and use mathematical relationships in everyday life situations.

vi. Comprehend, analyse, synthesise, evaluate and make generalisations to statements and situations so as to solve mathematical problems.
vii. Collect, organise, represent, analyse, interpret data and make conclusion and predictions from its results.
viii. Apply mathematical knowledge and skills to familiar and unfamiliar situations.
ix. Appreciate the role, value and use of mathematics in society.
x. Develop a willingness to work collaboratively.
xi. Acquire knowledge and skills for further Education and Training.
xii. Communicate mathematical ideas.

The instructional approach used in mathematics should enhance the achievement of the general objectives. Specific objectives are translated from the subject general objectives so as to render the general objectives more useful and achievable. The specific objectives are quite explicit, operational, time bound and quantifiable. They attempt to describe in the clearest terms possible exactly what a student will think act or feel at the end of a learning experience. They describe an activity that the learners will be able to do in order to demonstrate their mastery. These activities are described in measurable and observable terms (MoEST, 2006).

2.5 Instructional Methods Used in Mathematics

Methods of teaching refer to the processes or set procedures of teaching which tend to promote specific strategies of teaching (Kiruhi, Githua & Mboroki, 2009). Each strategy is associated with particular methods of teaching. Strategies of teaching can broadly be classified into two namely: Expository and Discovery teaching strategies. According to Cockroft (1982) mathematics teaching at all levels should include opportunities for exposition by the teacher, discussion between teacher and pupils and between pupils themselves, appropriate practical work, consolidation and practice of fundamental skills and routines, problem solving, including the application of mathematics to everyday situations and investigational work.

The expository methods are methods of teaching in which the teacher is the main focus of the instructional process and the learner is a passive receiver of information. The teacher is often seen as the imparter of knowledge and the learner a mere absorber of knowledge (Kiruhi et al., 2009; Ndirangu, 1991). The purpose of expository methods is to transmit information to a more or less passive learner.

Conventional teaching is concerned with the teacher being the controller of the learning environment. Power and responsibility are held by the teacher and they take the role of instruction and decision making in regards to curriculum content and specific outcomes. They regard students as having knowledge holes that need to be filled with information (Novak, 1998). Learning is chiefly associated with the classroom and is often competitive. The lessons content and delivery are considered to be most important and students master knowledge through drill and practice. Content cannot be learned in context (Johnson & Johnson, 1995).

In the discovery methods of teaching the learner is the main focus of the instructional process. The learners are encouraged to discover by actively engaging in the learning process. These are teaching methods in which learning is portrayed as an active process where learners construct new ideas through use of their knowledge and understanding. The teacher guides, facilitates and supports the schemes used by the learner in seeking new knowledge; forming schemes of knowledge and being self-driven in inquiries. Activity learning technique is an instructional technique with focus on the learner interacting with the subject matter content through active participation in generating of ideas, rather than being a passive recipient of knowledge (Salman, 2009). Some of the instructional methods commonly used in teaching mathematics include lecture, demonstration, cooperative learning, guided discovery and practical mathematical activities.

2.5.1 Lecture Method

This is a didactic method of teaching in which an active teacher communicates information to more or less passive learners who listen and make notes (Kiruhi et al, 2009). In this approach, a teacher talks most of the time, uses audio visual materials to illustrate mathematical concepts, works out mathematical problems on chalkboard while students listen, take notes and have limited chances of asking questions (Gall, 2013). According to Githua (2002) in secondary schools mathematics instruction, short lectures within a lesson are used to arouse students' interest, review previous work, introduce a topic, tell students the goal of a lesson, and give supplementary explanations or present original concepts integrated from different sources. The short lectures could be interjected with group work, supervised practice or any other mathematical activity in order to give students an opportunity to participate in mathematical activities. Lecture method has many disadvantages; first students strong in learning styles other than auditory have hard times in lectures and also those poor in note taking (Gall, 2013). It's also a boring method and can make learners lose interest. Due to the fact that it is passive it becomes hard to evaluate learning. Therefore a purely lecture method is not effective in the teaching of mathematics at secondary level.

2.5.2 Demonstration Method

This is an expository teaching method in which a teacher may show a procedure of solving particular types of mathematics problems, or use a model or apparatus to demonstrate a principle (Kiruhi et al, 2009). This method requires careful planning on the part of the teacher. It has an element of passive learning and some students may not observe all the necessary details required (Maundu, Sambili & Muthwii 1998). Teachers use demonstration to save time. Before the actual demonstration the teacher should try out the problem to ensure it is workable. Learners participate in the demonstration by asking questions. At the end of the demonstration there should be time for discussion of the procedures, learner's questions and practise. However it reduces active involvement of learners as they are mainly observers (Wachanga, 2005).

2.5.3 Cooperative Learning Method

This is a method of instruction where students work together in groups usually with a goal of completing a task (Johnson, Johnson & Smith, 1998). According to Johnson and Johnson (1995) students learn in groups by participating actively in a relaxed friendly atmosphere. This is in agreement with Hollowell (2013) that the method is task oriented, gives learners an opportunity to be active, practice social skills, exercise freedom and responsibility in a group and acquire problem solving skills that help them in mathematics. Working in groups enables students recognise and adopt correct problem solving strategies, quickly detect errors of problem presentation and reject them (Githua, 2002). Groups are able to process more information collectively than individuals for problem solving. Groups can be based on students' ability, interest, skill, activity or integration. According to Burden (1995) a group could be a mixed ability one, a cooperative learning group or a peer tutoring group working on some identified problem depending on the objectives of the lesson.

According to Johnson and Johnson (1995) students are motivated to learn in groups through cognitive controversy. In group classroom arrangement a teacher directs and supervises the activities of each group and finally obtains results from each group leader of a class discussion (Munetsi, 1994). In cooperative learning groups, students' critical thinking skills,self-esteem, self-efficiency, effort and regular attendance in class are enhanced (Biehler & Snowman, 1997, Theodore, 1999). Students are motivated to learn by being given an opportunity to praise others, receive help and praise from others and have opportunities to elaborate personal views during learning. Advantages associated with group discussion teaching methods include: encouragement of students to actively participate in a lesson; allowing feedback to take place immediately; achievement of a wide range of high level cognitive and non-cognitive objectives; giving an opportunity to students to examine topics in great depth and developing in students interpersonal skills (Kiruhi et al, 2009). However cooperative learning approach does not give the learner and the instructor a platform to plan activities and apply the learnt knowledge to real life situation.

2.5.4 Guided Discovery Method

This is an inductive teaching approach in which the teacher presents a series of structured situations to the learner. The learners then study this situation in order to discover some concept or generalisation (Theodore, 1999). According to Dean (1982) in this teaching approach a teacher initiates mathematical facts or concepts to be explored. Usually students are guided and led to discover facts, concepts or method of solving mathematical problems by themselves. Discovery learning techniques are most useful when students have the necessary skills and motivation to succeed (Dembo, 1994). Guided discovery can be used as a supplementary procedure to teach problem solving skills, stimulate curiosity and encourage more self-directed learning.Discovery learning emphasises high level thinking, focuses on intrinsic motivation and helps students to remember important information and take responsibility for their own learning (Githua, 2002). Teachers' responsibility in guided discovery approach of instruction is to plan, confirm student's findings and facilitate the learning process. The learners' role is to identify the rule or generalisation.

2.5.5 Investigations Method

Investigation is a form of discovery. At its best students will define their own problems, set procedures and try to solve them (Theodore, 1999). In the end it's crucial for students to discuss not only the outcomes of the investigation but also the process pursued in trying to solve the problem and find answers to the problem. Investigations cover a broad area of mathematics objectives and include activities which may have more than one correct answer.

2.5.6 Question and Answer Method

In this teaching approach a teacher introduces a mathematics lesson, asks students' probing questions while students answer the questions. A teacher may give students cues leading to correct responses. Finally a teacher summarises the main points of the lesson on chalkboard.

According to Walkin (1994), planned questions stimulate, encourage and consolidate learning as instruction progresses while verbal praise of students for correct responses motivates them to learn. Questions should be clear, purposeful brief, asked in natural language, addressed to entire class in normal conversational tone and asked one at a time (Good & Brophy, 1995).

2.5.7 Games and Out of Class Mathematical Activities Method

In this approach learners are engaged in games and practical tasks that involve working out mathematical problems outside the classroom, for instance calculating height of a flag post, tossing coins to get probability of an event occurringor any other mathematical task when given some information (UNESCO, 1987). Games employ skills and /or chance and has a winner. Students are usually active, co-operative and self-reliant when given an opportunity to solve problems outside the normal mathematics classrooms. This method stimulates students' interest and creativity (UNESCO, 1987) and can be used to practice and reinforce basic skills. Learning by doing has more advantages than direct teaching. It heightens motivation and affects retention of information and better transfer of knowledge to solution of problems.

2.5.8 Practical Mathematical Activities Method

In this approach a teacher in a mathematics classroom provides material and instructs students on what to do. The activities should be relevant to the learners and have mathematical value. They can be involved in construction of solids and nets or survey tasks of the school compound when tackling scale drawing and survey. This method of teaching enhances psychomotor skills, helps students to discern mathematical relationships in objects and concretize mathematical concepts. Learning by doing also raises learners' level of recall and retention of mathematical content in long term memory (Githua, 2002).

Experiential Learning Approach give students opportunities to learn, to search, explore, make conjectures, hypothesize, examine, refute, adapt strategies, devise plans, conclude, reason and justify their conclusions and reflect on them, monitor, and experience the processes that they have gone through. Thus, teachers should adapt teaching approaches that acknowledge students' potential for generating multiple solutions to a given problem rather than to emphasize just on following algorithms, rules and procedures for finding a single correct answer to the problem without considering the essence of mathematics.

2.6 Mathematical Creativity

The main goal of mathematics education is the "mathematisation" of the child's thinking. Clarity of thought and pursuing assumptions to logical conclusions is central to the mathematical enterprise (Pooja, 2012). There is no commonly accepted definition of Mathematical Creativity (Mann, 2006, Sriraman, 2005). However, researchers have come up with various definitions. According to Runco (1993) creativity is a construct involving both divergent and convergent thinking, problem finding and problem solving, self expression, intrinsic motivation, a questioning attitude and self confidence. Krutetskii (1976) characterises mathematical creativity in the context of problem formation (problem finding) invention, independence and originality.

Mathematical Creativity is the ability to solve problems or to develop thinking structures, taking into account the peculiar logical – deductive nature of the discipline and of the fitness of the generated concepts to integrate into the core of what is important in Mathematics (Ervynck, 1991). According to Sriraman (2005), Liljendal and Sriraman (2006) and Freiman and Sriraman (2007) Mathematical Creativity at classroom setting is the process that results in novel and insightful solutions to a given problem and the formulation of new questions and possibilities that allow an old problem to be regarded from a new point of view. Sheffield (2009) points out that mathematical creativity include the ability to overcome fixations and connect seemingly unrelated ideas.

Creative mathematics education must be centred on the mathematisation of the learnersthinking and the construction of mathematical knowledge through a mathematically thinking mind which is not an objective entity but subjective too (Jha, 2012). The main aim of creative mathematics education is to develop the creative problem solving ability in mathematics among students. Students should identify themselves with the ability to use mathematical knowledge for problem solving, ability to communicate mathematically, reason mathematically and a mathematical propensity. Students therefore need to be provided with challenging problems that can stimulate them to develop diverse and sound ways of mathematical thinking and to think creatively. Guiding students to solve a problem using several methods and strategies help students develop and extend their mathematical thinking.

According to Stoyanova and Ellerton (1996) creative thinking ability and expressive ability in the field of mathematics can be measured by open – ended or open – response problems and questions that require more than one answer. The study further argues that mathematical problem posing is the process by which, on the basis of mathematical experience students construct personal interpretations of concrete situations and from these situations formulate meaningful mathematical problems.

Limiting the use of creativity in classroom reduces mathematics to a set of skills to master and rules to memorize and this causes many childrens natural curiosity and enthusiasm for mathematics to disappear as they get older. Solid mathematical knowledge is essential for the development of mathematical creativity (Meissner, 2000). One important reason for this necessity is the fact that excellent knowledge of the content helps individuals to make connections between different concepts and types of information (Sheffield, 2009). Therefore students who are characterised by mathematical accuracy and fluency are more able to present creative thinking in new mathematical tasks providing original and meaningful solutions (Binder, 1996).

Balka (1974) introduced a criteria for measuring mathematical creative ability. He addressed both convergent thinking characterised by determining patterns and breaking from established mind sets, and divergent thinking defined as formulating mathematical hypotheses, evaluating unusual mathematical ideas, sensing what is missing from a problem and splitting general problems into specific sub problems.

Mathematical creativity is a multifaceted construct characterised by four dimensions (Kim Cho & Ahn, 2003; Imai, 2000; Gill, Ben-Zvi & Apel, 2007; Leikin, Berman & Koichu, 2010; Jha, 2012). These include fluency, flexibility, originality and elaboration.

Fluency: This is the number of relevant ideas and it shows the ability to produce several different responsesto a mathematical question. Usually it is simply the number of relevant responses to a mathematical task. It also relates to the continuity of ideas, flow of association and use of basic and universal knowledge (Leikin, Berman & Koichu, 2010; Mann, 2005). This skill can be developed in the students when their learning involves thinking of different ideas for writing, drawing or speaking and thinking of different ways of solving a problem.

Flexibility: This is generally based on the number of categories or classes represented in a learners pool of ideas and responses. This is the shift in categories or methods in the responses to a given mathematical task. It may be defined as the ability to generate a wide range of ideas and a variety of solutions (Gill, Ben-Zvi & Apel, 2007; Leikin, Berman & Koichu 2010). The flexibility mark refers to the number of different categories of ideas and different approaches to a certain problem.

Originality: This is defined as statistical infrequency. It is characterised by a unique way of thinking and unique products of mental activity (Leikin, Berman & Koichu, 2010). This is when responses are novel compared to others to the same mathematical task. These are unique or unusual responses. Originality in thinking means the production of unusual far fetched, remote and clever responses (Jha, 2012). In addition an original idea should be socially useful.

Elaboration: is building on other ideas. It requires extending ideas, giving constructive criticism and providing details. It means the feature that someone can think or fill the need in detail. Elaboration mark refers to the number of details in solving a problem not in an absolutist fashion but in a fallibillist fashion (Jha, 2012). Elaboration in thinking means the ability of a person to produce detailed steps to make a plan work and explain it to others.

Researchers have shown that there is a significant relationship between mathematical creativity and achievement (Kadir & Maker, 2011; Ganihar & Wajiha, 2009; Brunkalla, 2009). According to Brunkalla (2009) students have higher academic achievement if they like mathematics and have positive feelings about it. A study by Pooja (2012) found a positive relationship between mathematical creativity and achievement. He asserts that mathematical creativity facilitates achievement of students because students enjoy creative thinking in the use of mathematical principles. Without fear of rejection, students give multiple answers of one question, consequently knowledge understanding, skill and application is enhanced. Mathematical creativity teaching strategy has also been shown to improve achievement in mathematics (Githua & Njubi, 2013).

Creativity is a concept that evokes various feelings, meanings and definitions. Developing creativity in learners promotes talents, innovations in the field of science, technology and the arts (Craft, 2000). It encourages the most graphic manifestation of the power of imagination. It makes the learners go beyond the obvious. Creativity promotes "possibility" thinking and is a valuable resource in coping with life The expository methods of instruction currently in use in teaching mathematics in most secondary schools in Kenya have been blamed for students inability to achieve meaningful learning since they leave little room for the students to think and be creative (Ndekei, 2011). In an attempt to address this issue this study explored the effects of Experiential Learning Approach on students' Mathematical Creativity and Achievement.

2.7 Gender Differences in Mathematical Creativity and Achievement

Gender is a social aspect that describes the activities to be carried out by the boys and girls in the community. Although sex and gender are terms that are used interchangeably. Gender in this case will be preferred because of the emphasis or the difference in awareness between girls and boys in secondary school mathematics.Studies indicate that girls surpass boys in flexibility dimension of mathematical creativity (Pooja, 2012; Ganihar & Wajiha, 2009). One interpretation that might explain this gender difference is that males and females do extremely well in different aspects of creativity. This dissimilarity may be possible due to gender identity. A study in Spain on gender differences in mathematical creativity (Ai,1999) indicate that flexibility and elaboration is more important for males while fluency and elaboration is more important for females. Thus there are no conclusive results for gender differences in mathematical creativity.

Gender disparity in mathematics achievement at secondary school level exist which contributes to fewer females than males choosing proffesions in mathematics, science and technology fields. In the United States fewer females enrol for more advanced mathematics courses such as trigonometry and calculus and the same is true for intensive and advanced mathematics courses in Australia and the United Kingdom. Data from TIMMS (2011) report indicate that boys continue to outperform girls in mathematics. In Africa the number of women graduating in science and science based courses is much lower than that of men (Ojanji, 2002).
KNEC (2015) indicates that the mean score for girls in mathematics is lower than that of boys. In 2014 the mean score for the boys was 31.38 compared with 25.30 for the girls and in 2013 the boys'meanscore was 27.80 compared with the girls' 21.00. This shows that there is a gender disparity in favour of the boys in mathematics performance at KCSE.

According to Mondoh (2000) male and female students differ in their cognitive styles, this may partly explain why male students have been performing better than female students. During mathematics lessons female and male students perceive, process,store, transform and utilize information differently. Changeiywo (2001) argued that inherent factors do not cause gender differences in sciences and mathematics achievement. However cultural orientation of male and female students influence their achievement in these subjects.This argument is consistent with the view that boys engage in more mathematical and scientific activities as compared to girls while out of school (Mondoh 2000). These different experiences indirectly lead to a difference in mathematics achievement.

According to Ajogbeje and Omirin (2013) gender stereotype has direct influence on students' achievement in mathematics which is in agreement with Maduabum (2006) that gender stereotype indirectly affects student's achievement in mathematics through self confidence,problem solving habits and attitude towards mathematics. Githua (2002) found that there is a gender difference favouring boys in students' self concept in learning mathematics. According to Fennema and Leder (1990) males attribute their success in mathematics to ability while females attribute their success in mathematics to effort and luck.It's known that ability is a stable characteristic while effort is within an individual power to change over time. A childs' mathematical development is influenced by three social sex linked factors (Dean, 1982). These are direct parental reinforcement, simple initiation and child's concept as a member of the society. Many parents consider mathematics to be a masculine subject,so they expect boys to understand it but are ready to make excuses for the girls who cannot.

2.8 Experiential Learning Instruction Approach

Experiential learning refers to a teaching learning strategy in which learners are actively involved in the planning of learning activities and in the gathering, analysis and using the subject matter, in construction of knowledge through grasping and transformation of experience (Deryakulu, Sener & Huseyin, 2010). According to Kolb (1984) Experiential learning is the process whereby knowledge is created through the transformation of experience. It lays emphasis in exploring the processes associated with making sense of concrete experiences and the different styles of learning that may be involved.

Experiential learning is an educational philosophy that lays emphasis on learning from experience through reflection. It refers to a process in which the learner develops knowledge, skills and values through observation, simulation and/or participation that provides depth and meaning to learning experiences by engaging the mind, heart and body through activities, reflection and application in a learning situation characterised by a high level of active involvement and personal responsibility (Zhang,2008)

The foundation of experiential learning can be traced back to Dewey's philosophical pragmatism, Lewins social psychology, Piaget's developmental genetic epistemology and the humanistic work of Rogers and Maslow (Nunan, 1992; Kolb, 1984). Dewey in his contribution noted that learners' experiences and environment provided the premises for learning. He emphasised that experience reinforces what has been learnt and provides better understanding in light of real life situations. These ideas were also noted in Piagets notions of assimilation and accommodation (Kyriacou, 1997).

Kolb (1984) added another dimension on the role of experience in learning. He observed that learning occurs best where there is dialectic tension between concrete experience and abstract conceptualization on one hand and active experimentation and reflective observation on the other. Experiential learning from the ideas of Dewey and Kolb is noted in the learners experience providing a basis for observation and reflection, formation of abstract concepts and generalisations; and testing and application of ideas.

The main feature of experiential learning is that the learner occupies a central place in all considerations of teaching and learning. The key element of this instructional approach is that the learners analyse their experience by reflecting, evaluating and reconstructing it in order to draw meaning from it in the light of prior experience. The learning experiences gained in the process of learning will have a cumulative effect on the development of learners' cognitive and affective characteristics and views of themselves as learners (Kolb & Kolb, 2005). Table 4 shows the difference between Conventional Teaching Methods and the Experiential learning based approach.

Table 4

Comparison of Conventional and Experiential EducationalModels

Dimension	Conventional Model	Experiential Learning Model
View of learning	Transmission of knowledge	Transformation of Knowledge
Power relation	Emphasis on teachers authority	Teacher as "learner among learners"
Teachers' role	Providing mainly frontal instruction	Facilitating learning
View of knowledge	Presented as "certain" application problem solving.	Construction of personal knowledge; identification of problems
Learning Experiences	Knowledge of facts, concepts and skills, focus on content and product	Emphasis on process learning skills, self inquiry, social and Communicative skills.
Control of process	Mainly teacher structured learning.	Emphasis on learner self -directed learning.
Motivation	Mainly extrinsic	Mainly intrinsic
Evaluation	Product oriented, achievement testing, criterion referencing	Process oriented; reflection on process; self assessment; criterion Referencing.
Learners role	Relatively passive recipient of information	Active participant

Source: Kolb and Kolb (2005)

From Table 4 we can conclude that the conventional teaching methods and the experiential teaching are different from each other in almost every aspect of the teaching and learning process. Students learn best when they have personal experience of the learning tasks (Rogers & Freiberg, 1994). In experiential learning, students receive information and participate in doing.

The students are actively involved through listening practices which help them to absorb what they hear and apply course material to real life situations and new problems (McKeachie, 2001).

Experiential learning approach asserts that acquisition of skills and construction of knowledge by the learners is direct result of experience. The learner is said to have the ability to select and to participate in experiences that will further their growth (Atherton, 2009). Experiential learning can exist without a teacher and relates solely to the meaning making process of the individuals' direct experience. This is in agreement with Rogers (1969) who asserts that experiential learning is equivalent to personal growth and change. According to Newsome, Wardlow and Johnson (2005) experiential learning approach elevates students' cognition levels, increases use of critical thinking skills and therefore enhances students' ability to obtain, retain and retrieve knowledge hence increased achievement.

According to Kolb, knowledge is continuously gained through both personal and environmental experiences (Merriam, Caffarella & Baumgarther, 2007). He states that in order to gain genuine knowledge from an experience, certain qualities are required. These are;

i) The learner must be willing to be actively involved in the experience.
ii) The learner must be able to reflect on the experience.
iii) The learner must possess and use analytical skills to conceptualize the experience
iv) The learner must possess decision making and problem solving skills inorder to use the new ideas gained from the experience.

The role of the teacher is to facilitate the learning by setting a positive climate for learning, organising and making available learning resources, balancing intellectual and emotional components. Learning is facilitated when students participate fully in the learning process, when the subject matter is relevant to the interest of the student. The more life experiences a student has the more likely they are to view learning as an internal, experience – based process. That is making sense of information, extracting meaning and relating information to everyday life (Salvo, 1979).

Learning is a cycle that begins with experience continues with reflection and later leads to action which itself becomes a concrete experience for reflections. Kolb (1984) developed a model of how students can learn. In the Kolb's experiential learning model the process of learning is divided into four stages all of which must be gone through for learning to be most effective. The stages include;

a) Concrete experience- this provides the basis for the learning process. The lessons at this stage engage the individual personally and learning relies on open mindedness and adaptability rather than a systematic approach to situation or problem. There is involvement in personal experiences and an emphasis on feeling over thinking. The role of the teacher is to describe the activity while the students perform. Creative work involves a certain amount of pre-existing domain knowledge and its transformation into new knowledge (Naikakoji, Yamamoto & Ohira, 1999).
b) Reflective observation – in this stage the learners make sense of the experience. They focus on understanding the meaning of ideas and concepts by careful observations. They are also concerned with how things happen by attempting to see them from different perspectives. Learning occurs as a result of patience, objectivity, careful judgement and observation. Reflection helps students break their experiences into parts and to categorize them for use in the next stage of learning. Students develop logical thoughts, verbalize those thoughts, relate to others in the group and compare experiences and opinions. The applications of classroom knowledge in the context of real world situations are the focus of learning (Arnold, Warner & Osborne, 2006). The role of the teacher is to promote an atmosphere of acceptance of individual participants and diverse thinking. . For learners to become creative in mathematics learning it is important for the teacher to design activities that help learners to construct meaning and think for themselves by having a critical mathematical eye (Jha, 2012)
c) Abstract Conceptualization – this is where the learner assimilates and distils the observation and reflections into a theory. The students come to understand the general concept of which their concrete experience was one example by assembling their experience into a general model. Abstract conceptualization requires student to use logic and a systematic approach to problem solving. There is emphasis on thinking manipulation of abstract symbols and tendency to neat and precise conceptual systems. The students share their reactions and observations about their experiences. The learners at this stage provide answers to the questions arising from the experiences by providing solutions and making generalisations. According to National Council of Mathematics Teachers (NCTM) (2000) the ability to solve a problem with several strategies or the ability to reach different answers in a specific task are valuable evidences of the development of mathematical reasoning.

d) Active Experimentation – emphasis in on practical applications, testing theories that lead into new experiences. In this stage students use the theories they developed during the abstract conceptualization stage to make predictions about the real world situations. They connect subject matter and life skills discussion to the larger world.Students' actions are a new concrete experience. The learners are expected to use or test the conclusion, generalizations and solutions in new situations (Kolb & Kolb, 2008). The learner involvement facilitates personal growth and skill development, giving a measure of empowerment to the learners. The learner therefore feels safe to take responsibility for their learning. The four learning stages are cyclic and continuous. Figure 2 shows these stages with the activity for each stage.

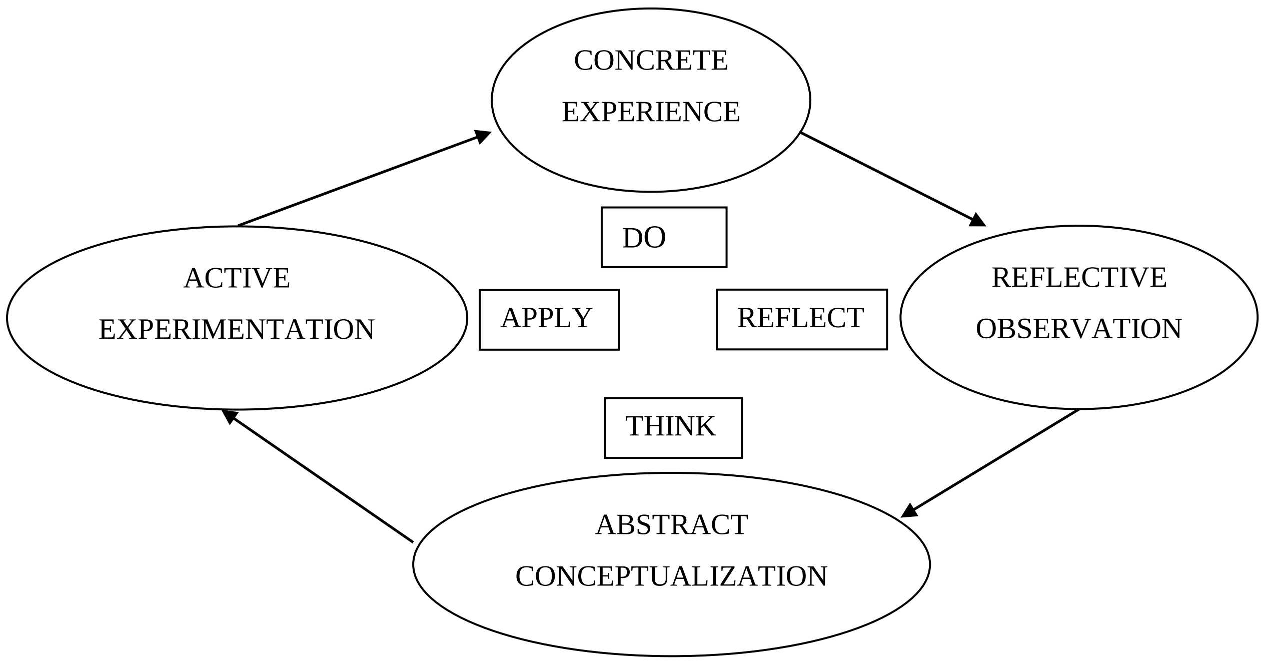


Figure 2: Stages of the Learning Cycle

The second word in each of the four stages indicates what the learner experiences. The learner begins by having an experience that involves him or her in a situation (experience) and then reflects on the experience from several perspectives (observation). From these reflections the learner draws concepts or conclusion and formulates them into theories or models (conceptualization) that lead them to experiment or act (experimentation). In order to develop Mathematical Creativity emphasis is placed on creating authentic learning situations where learners are thinking, feeling and doing what practicing professionals do (Renzulli, Leppien & Hays, 2000) thus ELA provides such a situation.

Moon (2004) has elaborated on this cycle arguing that experiential learning is most effective when it involves a reflective learning phase, a phase of learning resulting from the actions inherent to experiential learning and a further phase of learning from feedback.This process of learning can result in changes in judgement, feeling or skills for the individual (Chickering, 1977). The teacher is seen as an agent assisting in educational experiences and making connections between prior knowledge and new learning. The reflective observation component encourages students to critically examine a concrete experience (Zilbert & Leske, 1989). This reflection period forces students to take responsibility for their own learning and engages the learner mentally and emotionally in the recent experience. Reflection is a crucial part of the experiential learning process, and like experiential learning itself it can be facilitated or independent. Dewey wrote that "successive portions of reflective thought grow out of one another and support one another," creating a scaffolding for further learning and allowing for further experiences and reflection (Kompf & Bond, 2001). This reinforces the fact that experiential learning and reflective learning are interactive learning processes and the learning builds and develops with further reflection and experience. The use of abstract conceptualization allows students to make generalizations about principles related to the experience and strive for improvement. Active experimentation requires the transfer and application of principles to a new situation.

2.8.1 The Experiential Learning Model and Learning Styles

Experiential Learning Theory (ELT) defines learning as the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience. The ELT model portrays two dialectically related modes of grasping experience that is Concrete Experience and Abstract Conceptualization and two dialectically related modes of transforming experience that is Reflective Observation and Active Experimentation. According to the four stage learning cycle, immediate or concrete experiences are the basis for observations and reflections. These reflections are assimilated and distilled into abstract concepts from which new implications can be actively tested and serve as guide in creating new experiences. Figure 3 illustrates the dialectic relationships.

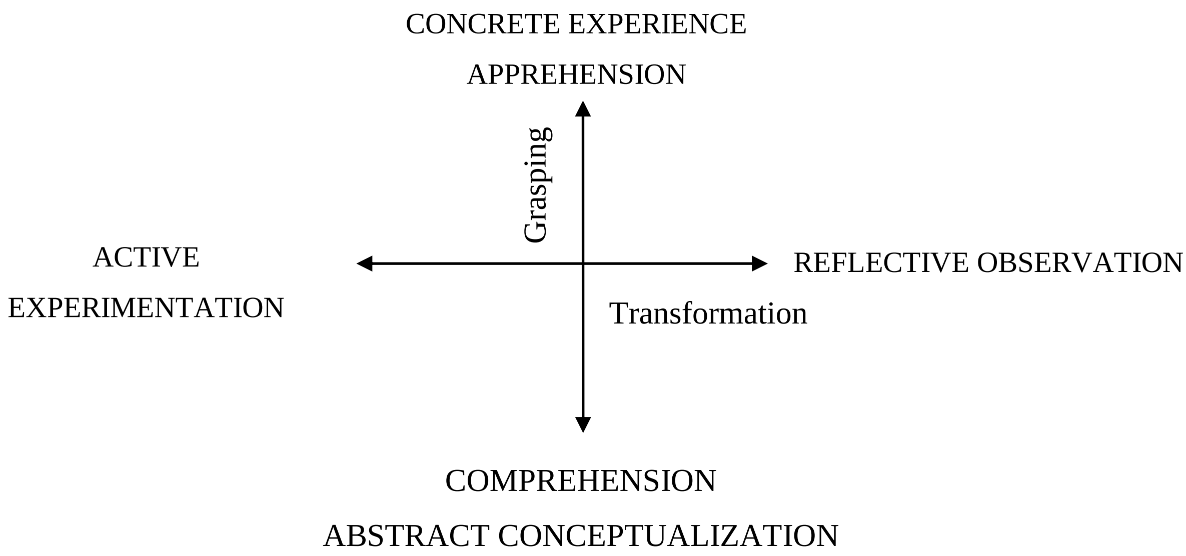


Figure 3: Dialectic Relationship in Kolb's Experiential Learning Model

The first dialectic occurs when a learner has a first-hand experience, which Kolb (1984) referred to as apprehension, and grasps the essence of the experience through abstract conceptualisation which he labelled Comprehension. The second dialectic, transformation occurs between active experimentation and reflective observation. Concrete experience and active experimentation are external while abstract conceptualization and reflective observation are internal learning activities (Kolb, 1984). Learning requires abilities that are polar opposites, and that the learner must continually choose which set of learning abilities he/she will use in a specific learning situation. In grasping experience some people perceive new information through experiencing the concrete, tangible, felt qualities of the world relying on senses and immersing themselves in concrete reality. Others tend to perceive, grasp' or take hold of new information through symbolic representation or abstract conceptualization, thinking about, analysing or systematically planning rather than using sensation as a guide.

Similarly in transforming or processing experience some people tend to carefully watch others who are involved in the experience and reflect on what happens while others start doing things. The watchers favour reflective observation while doers favour active experimentation. Each dimension of the learning process presents a choice. Conflicts between concrete or abstract and between active or reflective are resolved in some patterned characteristic ways. These patterned ways are known as "learning styles". Kolb (1984) found that learners did not use all four learning stages equally, but preferred to concentrate on one or two of them. Kolb identified and described four learner preference groups based on a set of questions called the learning style inventory. These groups are divergers, assimilators, convergers and accommodators. Understanding the preferences is critical to understanding how students may respond to lessons designed specifically for each stage (Knud, 2007). Figure 4 presents the learning styles fitted into Kolb's stages of the learning cycle.

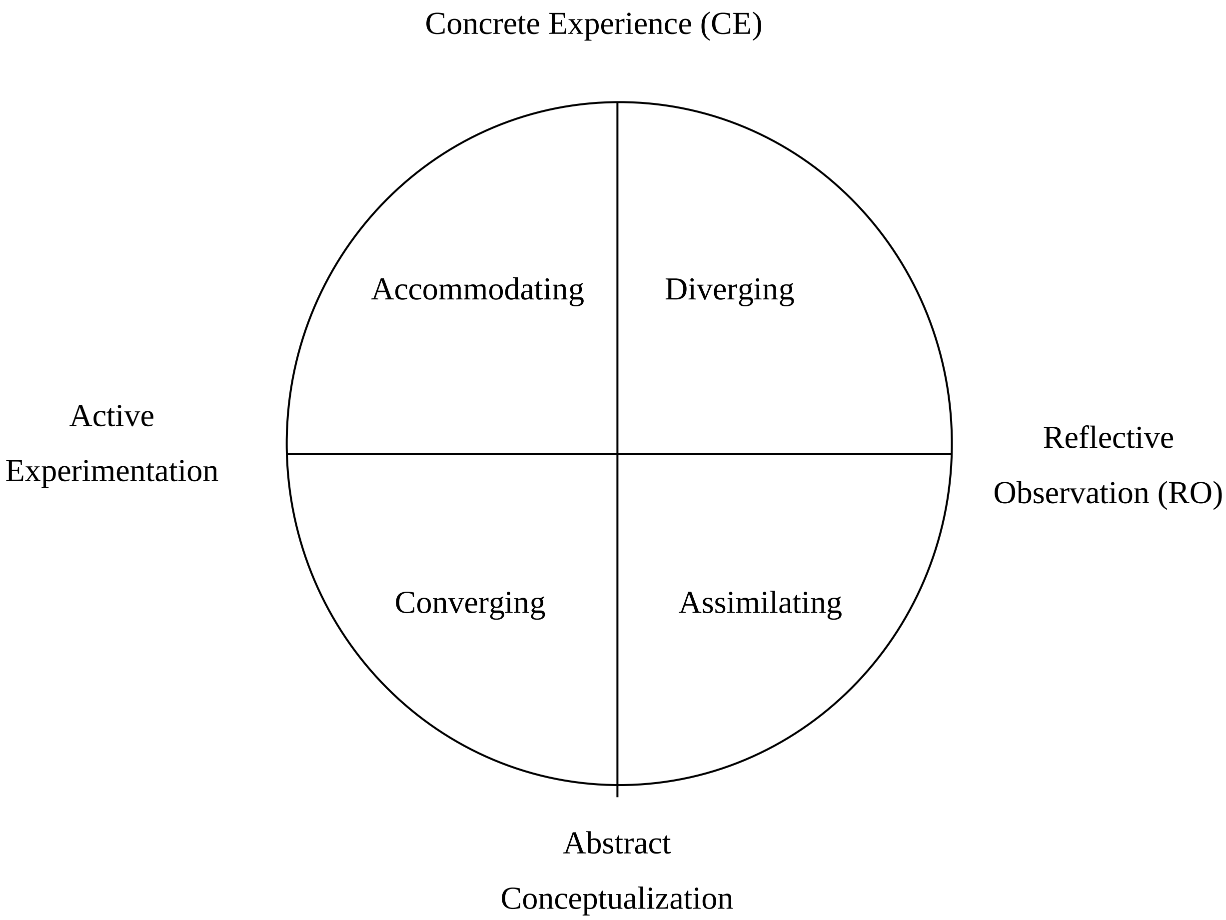


Figure 4: The Four Learning Styles in Kolb's learning cycle

(modified from Kolb, 1984)

i. Diverging - the diverging style dominant learning abilities are Concrete Experience and Reflective Observation. Divergers are particularly adopted at viewing a situation or problem from many perspectives. They perform better in situations that call for generation of ideas such as brainstorming sessions. They have broad cultural interests and like to gather information. They also have interest in people, are imaginative and emotional. In mathematical context these learners could be referred to as allegorizers.

They consider new ideas to be reformulation of known ideas. Divergent thinking is a potential for mathematical creativity and problem solving (Runco,2008).

ii. Assimilating – the assimilating styles dominant learning abilities are Reflective Observation and Abstract Conceptualization. Assimilators are best at understanding a wide range of information and putting into concise, logical form. They are less focused on people and more interested in ideas and abstract concepts. In the Mathematical context they are referred to as analyzers. These learners desire logical explanations and algorithms. They solve problems with a logical step by step progression that begins with the initial assumptions and concludes with the solution (Runco, 2008. Sheffield, 2009).

iii. Converging – the converging styles dominant learning abilities are Abstract Conceptualization and Active Experimentation. Convergers are best at finding practical uses for ideas and theories. They have the ability to solve problems and make decisions based on finding solutions to questions or problems. These are the synthesizers in mathematics. These learners see concepts as tools for constructing new ideas and approaches. They solve problems by developing individual strategies and approaches (Runco, 2008. Sheffield, 2009).

iv. Accommodating – the accommodating styles dominant learning abilities are Concrete Experience and Active Experimentation. Accommodators have the ability to learn from primarily hands-on experience. They enjoy carrying out plans and involving themselves in new and challenging experiences. They are risk takers. In problem solving, accommodators rely more heavily on people for information than their own technical analysis. These are the intergrators in mathematical context. These learners rely heavily on comparisons of new ideas to known ideas. They address problems by relying on common sense insights that is by comparing the problems to problems they can solve (Runco, 2008. Sheffield, 2009). The description of these four learning styles is shown in Table 5

Table 5

Description of the Four Learning Styles

Learning Style	Learning Abilities	Description
Diverging	Concrete Experience Reflective Observation	• Strong in imaginative ability • Good at generating ideas and viewing things from different perspectives • Broad cultural interests
Assimilating	Reflective Observation Abstract Conceptualization	• Strong ability to create theoretical models • Excels in inductive reasoning • Concerned with abstract concepts rather than with people
Converging	Abstract Conceptualization Active Experimentation	• Strong in practical application of ideas • Can focus on hypo deductive reasoning on specific problems • Unemotional • Has narrow interests
Accommodating	Active Experimentation Concrete Experience	• Action oriented • More of a risk taker • Perform well when required to react to immediate circumstances • Solve problems intuitively

Source: Kolb (1984)

The learning strategies that provide opportunities for Concrete Experience include experiments, observations, simulations, fieldwork, storytelling, newspaper and journal articles, examples, problem sets, surveying and reading texts. For Reflective Observation the techniques include discussions, brainstorming, thought questions and rhetorical questions. Techniques that provide opportunity for Abstract conceptualization include listening to lectures, seeking out and critiquing models in texts or articles from other students, building maps or models and construction analogies, generating hypotheses and projects. As for Active Experimentation doing simulation case studies, fieldwork, assignments, projects and conducting experiments are appropriate (Brock, 1999; Kelly & Kolb, 2002; Lombari, 2007; Wambugu, 2011). These are guidelines and techniques which could be used in each stage in order to successfully apply Kolb's learning cycle.

2.9 Experiential Learning and the Teaching and Learning of Mathematics

Mathematics can be found in virtually ever aspect of the world around us and im most human endeavors. Experiential Learning in mathematics class allows students to discover this for themselves. Experiential Learning activities are inherently interesting for most students and promote an appreciation for the usefulness of mathematics. At the beginning of a Mathematics class students are presented with sample ideas for their experiential project along with a scoring rubric so that they understand how to receive full credit. The students are then taken through the experiential learning cycle activities. At the end all students complete a narrative self evaluation that invites them to comment on what they found particularly helful and its application to real life (Stogsdill, 2014).

Kolbs learning styles can be interpreted as mathematical learning styles as follows:

- **Allegorizers –** these students consider new ideas to be reformulations of known ideas. They address problems by attempting to apply known techniques in an adhoc fashion. They may approach problems by trying to mimic an example in the textbook.
- **Intergrators –** these students rely heavily on comparisons of new ideas to known ideas. They address probems by relying on their 'common sense' insights for example comparing the problems to problems they can solve.
- **Analyzers –** these students desire logical explanations and algorithms. They solve problems with a logical step by step progression that begins with the initial assumptions and concludes with the solution.
- **Synthesizers –** these students see concepts as tools for constructing new ideas and approaches. They solve problems by developing individual strategies and approaches.

It is necessary to pay deeper attention to train teachers especially improving teachers' ability to design and implement educational environments that promote creativity in mathematics. In such environments seeing a problem from different aspects is not only not rejected but also alternative ideas are appreciated. Teachers should guide students through asking suitable questions so they acquire enough experiences for constructing mathematics concepts and ideas on their own and give them opportunity to reflect on them and their relations for the purpose of emerging a new idea for solving the problem. In order to do mathematics and think as mathematicians, students should be given opportunities to learn to search, explore, make conjectures, hypothesize, examine, refute, adapt strategies, devise plans, conclude, reason and justify their conclusions and reflect on them, monitor, and experience the processes that mathematicians have gone through. Thus, teachers should adapt teaching approaches that acknowledge students‘ potential for generating multiple solutions to a given problem rather than to emphasize just on following algorithms, rules and procedures for finding a single correct answer to the problem without considering the essence of mathematics. Teachers help students to discover mathematical knowledge and apply them in new problem situations in order to generate insightful solutions to the problem. Teachers, whose approaches are based on guiding students to think creatively and flexibly about mathematical ideas, establish classroom environments in which students have shared their insights and ideas. In such environments, teachers do not tell students the solution, instead, through offering some necessary hints which are of great help to students help them to engage in challenging problem solving situations and reflect on their own ideas in order to gain a new insight into the problem. This way, students are encouraged to take risks, make mistakes and have chance to investigate alternative pathways. Planning and implementing such learning environments would lead to the development of creativity in mathematics. In reality, nevertheless, not paying attention to such learning environments is a truth that should be clarified by formal structure of school education (Hong & Milgram, 2008).

2.10 Theoretical Framework

The study was based on the constructivist theory of learning by Bruner (1960). Constructivism emphasizes on construction of knowledge by the subject in a personal manner in a given social-cultural setting (Jha, 2012). The teacher serves as a facilitator who attempts to structure an environment in which the learner organises meaning at a personal level. Three basic principles in Constructivism are:

- Instruction must be concerned with the experiences and contexts that make the student willing and able to learn (readiness, not pretending to learn, application in context, the creation of social products).
- Instruction must be structured so that it can be grasped by the student (spiral organisation, manageable chunks and integration).

- Instruction should be designed to facilitate extrapolation and or fill in the gaps (going beyond the information given; using inituition, haunches and imagination) (Christie, 2005).

According to Good and Brophy (2003) constructivist model of learning is one that emphasizes learners' active construction of new meanings or new knowledge through a process that link new knowledge to prior knowledge. The construction of knowledge is an effortful process requiring significant mental engagement by the learner. In the constructivists' model, students actively mediate the input by trying to make sense of it and relating it to what they already know about the topic (Wachanga, 2005). This constructivist process is important because students build their own representation of new learning which would otherwise have been retained as relatively meaningless and inert rote memory (Good & Brophy, 1995).

Views of constructivism include the fact that knowledge can never be totally transferred to another person; knowledge is as a result of a person's interpretation of experiences influenced by factors such as age, gender, race or knowledge base. In essence some aspects of it are lost during translation when knowledge is transferred. Secondly, individuals make observations, test hypotheses and draw conclusions about events that are consistent with one another. This leads to consensus about different people's view of the world. Thirdly it has to do with the formation and changing of knowledge structures, addition to, deletion from and modification of these interpretations (Joyce & Weil, 1980).

The learner needs to be actively involved in the learning process. Learners construct their own understanding and they do not simply mirror and reflect what they need. They look for meaning and will not try to find regularity and order in the events of the world even in the absence of full or complete information (Wambugu, 2011). The teacher in this case adapts the role of a facilitator to allow learners to get their own understanding of the content. Furthermore it is argued that the responsibility of learning should reside increasingly with the learner (Glaserfield, 2009).

Driver (1986) explains that in the constructivist theory learning outcome depends not only on the learners' knowledge but also the environment. It is from the environment that learners have concrete experience and come face to face with specific events or find themselves involved in designated learning activities. ELA is a strategy which enables learners to reflect and construct meaning through the abstract conceptualization. During the last stage of the ELA cycle learners are expected to use or test conclusions, generalisations, hypotheses and solutions in new situations. They also apply the new ideas in real life situations. Students are responsible for their learning in that they have to direct their attention to the learning task, draw on their present knowledge to construct meaning for themselves and evaluate that meaning (Driver, 1986). Thus the teaching tasks involve students to organize their own experiences successfully in a way that makes sense to them.

2.11 Conceptual Framework

In this study the independent variables were Experiental Learning Approach and the Conventional Teaching Methods. The dependent variables were Mathematical Creativity and achievement in Mathematics. The intervening variables were teachers, characteristics and learners' characteristics. The framework is represented diagrammatically in figure 5.

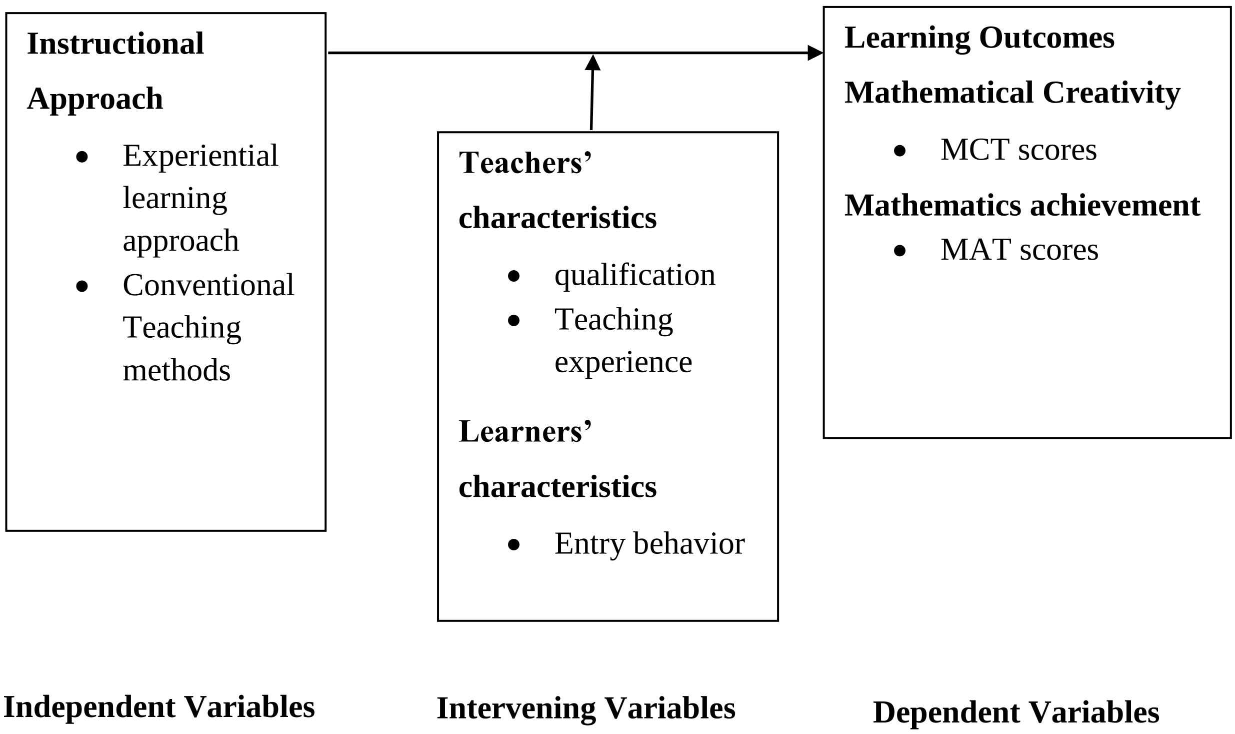


Figure 5: The Interaction between Variables of the Study

Learning outcomes are influenced by various factors. These include learner characteristics and teacher characteristics. These are intervening variables which have to be controlled. Teachers training and experience determines the teaching approach a teacher uses and how effective the teacher will use the approach. To control for teachers characteristics as threats of internal invalidity only teachers of equivalent training and experience of three years and above was used.To control for learners entry behaviour the same category of schools was selected.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter deals with the description of the procedures followed while conducting the research. The chapter describes the research design, specifies location of study, the target and accessible population as well as its characteristics. It also outlines the sampling procedures, sample size, the instruments used in data collection and their validation, data collection procedures and finally the statistical methods that were used in data analysis.

3.2 Research Design

The study involved Quasi-experimental research in which the researcher used the Solomon Four Non-Equivalent Control Group Design. The design is considered rigorous enough for experimental and quasi-experimental studies. The secondary school classes once constituted exist as intact groups and school authorities do not normally allow such classes to be broken up and reconstituted for research purposes (Borg & Gall, 1989; Fraenkel & Wallen, 2000). This design has an advantage over others since it controls the major threats to internal validity except those associated with interaction and history, maturity and instrumentation (Cook & Campbell, 1979). Figure 6 presents Solomon Four Non-Equivalent Group Design.

Group 1	O_1	X	O_2
Group 2	O_3	-	O_4
Group3	-	X	O_5
Group4	-	-	O_6

Figure 6: Solomon Four Non-Equivalent Control Group Research Design
(Source: Cohen & Manion, 1994; Gall, Borg & Gall, 2007)

Key

Pre-tests: O_1 and O_3Treatment: X

Post-tests: O_2, O_4, O_5 and O_6 No pre-test or no treatment: ___

Experimental groups: Group 1 and group 3

Control groups: Group 2 and Group 4

Non-equivalent control groups: - - - - - - - - - - - - -

In this design, to control for interaction between selection and interactions the schools were randomly assigned to control and treatment groups while that of interaction between selection and instrumentation was controlled by ensuring that the conditions under which the instruments were administered were kept as similar as possible in all the schools (Borg & Gall, 1989; Zechmesh & Shanghnessy, 1994). The effect of maturation was taken care of by the short time the study took. Solomon Four Non Equivalent Control Group Design has been used successfully in studies to determine the effect of teaching approaches on student achievement in Kenya (Wambugu&Changeiywo, 2008; Wachanga&Mwangi, 2004; Keraro, Wachanga&Orora, 2007). This design is designed to deal with a potential testing threat which occurs when the act of taking a test affects how people score on a pre-test or post-tests (William &Trochim, 2006). According to Gall, Borg and Gall (2007), this design helped achieve four main purposes;

i. To assess the effects of the experimental treatment relative to the control condition.
ii. To assess the interaction between pre-test and experimental conditions.
iii. To assess the effects of the pre-test relative to no pre-test.
iv. To assess the homogeneity of the groups before administration of the treatment.

3.3 Location of the Study

The study was carried out in Kericho East Sub county, Kericho County. The sub county of Kericho County has all categories of schools that is Extra County, County and Sub County secondary schools. There are 30 secondary schools in the sub county. Among the registered secondary schools four are boys only, seven are girls only and 19 are Sub-county co-educational secondary schools. The large number of co-educational secondary schools in the sub county was suitable for the study. The problem being addressed can be adequately solved by using the schools in this area. The students performance in mathematics is generally low and therefore there is need to improve it by using appropriate teaching strategies.

3.4 Target and Accessible Population

The target population was all the form two students Kericho East Sub County. The accessible population was that of Form Two students in Sub-county Co-educational schools since the topic selected for study was that of Statistics I which is covered in Form Two as per the KIE syllabus.

3.5 Sampling Procedures and Sample Size

A list of all Sub-county secondary schools in Kericho East Sub County was obtained from the District Education Office (DEO). Preliminary information on mathematics teachers’ qualification and experience and learner characteristics was obtained from these schools. Based on the preliminary information collected, a provisional list was drawn and the schools visited to ascertain that they were suitable for the study. The list of 19 Sub-county coeducational secondary schools in Kericho East sub county formed the sampling frame. The unit of sampling was the schools rather than individual learners because secondary schools operate as intact groups (Borg & Gall, 1989).

Based on the design adopted four (4) Co-educational Sub-county secondary schools were purposively selected. Purposive sampling technique was preferred to enable selection of schools with a relatively same number of boys and girls and to enable the selection of schools which are far apart from each other to eliminate contamination from the experimental groups to the control groups. The students admitted to the Sub-county co-educational schools have comparable academic abilities arising from the selection process after Kenya Certificate of Primary Education Examinations. After identifying the schools they were then randomly assigned into treatment and control groups. Each school provided Form Two class to participate in the study. In case of schools with more than one stream per class, all streams took part in the study and simple random sampling was used to pick one stream for purposes of data analysis. Fraenkel and Wallen (2000) recommend at least 30 subjects per group. In this study however 168 students were selected for the study. They were distributed as shown in Table 6.

Table 6

Distribution of Students who Participated in the Study

	Male	Female	Total
Experimental Group	39	48	87
Control Group	39	42	81
Total	78	90	168

3.6 Instrumentation

The researcher developed a teachers manual which was used to train teachers in the experimental schools. The teachers manual assisted the mathematics teachers in the experimental schools plan and implement the teaching and learning programme based on the Experiential Learning model. The manual was organised into the following areas: planning for instruction, Instructional objectives, theory and practice of Experiential learning and the units to be covered in the study.

Data was collected using Mathematical Creativity Test (MCT) and Mathematics Achievement Test (MAT). The MAT was developed by the researcher based on past KCSE papers.The MATcontained nine items adapted from KCSE past papers and modified to make them suitable for the study. The test assessed the students' general achievement before the treatment and also the conceptual understanding of the topic Statistics1 in Form Two. The test had a maximum score of 50 marks.

The researcher adapted the Creative Ability in Mathematics Test (CAMT) tool developed by Balka (1974) in developing the MCT. The MCT contained five items assessing the four dimensions of creativity namely fluency, flexibility, originality and elaboration. The items were scored as follows

Fluency was measured by the number of relevant responses or number of problems a student generated. The learners were tested using open ended questions so that they could give as many answers as they could think of and also they were required to set questions from some given data.

Flexibility was measured by the number of relevant categories of the responses.The responses given under fluency were put into various categories nand marks awarded for each category.

Originality scores were based on category weights that reflect the percentage of sample population that will provide an answer within a particular category.

Elaboration was based on the number of details in solving a problem. These include number of steps in solving the problems and building on ideas.

3.6.1 Validity

The MAT and MCT were validated by education experts from the Department of Curriculum Instruction and Educational Management of Egerton University. Mathematics teachers from selected secondary schools also helped in ensuring face(relevance) and content validity of the instruments.

3.6.2 Reliability

To estimate the reliability of the instruments it was administered on Forty Five (45) respondents selected from a secondary school which did not participate in the study. The pilot testing was carried out in the neighbouring Kericho West sub county in which learners were assumed to have similar academic abilities to those from Kericho East Sub County and the school having similar characteristics to those used in the study. Kuder Richardson (K-R 21) was applied to calculate the reliability index for the MAT (Nkapa, 1997; Popham, 1990). The formula is suitable when the test items are dichotomous and can be scored as correct or incorrect and was therefore appropriate since the test items were objective questions which can be scored either as wrong or right.

K-R 21 reliability coefficient = $\frac{K}{K-1}\left(1 - \frac{M(K-M)}{KS^2}\right)$

where

K – no. of items in the test

M – Mean of the set of test scores

S – Standard deviation of test scores

The reliability of the MAT was calculated as 0.978 using the KR 21 reliability coefficient formula which was considered appropriate because it was greater than 0.7.

The reliability of the MCT was estimated using the Cronbach's alpha coefficient. The method was suitable because the test items had a range of scores. A reliability measure of 0.778 was established and it was considered appropriate since its above 0.7 (Fraenkel & Wallen, 2000).

3.7 Data Collection Procedures

Prior to data collection the researcher obtained clearance from Board of Post Graduate Studies Egerton University to collect data. The researcher also obtained a permit from the National Commission of Science, Technology and Innovation (NACOSTI). The researcher then notified and obtained preliminary information from the county director of Education in Kericho County. This information assisted in the sampling process. The researcher then sought permission from the head teachers of the sampled schools and carried out induction on the mathematics teachers on the expectation and procedures of ELA. Group I and II were given a pre-test before the start of the treatment. This was then followed by the treatment which took three weeks. After the treatment the researcher with the assistance of the mathematics teachers administered post-tests to the four groups. The researcher then scored the MAT and MCT and generated quantitative data which was analysed.

3.8 Data Analysis

The data collected was analysed using both descriptive and inferential statistics. The hypotheses were tested at 0.05 alpha (α) level of significance. To test for differences in mean scores between experimental and control groups t-test andANOVA was used. The analysis was done with the help of Statistical Package for Social Sciences (SPSS) version 21 program. Table 7 summarizes the variables and statistical techniques which were used in this study.

Table 7

Summary of the Variables and Statistical Tests of the Study

Hypothesis	Independent Variable	Dependent Variables	Type of test Statistics
H_o1: There is no statistically significant difference in students' mathematical Creativity between those taught through Experiential Learning Approach and those taught through conventional methods	ELA CTM	Post-test scores on MAT	ANOVA
H_o2 There is no statistically significant difference in mathematical creativity of students taught through experiential learning approach by gender	Gender	Post-test scores on MCT	t-test
H_o3: There is no statistically significant difference in students' mathematics achievement between those taught through experiential learning and those taught through conventional methods	ELA CTM	Post-test scores on MCT	ANOVA
H_o4: There is no statistically significant difference in mathematics achievement of students taught through experiential learning approach by gender	Gender	Post-test scores on MAT	t-test

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents findings of the study in the form of tables , interprets them and discuss them. The chapter presents the results of the MCT and MAT Pretest and their implications, the MCT and MAT posttest results for all the groups and the comparison of the results by gender.

4.2 Results of the Pretest

The research design employed in this study allowed the use of two groups to sit for pre-tests. Experimental Group 1 and Control Group 1 sat for the pre-tests MCT and MAT. The pretest enabled the researcher to find out if the groups were comparable/equivalent before the administration of the treatment. Table 8 shows the pre-test means and standard deviation on MCT and MAT of Experimental Group 1 and Control Group 1.

Table 8

Comparison of Pre-test Means and SD on MAT and MCT

Variable	Group	N	Mean	SD
MCT	E_1	45	22.5556	2.6505
	C_1	41	23.4146	4.1712
MAT	E_1	45	12.5333	3.1378
	C_1	41	11.4634	2.7120

MAT maximum score =50

MCT maximum score =75

The results in Table 8 show that the mean scores and standard deviation of the pre-test of E1 and C1 were different for both MCT and MAT. A t-test was undertaken to determine whether the differences were statistically significant at the 0.05 level of significance.Table 9 shows the t-test results of the pre-test mean scores on MAT and MCT for E1 and C1.

Table 9

Independent Samples t-test of the Pre-Test mean Scores on MAT and MCT

Variable	Group	N	Mean	SD	Df	T	Sig. (2-tailed)
MAT	E1	45	12.5333	3.1378	84	1.684	.096
	C1	41	11.4634	2.7120			
MCT	E1	45	22.5556	2.6505	84	-1.150	.253
	C1	41	23.4146	4.1712			

Comparison of the MAT and MCT pretest results in Table 9 for groups E1 and C1 showed that $t(84) = 1.684$, $p>0.05$ for MAT and $t(84) = -1.150$, $p>0.05$ for MCT indicating that there was no statistically significant difference between the groups in both MAT and MCT scores. Since the difference between E1 and C1 MAT and MCT scores were not statistically significant the two groups used in the study exhibited comparable characteristics and therefore suitable for the study.

4.3 Effects of ELA on Students' Mathematical Creativity

To determine the relative effect of ELA on Mathematical Creativity an analysis of the students post test MCT scores was carried out. Hypothesis H_o1 of the study sought to find out whether there was any statistically significant difference between mathematical creativity of students who were exposed to ELA and those who were not. Table 10 shows the MCT post test mean scores obtained by the students in the four groups.

Table 10

MCT Post-test Mean Scores obtained by the Students in the Four Groups

	N	Mean	SD
Experimental Group 1	45	35.5333	9.4643
Control Group 1	41	26.0244	4.4637
Experimental Group 2	42	32.7857	8.2033
Control Group 2	40	24.9750	4.0604
Total	168	30.0119	8.2990

Table 10 indicate that the MCT mean scores for the Experimental groups E1 and E2 were higher than those of the Control groups C1 and C2. The students in E1 and E2 were exposed to ELA and their MCT mean scores were higher than those in C1 and C2. This shows that ELA had an effect of enhancing Mathematical Creativity as compared to CTM. To establish whether the MCT mean scores were statistically significantly different ANOVA was done and the results are shown on Table 11

Table 11

ANOVA of the Post-test Scores on MCT

	Sum of Squares	Df	Mean Square	F	P-Value
Between Groups	3361.754	3	1120.585	22.576	.000
Within Groups	8140.222	164	49.636		
Total	11501.976	167			

Table 11 ANOVA results show that that F(3,164) =22.572, p<0.05 indicating that the differences in post-test scores of MCT for the four groups were statistically significant. Since the differences in MCT mean scores were statistically significant Ho1 which stated that there is no statistically significant difference in students' mathematical creativity between those taught through Experiential Learning Approach and those taught through Conventional Methods was thus rejected. To determine where the significant difference was, a Post Hoc multiple comparisons analysis was carried out. The tests were conducted using Tukeys post-hoc analysis tests of multiple comparisons. Tukeys analysis was preferred for this study because the group sizes were unequal and multiple comparisons were being made. Whenever there is a significant difference between the means of different groups, this test in particular shows where the differences occurred. The results of the Tukeys analysis are presented in Table 12.

Table 12

Tukeys post-hoc Pairwise Comparisons of the Post-Test MCT for the Four Groups

		Mean Difference (I-J)	SD	P-Value
E1	C1	9.5089*	1.5211	.000
	E2	2.7476	1.5116	.269
	C2	10.5583*	1.5310	.000
C1	E1	-9.5089*	1.5211	.000
	E2	-6.7613*	1.5467	.000
	C2	1.0492	1.5657	.908
E2	E1	-2.7476	1.5116	.269
	C1	6.7613	1.5467	.000
	C2	7.8107*	1.5565	.000
C2	E1	-10.5583*	1.5301	.000
	C1	-1.0494	1.5657	.908
	E2	-7.8107*	1.5565	.000

* The mean difference is significant at the 0.05 level.

The post-hoc results indicate that the differences in MCT mean scores of groups E1 and C1, E1 and C2, E2 and C1 and E2 and C2 were statistically significant at $p<0.05$, however there was no statistically significant difference in the means between groups E1 and E2 and groups C1 and C2. The results of the post hoc comparisons confirmed that ELA had a positive effect on students mathematical creativity.

The study found that students who were taught using ELA achieved significantly higher scores in MCT than those who were taught through the conventional methods as shown in Table 12. This is an indication that the use of ELA was more effective in improving students' mathematical Creativity as compared to the conventional teaching/learning methods. Therefore use of ELA gives learners an opportunity to become creative in mathematics by constructing meaning and having a critical mathematical thinking. ELA also helps students to develop abilities to solve problems with several strategies or the ability to reach different answers in a specific task which are valuable evidences of the development of mathematical reasoning. Mathematical Creativity at classroom setting is the process that results in novel and insightful solutions to a given problem and the formulation of new questions and possibilities that allow an old problem to be regarded from a new point of view (Sriraman, 2005). The concern on mathematical creativity is the ability to generate ideas from given information. Thus it is appropriate that students should at least be given the opportunity to examine a wide variety of enrichment problems in mathematics. By providing divergent responses in unconventional questions and other problem-solving experiences, mathematical creativity can be explored to the fullest.

There is need therefore to come up with teaching methods that will enhance Mathematical Creativity and the use of ELA is just one such method. Experiential learning offers a critical link between the classroom and real world. The findings of this study are in agreement with those of Casanovas, Miralles, Gomez and Garcia (2010) who noted that science learning based on the experiential learning model promotes students instruction of scientific knowledge and increase the fluency and flexibility of ideas generated.

4.4 Effects ELA on Students' Mathematical Creativity by Gender

To determine whether there was any gender differences in Mathematical creativity between boys and girls exposed to ELA the analysis of post-test scores on MCT was done and the results are as shown in Table 13

Table 13

MCT post-test mean scores obtained by Students based on Gender

	Students Gender	N	Mean	S D
MCT	Male	39	34.7436	9.6046
	Female	48	33.7708	8.4280

Table 13 shows that the boys exposed to ELA had a higher mean score in MCT than the girls exposed to ELA. An independent t-test was thus carried out to establish whether the difference in the means was statistically significant. Table 14 shows the t-test of the post test scores on MAT for Experimental Groups 1 and 2 with regard to gender.

Table 14

Independent Samples t-test of the Post Test scores on MCT for the Experimental Groups based on Gender

	Gender	N	Mean	SD	df	T	p-value
MCT	Male	39	34.7436	9.6046	85	.503	.616
	Female	48	33.7708	8.4280			

Independent samples t-test of the post test scores on MCT for the Experimental Groups by gender shows that $t(85) = 0.503$, $p > 0.05$. This shows that there is no statistically significant difference between the groups in MCT scores. Both male and female students performed relatively the same. The hypothesis Ho2 that stated there is no statistically significant difference in students' Mathematical Creativity of students taught through experiential learning approach by gender was therefore accepted at 0.05 alpha level.

The findings of this study indicate that there was no statistically significant difference in mathematical creativity scores between male and female students taught through ELA. The results have also shown that both male and female students taught through ELA performed significantly better than their counterparts who were taught using conventional teaching methods. Therefore ELA has proved to be more effective in enhancing mathematical creativity for both male and female students.

The findings of this research are similar to the findings of Pooja (2012) and Ganihar et al., (2009) who noted that in general there is no gender differences in Mathematical Creativity. However girls surpass boys in flexibility dimension of mathematical creativity. One interpretation that might explain this gender difference is that males and females do extremely well in different aspects of creativity. This dissimilarity may be possible due to gender identity. A study in Spain on gender differences in mathematical creativity (Ai,1999) indicate that flexibility and elaboration is more important for males while fluency and elaboration is more important for females. ELA provided equal opportunities for both boys and girls to express themselves, reflect on their experiences, think critically and hence enhance their mathematical creativity.

4.5 Effects of ELA on Students' Mathematics Achievement

To determine the effect of ELA on students achievement in Mathematics, an analysis of the students post-test MAT scores was carried out. Hypothesis three (H_o3) of the research study stated that there is no statistically significant difference in students' mathematics achievement between those taught through experiential learning and those taught through conventional methods. To test this hypothesis an analysis involving ANOVA and Post Hoc tests were carried out. Table 15 shows the MAT post-test mean scores obtained by the students when the four groups were compared.

Table 15

MAT Post-test Mean Scores Obtained by the Students in Four Groups

	N	Mean	SD
E1	45	26.1333	6.36967
C1	41	19.5122	5.99634
E2	42	23.6667	5.46236
C2	40	19.1000	4.53363
Total	168	22.2262	6.34129

The means of the four groups were different. Experimental groups E_1 and E_2 achieved higher mean scores than control groups C_1 and C_2. The students in the Experimental groups were exposed to ELA and their mean scores were higher than those in the control groups. This shows that ELA had an effect of improving performance as compared to the conventional teaching methods. Table 15 shows higher mean score for E_2 compared to C_2, both groups were not pre-tested though E2 received treatment. It can be deduced that the treatment had a positive effect on the achievement of students in E_2. The control groups which did not receive treatment obtained lower mean scores than the experimental groups. If there was any pre-test effect on the pretested groups then the post test means of E1 and C1 would be much higher than E2 and C2.A comparison of the post test mean scores does not indicate any effect caused by the pre-test. ANOVA was also carried out to establish whether the difference in the groups mean scores on the MAT were statistically significantly as shown in Table 16.

Table 16

ANOVA of the Post-test Mean Scores on the MAT

	Sum of Squares	Df	Mean Square	F	p-value
Between Groups	1467.028	3	489.009	15.280	.000
Within Groups	5248.377	164	32.002		
Total	6715.405	167			

Table 16 ANOVA results show that that $F(3,164) = 15.280$, $p < 0.05$ indicating that the differences in post-test scores of MAT for the four groups were statistically significant. Hence H_o3 which stated that there is no statistically significant difference in students' mathematics achievement between those taught through Experiential Learning Approach and those taught through conventional methods was thus rejected.Since there was a significant difference between the means of the groups, it was necessary to carry out post hoc comparisons test of MAT mean scores to establish where the differences occurred. The tests were carried out using Tukeys procedure at $p<0.05$ level because the group sizes were unequal. Table 17 shows the results of the Tukeys post-hoc test of MAT mean scores.

Table 17

TukeysPost Hoc Comparisons of the Post-test of MAT means for the Four Groups

		Mean Difference (I-J)	SD	p-value
E1	C1	6.6211*	1.2214	.000
	E2	2.4667	1.2137	.180
	C2	7.0333*	1.2293	.000
C1	E1	-6.6211*	1.2213	.000
	E2	-4.1545*	1.2419	.006
	C2	.4122	1.2572	.988
E2	E1	-2.4667	1.2137	.180
	C1	4.1545*	1.2420	.006
	C2	4.5667*	1.2498	.002
C2	E1	-7.0333*	1.2293	.000
	C1	-.4122	1.2572	.988
	E2	-4.5667*	1.2498	.002

*. The mean difference is significant at the 0.05 level.

The post-hoc comparisons showed that the mean differences between E1and C1(6.62), E1 and C2(7.03), E2 and C1(4.15) and E2 and C2(4.6) groups were statistically significant at $p<0.05$ level. However there was no statistically significant difference in the means between groups E1and E2(2.47) and groups C1 and C2(0.41). The results of the post hoc comparisons confirmed that ELA had a positive effect on students' achievement in Mathematics.

The study found that students who were taught using ELA achieved significantly higher scores in MAT than those who were taught through the conventional methods. This is an indication that the use of ELA was more effective in improving students' mathematics achievement as compared to the conventional teaching/learning methods. These findings are in agreement with findings of similar studies carried out earlier. Otaala (1999) in the study on improving academic teaching and learning stressed the use of Kolb's learning cycle to ensure that students reflect on their own experiences. The cycle should be followed by a consolidation which draws students into active work to explore the information and relate it to previous knowledge before moving to a new topic. This helps the students to maintain intrinsic motivation by application of learnt knowledge to real life situations (Zoldosava & Prokop, 2006).

Pascul and Uribe (2005) found that when experiential learning was used in an engineering course, there was consistent student participation. They found that experiential learning as an active instructional strategy improved academic performance and was stimulating for the teachers as the approach attained the stated outcomes. Studies on Experiential learning in Kenya show that students in Agriculture performed better than those taught using regular teaching methods (Ngesa, 2002). Other findings include those of Wambugu (2011) on experiential learning in physics education classrooms. The study findings showed that use of experiential learning improved achievement and motivation to learn physics in secondary schools.Arnold, Warner and Osborne (2006) in their study on Experiential Learning in Agricultural Education classroom, found out that use of this approach increased subject matter retention among students.

4.6 Effects of ELA on Students Achievement by Gender

Hypothesis Ho4 sought to establish whether there was a statistically significant gender difference in mathematics achievement when exposed to ELA. Table 18 shows the post test MAT mean scores for experimental groups 1 and 2 with regard to gender.

Table 18

Post Test Mean Scores on MAT for Experimental Groups Based on Gender

	Students Gender	N	Mean	SD
Mathematics Achievement	Male	39	26.2308	6.78412
	Female	48	23.8958	5.20736

Table 18 shows that the boys exposed to ELA had a higher mean score in MAT than the girls exposed to ELA. An independent t-test was thus carried out to establish whether the difference in the means was statistically significant. Table 19 shows the t-test of the post test scores on MAT for Experimental Groups 1 and 2 with regard to gender.

Table 19

Independent Samples t-test of the Post Test Scores on MAT for the Experimental Groups basedon Gender

	Gender	N	Mean	SD	df	T	p-value
MCT	Male	39	26.2308	6.7841	85	1.816	.073
	Female	48	23.8958	5.2074			

Independent samples t-test of the post test scores on MAT for the experimental groups by gender show that $t(85) = 1.816$, $p>0.05$.this shows that there is no statistically significant difference between the groups in MAT scores.Both male and female students performed relatively the same. The hypothesis Ho4 that stated there is no statistically significant difference in mathematics achievement of students taught through experiential learning approach by gender was therefore accepted at 0.05 alpha level.

The findings of this study have shown that there was no statistically significant difference between the achievement in mathematics of male and female students taught through ELA. The findings also indicate that both male and female students taught through ELA performed better than those taught through conventional methods. Therefore ELA proved toenhance achievement in mathematics more than the conventional teaching methods. Male and female students differ in their cognitive styles this may partly explain why male students have been performing better than female students. Male and female students perceive, process, store, transform and utilize information differently. However ELA gave the students equal opportunities to develop knowledge, skills and values through observation, simulation and participation that provides depth and meaning to learning experiences by engaging the mind heart and body through activities, reflection and application in a learning situation characterised by a high level of active involvement and personal responsibility (Zhang, 2008) hence the higher achievement for both boys and girls.One of the factors stated for keeping girls out of school is failure in mathematics and science (FAWE, 2007) therefore if teaching methods such as ELA are implemented they would be retained in class.The findings of this study agree with those of Mwangi (2013) and Ericikan, McCreith and Lapointe (2005) who found no significant gender difference in Mathematics achievement.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter covers the discussion of major findings of the study based on the four hypotheses that guided the study, conclusions of the study based on the research findings and generalized to form two mathematics students in secondary schools in Kenya. Implications of the findings of the study in mathematics education are also discussed in this section. Finally the recommendations for mathematics educators and all stakeholders on ELA are made and recommendations for further research are outlined.

5.2 Summary of the Findings

The findings of the study are presented according to Pretest, objectives, and the Hypotheses of the study. The following are the findings of the study:

i. The results of the pretest on MCT and MAT show that there was no significant difference in the means of the two groups; Experimental Group 1 and Control Group. These results imply the groups were of comparable ability hence suitable for the study.
ii. The results of the Post Test Mean Scores on MCT for the four groups were significantly different. Group E1 and E2 had means of 35.53 and 32.79 respectively while group C1 and C2 had means of 25.83 and 24.98 respectively. ANOVA results show that the difference in the mean scores between the four groups were significant. These results therefore indicated that ELA has a positive effect on students' Mathematical Creativity.
iii. The results of the post test of the MCT by gender show that there was no significant gender differences in mathematical creativity.
iv. The results of the analysis of post test scores on MAT for the four groups were significantly different. Group E1 and E2 had means of 26.13 and 23.66 respectively while C1 and C2 had means of 19.51 and 19.10 respectively. ANOVA results show that the difference in the mean scores between the four groups were significant. Tukeys post hoc analysis results on pairwise comparison revealed that there was a significant difference in favour of the experimental groups. This implies that ELA improved achievement in mathematics.
v. The results of the post test of the MAT by gender show that there was no significant gender differences in mathematics achievement between boys and girls taught using ELA.

5.3 Conclusions

Based on the findings of the study the following conclusions were made

i. ELA instructional approach produced a significant impact on mathematical creativity among secondary school students.
ii. Students' mathematical creativity when taught through ELA is not affected by gender.
iii. ELA instructional approach had a significant effect on mathematics achievement among secondary school students. This implies that it facilitates the learning of mathematics better than the conventional teaching methods.
iv. The students' achievement in Mathematics when taught through the ELA instructional approach was not affected by gender. Girls and boys who were taught using ELA achieved significantly better results than those taught through conventional teaching methods.

In summary, the findings of this study indicate that ELA improves both mathematical creativity and achievement in mathematics. The results also revealed that there is no significant gender differences in mathematical creativity and achievement in mathematics when students are taught using the Experiential Learning Approach.

5.4 Implications of the Findings

The findings of this study have indicated that the use of ELA instructional approach improves mathematical creativity and achievement. When this method is used, differences in mathematical creativity and achievement between boys and girls are levelled out. Thus the instructional approach should be incorporated into the teaching of mathematics at the secondary school level. This instructional approach is likely to assist in improving the performance of girls which has been low as compared to that of boys at KCSE mathematics examination. The improved performance will lead to a better representation of the females in the scientific arena.

Students taught through the ELA instructional approach performed better in the Mathematical Creativity Test hence therefore since mathematical creativity is an essential aspect in the development of mathematical talent the use of this approach should be encouraged in mathematics classrooms and the teacher education institutions should make it part of their teacher training curriculum content.

Achievement in Mathematics in the national examinations has been quite low. The findings of this study indicate that if ELA is used in teaching mathematics it would improve the performance of the students. In this approach students learn through experience as they conceptualize what they learn applying it to real life situations. ELA also enhances critical thinking. Thus therefore teachers should incorporate this approach as they prepare to teach.

ELA requires that students take a greater responsibility during the teaching and learning process. They have to participate in setting instructional objectives, gathering content and learning resources and sharing their experiences while teachers have a challenge in terms of time because ELA requires a lot of time in planning and implementation. The findings indicate higher mathematical creativity and improved achievement in mathematics.

5.5 Recommendations

Based on the findings of this study the following recommendations have been made;

i. Mathematical creativity is an important aspect of learning mathematics and should therefore be included in the teaching and learning process and be tested in the national examinations. ELA as an instructional approach has proved to enhance mathematical creativity therefore teachers should be encouraged to use this method.
ii. Teacher education programmes should focus on preparing teachers to acquire appropriate skills in instructional methods such as problem solving and other student centred methods such as ELA thereby enhancing achievement in mathematics.
iii. Textbooks' authors may need to incoorporate more student activities and learning experiences into books as experience and student centred activities play a central role in the learning process.

5.6 Suggestions for Further Research

The findings of the study indicate that ELA is effective in improving mathematical creativity and achievement in mathematics. However, the researcher identified areas that require further investigation.

i. A study on effect of ELA on mathematical creativity and achievement using other topics in mathematics other than the one used in the present study.
ii. To compare the effects of ELA on scientific creativity and achievement in science subjects that is Biology, Physics and Chemistry.

REFERENCES

African Curriculum Organization (ACO) (1979) *Basic Training Course in Systematic Curriculum Development* Nairobi, published by Kenya institute of education.

Aguele, L. I. & Agwagah. U. N. V (2007). Female Participation in Science, Technology and Mathematics, (STM) Education in Nigeria and National Development, *Journal of Social Science,* 15(2) 121-126

Ai, X. (1999).Creativity and Academic Achievement: An Investigation of Gender Differences. *Creativity Research Journal,*12(4), 329-337

Ajogbeje, O.J. & Omirin M.S (2013). A Causal Model of Selected Non-Cognitive Learners Variables and Achievement in Juniour Secondary School Mathematics. *Journal of Education and Practice*. 4(12) 1-9

Amadalo, M. M., Shikuku, B. N. &Wasike, D. W. (2012). Investigation of Factors that Influence Syllabus Coverage in Secondary School Mathematics in Kenya. *International Journal of Humanities and Social Science* 2(15) 51 – 59

Arnold,S., Warner, J.W., & Osborne, E.W (2006) Experiential Learning in Secondary Agriculture Education Classrooms.*Journal of Southern Agricultural Education Research.*30 56(1)

Atherton, J.S. (2009). *Learning and Teaching External Learning*http://www.learning and teaching.info/learning/experience.html.

Baber, R.L. (2011). *The Language of Mathematics: Utilizing Math in Practice.* John Wiley & Sons, 78-79

Balka, D. S. (1974). Creative Ability in Mathematics, *Arithmetic Teacher* 21' 633-636

Biehler, R. F. & Snowman, J. (1997).*Instructors Lecture Enrichment and Resource Manual to Psychology Applied to Teaching.* (8^{th}ed) Boston: Houghton Mifflin Company.

Binder, C. (1996).Behavioural Fluency.Evolution of a new Paradigm. *The Behavior Analyst.*19, 163-197.

Borg, W.R & Gall, M. D (1989).*Educational Research; An introduction (5^{th}ed)* white plains NY: Longman

Breakel, J. & Mutunga, P. (1992).*Mathematics Education.*Nairobi: The Jomo Kenyatta Foundation.

Brock, K.L. (1999).Enlivening Political Science Courses with Kolb's Learning Preference Model. Political Science and Politics *http://www.findarticles.com/cfo/m2139123215489543/print.jhtml*

Brunkalla, K. (2009). How to Increase Mathematical Creativity–an Experiment.*The Montana Mathematics Enthusiast.*6(1)

Burden, P. R. (1995).*Classroom Management and Discipline.*Methods to Facilitate Cooperation and Instruction.Newyork, NY: Longman Publishers.

Buschang, R. E., Chung, G. K. & Kim, J. (2011). An Exploratory Study of the Relationship between Collaboration and Mathematics and Game Outcomes, *National Centre for Research on Evaluation, Standards and Student Testing (CRESST) Report 797,* Los Angeles, CA

Cassanovas, M., Miralles, F., Gomez, M., & Garcia, R. (2010). Improving Creativity Results and its Implementation in Organization using Creative Technique through Experiential Learning Training. *Proceedings of the XXI ISPM conference* 2010, Bilbao.

Changeywo, J. M. (2001). Gender Perspectives in Science and Technology Education in Kenya. *Journal of Education and Human Rsources,* 1(1) 14 - 30

Chickering, A (1977). *Experience and Learning.* New York: Change Magazine Press.

Christie, A. (2005). Constructivism and Its Improvement for Educators

Cockroft, W.J (chair) (1982) *Mathematics Counts.(Reports of the committee of inquiry into the teaching of mathematics in schools in England and wales*). London : HMSO.

Cohen, L. & Manion, L. (1994). *Research Methods in Education.* Routledge Publishers.

Colwell, R. (2000). Third International Mathematics and Science Study (TIMMS). *The Newyork Times* 39 - 44.

Cook, T.D & Campbell (1979).*Quasi Experimentation: Design and Analysis Issues for Field Settings*. Newyork, NY: Rand McNally.

Craft, A. (2000).*Creativity Across the Primary Curriculum,* London: Routeledge.

Dean, P.G (1982) *Teaching and Learning Mathematics*.London Woburn Press.

Dembo, M. H. (1994). *Applying Educational Psychology* (5thed). White Plains NY: Longman Publishing Company.

Deryakulu, D., Sener. B., & Huseyin, O.(2010). Predictors of Academic Achievement of Student ICT Teachers with Different Learning Styles.*International Journal of Psychological and Behavioural Sciences.*2(3), 145-151

Driver, R. (1986).*Students' Thinking and Learning Science: a constructivist view of learning. SSR* (Mar 86), 443-456.

Ericikan, K., McCreith, T. &Lapointe,V. (2005). Factors Associated with Mathematics Achievement and Participation in Advanced Mathematics Courses; An Examination of Gender Difference from an International Perspective. *School and Mathematics. 105,5*

Ervynck, G. (1991). Mathematical Creativity.In D. Tall (Ed), *advanced Mathematical Thinking* 42-53. Kluwer Academic.

Eshiwani, G. S. (1984). *The Death of New Mathematics in Kenya*. The Bureau of Educational Research.Kenyatta University. Occasional Paper No. 3042

Eshiwani, G. S. (1993). *Education in Kenya Since Independence*. East African Educational Publishers Ltd. Nairobi.

FAWE (2007). Bringing Gender Responsiveness to African Education, Advocacy: Action and Impact. Annual Report Nairobi: Wambugu P. W.

Fennema, E and Leder, G C (Eds) (1990*) Mathematics and Gender* New York: Teachers college Press.

Fraenkel, J. R and Wallen, N.E (2000) *How to Design and Evaluate Research in Education.*NewYork, NY: McGrawhill Companies Inc.

Freiman, V. &Sriraman, B. (2007). Does Mathematics Gifted Education Need a working Philosophy of Creativity? *Mediterranean Journal for Research in Mathematics Education,* 6(1-2), 23-46

Gall, M. D. (2013).*The Discussion Method in Classroom Teaching.* University of Oregon: Maxwell Gillet.

Gall, M.D., Borg, W.R., & Gall, J.P. (2007). *Educational Research: An Introduction.* White Plains NY: Longman.

Ganihar, N.N., &Wajiha, A.H. (2009).Factors Affecting Academic Achievement of IX Standard Students in Mathematics.*Edutracks*, 8(7) 25-33

Gasca, A.M. (2011). Mathematicians and the Nation in the Second Half of the NineteenthCentury as Reflected in the Luigi Cremona Correspondence, S*cience in Context.* Pp43-47

Gill, E., Ben-Zvi, D., &Apel, N. (2007).What is hidden beyond the data? Helpingyoung students to reason and argue about some wider universe. In D. Pratt & JAinley (Eds.), *Proceedings of the Fifth International Research Forum on Statistical Reasoning, Thinking and Literacy: Reasoning about StatisticalInference: Innovative Ways of Connecting Chance and Data* (pp. 1-26). UK:University of Warwick http://srtl.stat.auckland.ac.nz/srtl5/presentations

Githua, B.N. (2001). Factors Affecting Teaching and Learning of Mathematics in Kenya Secondary Schools: *Unpublished paper Presented at Nakuru District Science and Mathematics Teachers Seminar,*Nakuru High School, 9th -12th April.

Githua, B.N (2002) *Factors Related to the Motivation to Learn Mathematics Among Secondary School Students in Kenya's Nairobi province and three Districts of Rift valley* unpublished Doctoral thesis, Egerton university Njoro Kenya.

Githua, B.N &Njubi, J.N (2013). Effects of Practicing Mathematical Creativity Enhancing Learning/Teaching Strategy During Instruction on Secondary School Students Mathematics Achievement by Gender in Kenya's Nakuru Municipality, *Asian Journal of Management Science and Education* 2(2) 113-124

Glasserfield, E. (2009). Relativism, Fascism and the Question of Ethics in Constructivism.*Constructivism Foundations.* 4(3), 117-120.

Good, T.L., &Brophy, J. (1995). *Contemporary Educational Psychology* (5th Ed.).longman Publishers: USA.

Good, T.L., &Brophy, J. (2003). *Looking in the Classroom.* Boston: Allan & Bacon.

Hollowell, K. (2013). *Cooperative Learning Strategies.*www.ehow.com/way 5519645 cooperative-learning-strategies-math.html

Hong, E. & Milgram, R. M. (2008). *Preventing Talent Loss.* NY.: Routledge.

Imai, T. (2000).The Influence of Overcoming Fixation in Mathematics towards Divergent Thinking in Open-ended Mathematics Problems on Japanese Junior High School Students.*International Journal of Mathematical Education in Science and Technology*.31, 187-193

Jha, A. K. (2012). Creative Epistemology and Creative Pedagogy: *Implications for Creative Mathematics Education*: Paper presented in the 8th Global Conference on Creative Engagements: Thinking with Children at Mansfield College, Oxford , UK

Johnson, D.A. & Rising, G.N. (1972).*Guidelines for Teaching Mathematics.* (2nded). Belmonte, California: Waldsworth.

Johnson, D. W. & Johnson, R. T. (1995).*Reducing School Violence Through Conflict Resolution.* Alexandria VA. USA: Association of Supervision and Curriculum Development (ASCD).

Jonnson, D. W., Johnson, R. T. & Smith, K. (1998). *Active Learning: Cooperation in the College Classroom.* Interaction Book Company: Edina, MN.

Joyce, B., & Weil, M. (1980).*Models of Teaching.* New Jersey, NJ: Prentice –Hall.

Kadir, A. & Maker. (2011). Exploring the Relationship Between Mathematical Creativity and Mathematical Achievement. *Asia –Pacific Journal of Gifted and Talented Education.* 3(1), 34-45

Karega, M. (2008).*Increasing Effectiveness of south –south Cooperation: the Case of SMASSE Kenya and SMASSE-WECSA*, for South-South Cooperation and the Launch of the Global South-South Development Expo on 18th December 2008 at U.N. Headquarters/New York

Kelly, C (1997). David Kolb;The Theory of Experiential Learning and ESL. *The internet Tesh Journal 3(9).*

Kelly, C., & Kolb, D (2002). The theory of Experiential Learning and ESL *http://www.aitech.ac.jp/-itesslj/articles/ Kelly-experiential*

Keraro, F.N., Wachanga, S.W., &Orora, W. (2007). Effects of Cooperative Concept Mapping Teaching Approach on Secondary School Students' Motivation in Biology in GuchaDistrict,Kenya. *International Journal of Science and Mathematics Education.*5, 111-124.

Kericho District Education Office (2015) *Kericho Sub County 2014 KCSE Results*

Kenya National Examination Council (KNEC) (2015).*The Year 2014 Kenya Certificate of Secondary Education (KCSE) Examination Report.*

Kibe,M.,Odhiambo, R. and Ogwel, D. (2008). *Impact of SMASSE INSET on Students Capacity Through Improved Teaching and Learning in the Classrooms.* A paper presented at the 8th Regional Conference for SMASSE WECSA, Nairobi.

Kim, H., Cho, S. &Ahn, D. (2003). Development of Mathematical Creative Problem Solving Ability Test for Identification of Gifted in Math. *Gifted Education International*, 18, 174-184

Kiruhi, M. A., Githua,B. N. &Mboroki, G. (2009).*Methods of Instruction; A Guide for Teachers and Teacher Educators*. OngataRongai, Gugno Books and Allied Publishers

Knud, I. (2007). What do we actually mean by Experiential Learning? *Human Resource Development Review.*6(1), 84-95.

Kolb, A.Y., & Kolb, D.A (2008). Experiential Learning Theory: A Dynamic Holistic Approach to Management Learning. Education and Development in Armstrong, S.J. and Fukami, C. (eds).*Handbook of Management Learning Education and Development.*London Sage Publication.

Kolb, D. A. (1984) *Experiential Learning : Experience as a Source of Learning and Development* Eaglewood and Cliffs N. J USA : Prentice Hall.

Kolb,D.A., & Kolb, A.Y. (2005). Learning Styles and Learning Spaces.Enhancing Experiential Learning in Higher Education.*Academy of management Learning & Education,* 4(2), 193-212.

Kompf, M.& Bond, R. (2001). Critical Reflection in Adult Education in T. Barer Stem Kompft (Eds) *The Craft of Teaching Adults*, Toronto ON : Irwin

Krutetskii, V. A. (1976). *The Psychology of Mathematical Abilities in School Children.* Chicago: University of Chicago Press.

KyriaCou, C. (1997). *Effective Teaching in Schools: Theory and Practice.* Cheltenhan, U.K: Stanley Thornes (Publishers) Ltd.

Lamon, S. (2003). Beyond Constructivism: An Improved fitness Metaphor for the acquisition of Mathematical Knowledge. In R. Lesh& H. M. Doerr (Eds), *Beyond Constructivism*:

Models and modelling Perspectives on Mathematics Problem Solving, Learning and Teaching. Mahwah. NJ: Lawrence Erlbaum and Associates.

Leikin, R. (2009). *Exploring Mathematical Creativity using Multiple solution tasks.* Rotterdam. The Netherlands: Sense Publishers.

Leikin, R., Berman, A., &Koichu, B. (2010).*Creativity inmathematics and the education ofgifted students.* Rotterdam:Sense Publishers

Liljedahl, P. &Sriraman, B. (2006).Musings on Mathematical Creativity, *FLM.*26(1), 17-19

Lombari, M. (2007). Authentic Learning for 21st Century: An Overview. Educause Learning Initiative.In Mason, A. (2007).*Experiential Education.*Second life Community Convention.

Maduabum, M.A. (2006). Strategies for improving the access of Girls and Women Science, Technology and Mathematics (STM) University Education in Nigeria.*Ebonyi Journal of Science Education.* 1(1) 11-21

Mann, E. L. (2005). Mathematical Creativity and School Mathematics: *Indicators of Mathematical Crreativity in Middle School Students.* Unpublished doctoral dissertation, University of Connecticut, Hartford.

Mann, E. L. (2006). Creativity: The Essence of Mathematics. *Journal for the Education of the Gifted,* 30(2), 236-260.

Maundu, J. N., Sambili, H.J. &Muthwii, S.M. (1998).*Biology Education: A Methodological Approach*. Nairobi*:*Lactern Publishers.

Mckeachie, W.J. (2001). *Active Learning.*http://hydro 4.sc.fau.Edu/-rjordan/active learning.htm.

Meissner, H. (2000). *Creativity in Mathematics Education.* Paper presented at the meeting of the International Congress on Mathematical Education, Tokyo.

Merriam, S. B., Cafarella, R. S., &Baumgather, L. M. (2007).*Learning in Adulthood: A Comprehensive Guide*. Sam Francisco: John Wileys& Sons, Inc.

Miheso, K. M. (2012). *Factors Affecting Mathematics Performance Among Secondary School Students in Nairobi Province; Kenya.*Unpublished PhD Thesis. Kenyatta University http://ir-library.ku.ac.ke/etd/handle/123456789/2485

MOEST (2006).*SecondarySchool Mathematics Teacher's Handbook.*Nairobi, KIE.

Mondoh,H. O. (2000). *Individual Differences in a Mathematics Classroom*. A Paper Presented at a Teachers workshop held at Menengai High school, Nakuru.

Mondoh, H. O. (2005). *Methods of Teaching Mathematics.A Handbook for Teachers and Students.*Egerton University Press.

Moon, J (2004).*A Handbook of Reflective and Experiential Learning: Theory and Practice.*London RoutledgeFalma.

Munetsi, C. (1994). "Attempt at Innovative Strategies such as Small Groups Instruction in Primary schools in Chiduka area of Makoni District: Problems and Possible Solutions."*Zimbabwe Journal of Educational Research,* 6(3), 255-274

Mwangi, S. W. (2013). *Effects of Using Loci-Kit Models During Instructions on Secondary School Students' Achievement in the Mathematics Topic "Loci" by Gender in Kibwezi District, Kenya*. Unpublished Masters Thesis, Egerton University, Njoro Kenya

Naikakoji, K., Yamamoto, Y. &Ohira, M (1999).A framework that Supports Collective Creativity in Design Using Visual Images.In E. Edmonds & L. Candy (Eds).*Proceedings of the 3rd Conference on Creativity and Cognition,* pp. 166-173: ACM Press

National Council of Teachers of Mathematics (2000).*Principles and Standards for School Mathematics.*Reston, VA: NCTM

Ndeke, G. C. W. (2003). *The Effects of the Gender, Knowledge and Learning Opportunities and Scientific Creativity amongst Form Three Biology Students*: Unpublished M.Ed Thesis, Egerton University.

Ndekei, J.N. (2011). *Effects of Creativity Teaching Strategy on Students Mathematics Achievement and Perception of Classroom Learning Environment.*Unpublished Masters Thesis, Egerton University.

Ndirangu, M. (1991).*Designing Active Ways of Learning for Cooperative Education in Kenya.*Unpublished Masters Thesis, UK: University College of Wales.

Newsome, L.A., Wardlow, G.W., & Johnson D.M. (2005).*Effects of Lecture Versus Experiential Teaching Method on Cognitive Achievement, Retention and Attitudes Among High School Agriscience students.* National AAAE Research Conference 146-156.

Ng'eno, J. K. (2013). *Teachers Perception of their Preparedness to Effectively Implement Mathematics Curriculum in Secondary Schools in Selected Districts of Rift Valley Province, Kenya*. Unpublished PhD Thesis, Egerton University.

Ngesa, F.U. (2002). *Impact of Experiential and Mastery Learning Programmes on Academic Achievement in Secondary School Agriculture.*Unpublished PhD Thesis.Egerton University.

Nkapa, N. (1997) *Educational Research for Modern Scholar,* Enugu; Fourth Dimension Publishers Nigeria.

Novak, J. D. (1998). *Learning, Creating and Using Knowledge: Concept Maps as Facilitative Tools in schools and corporations.* Mawah, NJ: Lawrence Erlbaum and associates

Nunan, D.E. (Ed.) (1992). *Collaborative Language Learning and Teaching.* London: Cambridge University Press.

Ojanji, W. (2001 April 23rd). Promoting Science Education Among Girls. *Daily Nation* pp. 20

Ondiek, P. E. (1986). *Curriculum Development: Alternatives in Educational Theory & Practice.*Lake Publishers and Enterprises, Kisumu, Kenya.

Otaala, B. (1999). *Improving Teaching and Learning at the University of Namibia.* Avisim and workshop reports.University of Namibia.

Pascul, R., & Uribe, R. (2005).*Experiential Learning Strategies in a Mechanical Engineering Senior Course,* University De chileBeauchef 850: Santiago Chile.

Pooja, W. (2012).Achievement in Relation to Mathematical Creativity of Eighth Grade Students.*Indian Streams Research Journal.* 2(2) 1-7

Popham, W.J (1990). *Modern Educational Measurement*: A practitioners perspective (2ndedpp (20.145). Eaglewood cliffs, NJ: Prentice-Hall, Inc.

Ramsden, P. (1992). *Learning to Teach in Higher Education.*London: Routledge Record, 91(3) 409-21

Renzuli, J. S., Leppien, J. H. & Hays, T. S. (2000). *The Multiple Mean Model. A Practice Guide for Developing Different Curriculum*. Mansfield Center, CT: Creative Learning Press

Republic of Kenya (1981).*Report of the Working Party on the establishment of the SecondUniversity in Kenya* (Mackay Report). Government Printers: Nairobi, Kenya.

Republic of Kenya (1964).*The Kenya Education Report* (The Ominde Report). Government Printers: Nairobi, Kenya.

Riley, R. (2000). The Performance of American Students in International Mathematics Testing has been a subject of National Concern. *The New York Times.*Pp.39

Rogers, C.R. (1969). *Freedom to Learn.*Columbus , OH: Merrill

Rogers, C.R., & Freiberg, H.J (1994).*Freedom to Learn* (3rd Ed). Columbus, OH: Merill/Macmillan

Runco, M. A. (1993). *Creativity as an Educational Objective for Disadvantaged Students* (RBDM 9306) Storrs, CT: The National Research Centre on the Gifted and Talented, University of Connecticut.

Runco, M. A. (2008). Creativity and Education.*New Horizons in Education.*56 96-104

Salman, M. F. (2009). Active Learning Techniques (ALT) in Mathematics Workshop; Nigerian Primary School Teacher’s Assessment.*International Electronic Journal of Mathematics Education,* 4(1)

Saljo, R. (1979). *Learning in Practice. A social Cultural Perspective in Swedish.* Stockholm: Prisma.

Scopes, P. G.(1973). *Mathematics in Secondary Schools.* London: Cambridge University Press.

Sheffield, L. (2009). Developing Mathematical Creativity- Questions may be the Answer. In R. Leikin, A. Berman & B. Koichu (Eds), C*reativity in Mathematics and the Education of Gifted Students* (pp 87 -100) Rotterdam: Sence Publishers

Sriraman, B. (2005). Are mathematical giftedness and mathematical creativity synonyms? A theoretical analysis of constructs.*Journal of Secondary Gifted Education*, 17(1), 20–36.

Stone, J R &Wonser R (1991).An Experiential Education Perspective on VocationalEducation.*Journal on vocational and technical Education*, 8 (1) 3.24

Stoyanova, E. &Ellerton, N. F. (1996).A Framework for Research into Students Problem Posing in School Mathematics.In P. Clarkson (Ed).*Technology in Mathematics Education:* Mathematics Education Research Group of Australia.

TIMMS, (2011).*International Results in Mathematics.* TIMMS & PIRLS International Study Centre. Chestnut Hill, MA, USA

UNESCO, (1987).*Studies in Mathematics Education vol6 : Out of School Mathematics Education.* Paris, France: United Nations Educational, Scientific and Cultural Organisation.

URT, (2008). A Performance Audit Report on School Inspection Programme for Secondary Schools in Tanzania. National Audit Office of Tanzania.

Vale, C. (2009). Trends and Factors Concerning Gender and Mathematics in Australia from http://www.tsg.Tcmell.org/document/get/169

Wachanga, S. W. (2005). *Chemistry Education: An Introduction to Chemistry Teaching Methods.* Njoro: Egerton University Press.

Wachanga, S. W. &Mwangi, J. G. (2004).Effects of Cooperative Class Experiment Teaching Method on Secondary School Students Chemistry Achievement in Kenya's Nakuru District.*International Educational Journal*.5(1), 26-36.

Walkin, L. (1994).*Instructional Techniques and Practice.* Cheltenham: Stanley &Thornes Ltd.

Wambugu, P. W. (2006). *Effects of Mastery Learning Approach on Secondary School Students achievement, motivation and Self Concept in Physics in Kieni East Division of Nyeri District, Kenya.*Unpublished MEd Thesis, Egerton University

Wambugu, P. W. (2011). *Effects of Experiential Cooperative Concept Mapping Instructional Approach on Secondary School Students' Achievement and Motivation in Physics in Nyeri County, Kenya.*Unpublished PhD Thesis, Egerton University.

Wambugu, P. W. &Changeiywo, J. M. (2008).Effects of Mastery Learning Approach on Secondary School Students' Physics Achievement.*Eurasia Journal of Mathematics, Science and Technology Education,* 4(3)

Wanjohi, A. M. (2011). *Development of Education System in Kenya since Independence.* www.Kenpro.org/papers/education - system-kenya- independence-htm

Wojciech, W. (2009) Importance of Mathematics in TodaysComplex Society. *InternationalJournal of Educational Management* 14(23), 178 - 193

Woolfe, R (1992). Experiential learning in workshops. In T Hobbs (Ed*), Experiential Training : Practical Guidelines (pp1-13)* London ,U K : Routledge.

Xia, X., Lu, C. & Wang, B. (2008). Research on Mathematics Instruction Experiment Based Problem Posing, *Journal of Mathematics Education*, 1(1) 153-163

Yara, P.O. &Otieno, K.O.(2010). Teaching / Learning Resources and Academic Performance in Mathematics in Secondary Schools in Bondo District of Kenya*, Asian Social Science.* 6(12) 126-132.

Zechmesh, E & Shaughnessy J. J (1994) *A practical Introduction to Research Methods in Psychology* (2nded.) Newyork: NY:McGraw Hill, inc.

Zhang, Y. (2008). Cooperative Language Learning and Foreign Language Learning and Teaching.*Journal of Language Teaching and Research.* 1(1) 81-83.

Zilbert, E., &Leske, G. (1989).Agricultural Education and Experiential Learning.*The visitor.* 76(1), 1-4.

Zoldosova, K. &Prokop, P. (2006).Analysis of Motivational Orientations in Science Education.*International Journal of Science and Mathematics*, 4, 669-688

APPENDIX A: TEACHERS MANUAL

The purpose of this manual as developed by Ngesa (2002) and adapted in this research is to assist the teacher of mathematics in the experimental schools plan and implement a teaching – learning programme based on experiential learning model.

Experiential learning puts emphasis on the involvement of learners during the teaching – learning process. The idea is that learners should be provided with opportunities for integrating theory and practice. They should also have personal experience during the learning tasks.

ELA is of interest to Mathematics Educators and teachers because Mathematics is an applied science and it is used in day to day life. The subject should therefore encourage learning which involves "doing" and "thinking", and linking "thinking" and "doing".

The manual has been organised into the following areas:

1. Planning for instruction
2. Instructional objectives
3. Theory of Experiential Learning
4. Practice of Experiential Learning
5. Units to be covered

1.0 Planning for Instruction

The following points are important to a teacher when planning for Mathematics Instruction. As a mathematics teacher you should:

a. Define where the learners should be at the end of the teaching –learning process

b. Prepare plans to guide the teaching – learning programme

c. Collect and organise the subject matter to bring the desired change in the learners

d. Select, collect, prepare and organise teaching – learning resources and facilities based on the desired changes in the learners, the content to be covered and teaching learning plans

e. Select appropriate testing strategies and prepare assessment materials. Planning and determining where the learners should be at the end of a teaching – learning process is referred to as Instructional Objectives.

2.0 INSTRUCTIONAL OBJECTIVES

2.1 Meaning of Instructional Objectives

An instructional objective is a statement of the performance to be demonstrated by each learner in the class, stated in measurable and observable terms.

2.2 Reasons for Stating Objectives

a) Objectives assist in focusing on what learners should be able to do at the end of a teaching – learning process.

b) Objectives assist in the selection of the subject matter to be learned.

c) Objectives assist in choice of the methods of teaching, teacher activities and learner activities to be undertaken during the teaching – learning process.

d) Objectives assist in the choice of teaching and learning resources and facilities.

e) Objectives assist in the decision of the time required to adequately cover the content.

f) Objectives guide in determining the nature of measurement to use in determining learner performance.

Form Two Mathematics objectives are stated in the Secondary Education Syllabus(2002). Teachers are encouraged to examine these objectives very closely as they provide the starting point and the end of teaching learning process. Teachers can modify objectives if there is need to.

2.3 How to state objectives

i. Instructional objectives should clearly describe the end behaviour learners are expected to demonstrate.

ii. The expected behaviour should be expressed by use of action verbs.

iii. The instructional objectives should be sufficient in number to adequately describe the expected behaviour.

iv. The objectives should indicate the condition under which the behaviour should occur.

v. The objectives should indicate criteria of acceptable performance.

Learners should be made aware of the instructional objectives. They should be involved in modifying them when there is need to.

2.4 **Taxonomy (Classification) of Instructional Objectives**

According to Bloom (1956) instructional objectives are classified into cognitive, psychomotor and affective domain.

Cognitive domain- These objectives are mental and have six levels. The levels are hierarchical such that the second level depends on the first level, and the third level depends on levels one and two and so on.

1. **Knowledge:** recall of formulas, rules, methodology and procedures, mathematical concepts, facts and principles.
2. **Comprehension: -**explanation, translation, interpretation.
   -Translation of symbols and English sentences into mathematical sentences.
   -Interpretation of diagrammatic and graphical representations
3. **Application:-** calculation using formulae
   - Use of mathematical knowledge in dealing with problems
   - Ability to use knowledge gained to new unfamiliar situations
4. **Analysis: -**breaking complex ideas and content into simpler parts and seeing how they relate to one another.

. –Ability to discriminate and relate.

5. **Synthesis:** abilityto put parts together. Learners can prepare a proposal for a project.

6. **Evaluation**: makingjudgements. Learners can judge the adequacy of using certain Mathematical methods or approaches in solving mathematical problems.

Psychomotor domain – these objectives are for acquisition of manipulative abilities. Levels of psychomotor objectives are organized by the level of competency required.

1. **Perception-** Being aware of objects and their qualities
    - **a.** Sensory stimulation
    - **b.** Cue selection- associating sensory stimulation with behaviour.
2. **Set –**Being ready to act
    - **a.** Mental set- knowledge requirements
    - **b.** Emotional/psychological set – willingness to perform
    - **c.** Physical set – body posture/position
3. **Guided response –** learners perform under guidance.
    - **a.** Imitation- copying the performance of others.
    - **b.** Trial and error – learners try out how to do things and correct themselves as a result of mistakes.
4. **Mechanism –** learners become confident and proficient.

5. **Complex Overt Response –** degree of proficiency and confidence are high

6. **Adaptation –** learners use their skills in undertaking related tasks

7. **Origination-** learners reach a stage where they are able to come up with new ideas.

Affective Domain – These are objectives which aim at the achievement of desired attitudes and habits. These influence the amount of time learners are ready to spend on various tasks, but the domain is not normally measured directly at the school level.

1. **Receiving –** making learners be willing to receive stimuli for example the student will listen while the teacher explains new points.
2. **Responding –** Learners become committed to an idea or an activity for example learners can accept that personal practice in mathematics is worthwhile and enjoy doing it.
3. **Valuing –** The learners express their belief or attitude about value or worth of something for example learners will show appreciation of the topic statistics.
4. **Organization –** integrating several values

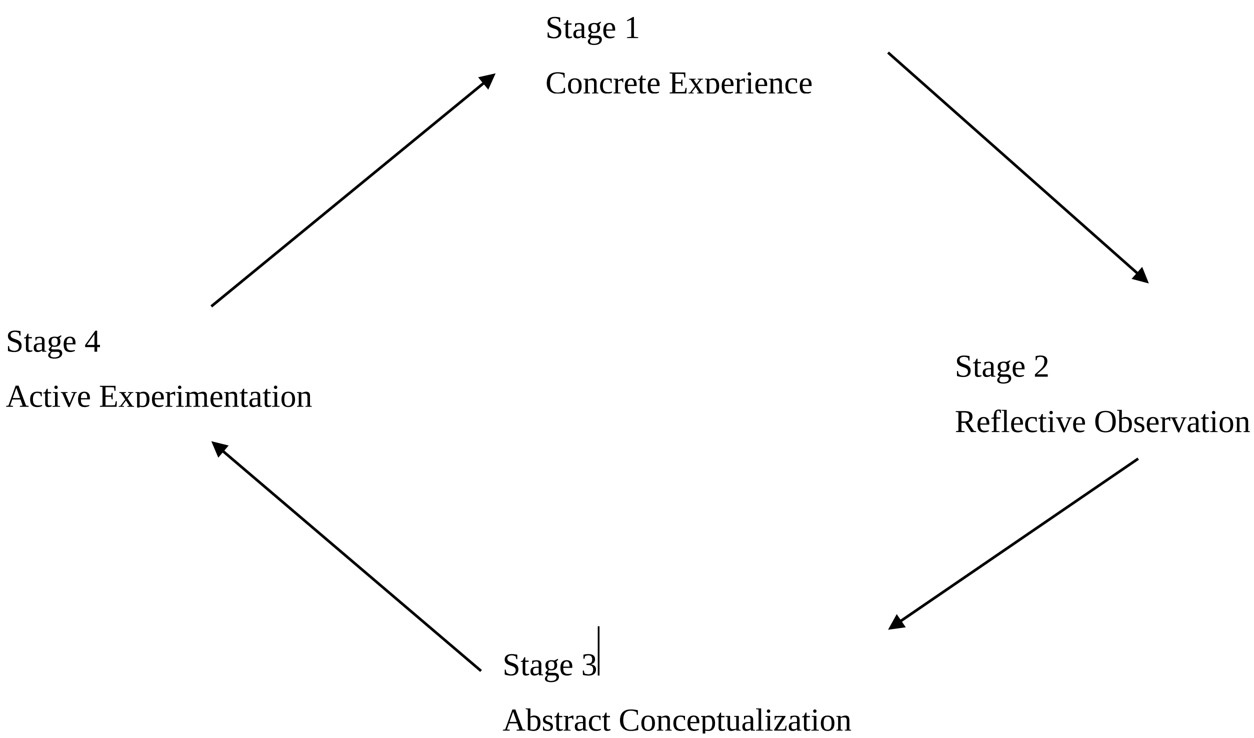
5. **Characterization by value system (complex) –** Developing a specific way of life, dealing with problems for example listening to others in class discussion / being rational.Affective objectives are very difficult to measure and are not measured in most examinations.

3.0 THEORY OF EXPERIENTIAL LEARNING

Experiential learning puts emphasis on the involvement of learners during gathering of content, analysing the collected subject matter and using the subject matter. The critical ideas in experiential learning are

a) Teacher plans and provides leadership in experiential learning.
b) Experiential learning involves cyclical sequence of learning activities which include learners coming into contact with a learning experience, reflection on the experience, gathering more content about the experience and then practising.
c) Learners are actively involved in the experience.
d) Learners must be encouraged to develop some independence from the teachers. Teachers' role is to plan appropriate learning experience for the learners, but it is only the learners who can demonstrate their changes in behaviour.
e) Learners must reflect on their experience critically.
f) The teaching – learning environment should be supportive to openness of learners.
g) The experiences must be meaningful and clear to learners.

The cyclical nature of experiential learning is represented by figure 1.



Learners must go through all the four stages for effective learning to take place.

Stage 1 Concrete Experience Learners come in contact with an experience or specific events. They are involved in designated learning activities, setting objectives and collecting data.

Stage 2 Reflective Observation Learners are given opportunities to reflect on the experience. Learners are expected to critically examine the experience with reference to their past experience and established knowledge and raise questions about the experience.

Stage 3 Abstract Conceptualizationlearners should provide answers to the questions arising from the experience by developing hypotheses, drawing conclusions, making generalizations and providing solutions.

Stage 4 Active Experimentation Learners use or test conclusions, generalizations, hypotheses and solutions in new situations.

4.0 PRACTICE OF EXPERIENTIAL LEARNING

The mathematics teacher who is going to use ELA needs to be familiar with the five phases which are critical in the planning and implementation of the programme.

Phase 1 Planning

During planning, learning needs are identified, instructional objectives are defined, teaching and learning activities are selected and designed and facilities and resources for teaching and learning are selected and prepared. The base of content in secondary school mathematics in Kenya is the KCSE mathematics syllabus. Teachers of mathematics however have to prepare schemes of work and lesson plans. During the preparation of schemes of work and lesson plans, special attention should be put on learner involvement, resources needed and the role of the teacher in providing a supporting and safe environment for learner involvement.

Phase 2 Introduction

At the beginning of the programme, learners are introduced to the broad themes, the expectations and the norms of ELA. The themes which should be emphasised include involvement, openness to experience, process orientation to learning and the responsibilities of teachers and learners. At the beginning of every unit introduction should be undertaken with the following elements:

- Description of unit in sufficient detail in order to bring the instructional objectives into focus and to link the learner to what is known.
- Provision of instructions with regard to learner responsibilities.
- Information on learning resources.
- Information on evaluation procedure.

Phase 3 Activity

This is when actual ELA occurs and proceeds as follows

1. **Planning for experience**
    a. Teacher and learners discuss the learning objectives and develop an action plan of what will be done during the learning experience.
    b. Teacher and learners discuss the criteria to be used in judging the quality of the learning experience.

c. In a case where the learners will be involved in collecting data the teacher should involve them in designing the learning experiences.
d. It is also during the planning of the experience that learners are organised for the experience and discussion on sequence and timing of learning activities take place.

2. **Enhancing awareness of the experience**

   This is the time when learners come into contact with the learning experience. Normally the teacher may be talking or demonstrating a skill or skills to the learners. Learners observe what the teacher does for example how to solve or analyse data and record what they hear and observe in their notebooks. They should also note any question for discussion.

3. **Reviewing and reflecting on the experience**

   Learners critically think through the learning experience during this phase. Learners can review the information recorded in their notebooks. Learners should have an opportunity to comment on the learning experience and to relate the learning experience in an organised manner.

4. **Providing classroom experiences**

   Classroom experiences usually tend to substitute for the real experiences. The most critical methods which a teacher can use as substitutes for real experiences are case studies, simulations, role plays and games.

Phase4: Debriefing

In this phase learners discuss completed learning experience in detail, in an orderly manner. It is the phase during which generalisations are made about content and learning process.

Phase 5: Summary

During the summary phase of a learning experience, the primary aim is to assist learners organise and give better meaning to the learning experience. The emphasis should be on

a. Highlighting the content, skills and process which are central to the instructional objective.
b. Integrating theory with the learner's experiences.
c. Developing generalisations about the experience and exploring the possible applications.

5.0 UNITS TO BE COVERED

- Definition of Statistics
- Collection and Organization of Data
- Frequency Distribution Tables (for grouped and ungrouped data)
- Grouping Data
- Measures of Central Tendency (mean, mode and median)
- Representation of Data
    - Line Graph
    - Bar Graph
    - Pie Chart
    - Pictogram
    - Histogram
    - Frequency Polygon

Interpretation of Data

APPENDIX B: TEACHERS GUIDE

OBJECTIVES

By the end of this topic the learner should be able to:

a. Define statistics
b. Collect and organise data.
c. Draw a frequency distribution table.
d. Group data into reasonable classes.
e. Calculate measures of central tendency ;mean, mode and median
f. Represent data in form of line graph, bar graphs, pie charts, pictogram, histogram and frequency polygons.
g. Interpret data from real life situations.

Method: Cycles of Experiential Learning

WEEK ONE

Lesson 1

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

i. Define statistics
ii. Distinguish between raw and organised data.
iii. Collect and organise raw data

5minutesIntroduction: The learners are introduced to the topic. Instruction on collection of data is also given.

20 minutesActivity: Students collect data concerning various situations for example

i) Masses in kilograms of students in class
ii) Colours and makes of vehicles passing by the gate of the school.

Organise data by tallying

10 minutesReflection and Conceptualization

This stage involves analysis of collected and organised data. It also involves criticism and how to apply to real life situations. Learners also provide answers to questions arising from experience and make generalizations. Work out examples.

5 minutes Teacher makes concluding remarks advising on areas to be addressed. Give learners questions on application of learnt knowledge.

Lesson 2

Topic: Frequency Distribution Table for Ungrouped Data

Objectives: By the end of the lesson the learner should be able to draw a frequency distribution table for ungrouped data.

5 minutes Brainstorming on concepts of previous lesson.

5 minutes Teacher introduces frequency distribution tables and state objectives with the learners.

10 minutes Activity Experience: students use data collected to create frequency distribution tables. Observations made as they draw the frequency tables.

10 minutes Abstract conceptualization: learners provide answersthrough further practice and solve more problems on ungrouped data.

5 minutes Learners test experience on new situations. Give more questions and applications to real life situations.

5 minutes Conclusion.

Lesson 3

Topic: Grouping data

Objectives: By the end of the lesson the learner should be able to group data into reasonable units.

5 minutes Teacher introduces the topic and state objectives with the learners. Instruction on collection of data within classroom is given.

10 minutes student collect data in class and with the supervision of the teacher group the data.

5 minutes Students go through the process of grouping data and analyse critically.

10 minutes Learners practice the process of grouping, providing answers to questions noted during observation stage.

5 minutes Learners test experience on new situations. Give more questions and applications in real life situations.

5 minutes Conclusion

Lesson 4

Topic: Frequency Distribution Table for Grouped Data

Objectives: By the end of the lesson the learner should be able to draw a frequency distribution table for grouped data

5 minutes Brainstorming on concepts of previous lesson and stating objectives of the current lesson.

10 minutes Teacher demonstrates how to construct frequency distribution tables using collected data. Students observe the process and take notes.

5 minutes Learners analyse the process of constructing frequency tables,discuss the processin groups and raise questions.

10 minutes Learners practice the construction of frequency distribution tables answer questions and make generalizations.

5 minutes Learners test conclusions and generalization in new situations.

5 minutes Conclusion

Lesson 5

Topic: MEASURES OF CENTRAL TENDENCY

Subtopic: Mean (X) for ungrouped data

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

- **i.** Calculate the mean (x) for ungrouped data
- **ii.** Work out the mean (x) by using the formula $\bar{X} = (\sum x)/n$ and $\bar{X} = (\sum fx)/\sum f$

5 minutes Teacher introduces the concept of mean and state the objectives of the lesson together with the learners.

10 minutes The teacher demonstrates to learners how to calculate mean as learners observe and take notes. Learners also take note of questions.

5 minutes Students critically think through the experience. They go through the process in pairs.

10 minutes Learners are given other examples to calculate the mean. Learners answer questions raised during the teacher demonstration. Try to make generalisations by deriving formulas.

5 minutes Learners test conclusions and generalisations in new situations.

5 minutes conclusion

Lesson 6

Subtopic: Mean for Grouped Data

Objectives: By the end of the lesson the learner should be able to find the mean of a grouped data.

5 minutes Brainstorming on concepts of previous lesson and teacher and learners state objectives of the lesson.

10 minutes Teacher and learners discuss how to calculate the mean of grouped data.

5 minutes Learners reflect on the experience. They go through the process of calculating the mean of grouped data in pairs.

10 minutes Learners work through other examples. Solve other problems and draw conclusions.

5 minutes Learners test generalisations and conclusions on new situations.

5 minutes Conclusion

WEEK 2

Lesson 1

Subtopic: Mode

Objectives By the end of the lesson the learner should be able to find mode from grouped and ungrouped data.

5 minutes Teacher and learners state objectives of the lesson. Teacher introduces the concept of mode.

10 minutesstudents record their weights on the chalkboard then fill in the frequency table so as to find the mode. For grouped data they group the data collected and identify the modal class.

5 minutes Learners think through the experience. Analyse it critically.

10 minutes Learners work through other questions. Make conclusions on mode.

5 minutes Learners test their conclusions on new situations.

5 minutes Conclusion

Lesson 2

Subtopic: Median from Ungrouped Data

Objectives By the end of the lesson the learner should be able to find the median from ungrouped data

5 minutes Brainstorming on concepts of previous lesson.

10 minutes Teacher introduces the concept of median. Learners put down their last mathematics examinations marks on the chalkboard and organise them in either ascending or descending order to be able to get the median.

5 minutes Learners reflect on the experience.

10 minutes Learners work through other examples and make generalisations.

5 minutes Learners test generalisations on new situations.

5 minutes Conclusion

Lesson 3

Subtopic: Median for Grouped Data

Objectives By the end of the lesson the learner should be able to find the median of grouped data.

5 minutes Brainstorming on concepts of previous lesson (median of ungrouped data). Teacher and learners state objectives of the lesson.

10 minutes Teacher and learners discuss how to find median of grouped data.

5 minutes Learners go through the process of finding the median of grouped data analysing it critically.

10 minutes Learners work through other questions on this subtopic, make conclusions and generalisation.

5 minutes Learners test formulas derived on new situations by working on other examples and assignments.

5 minutes Conclusion

Lesson 4

Topic: REPRESENTATION OF DATA

Subtopic: Line Graph

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

i. Represent data in form of a line graph.
ii. Interpret a line graph.
iii. Solve problems using a plotted line graph

5 minutes Introduction The learners are introduced to the topic.

10 minutes Teacher demonstrates how to draw a line graph and using it to solve problems. Students observe and take notes.

5 minutes Learners reflect on the process of drawing line graphs.

10 minutes Learners construct line graphs and solve problems using the line graphs constructed. Learners attempt to interpret the graphs.

5 minutes Learners interpret line graphs from real life situations for example temperature readings from a patient.

5 minutes conclusion

Lesson 5

Sub topic: Pie Chart

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

i. Represent data in form of a pie chart.
ii. Interprete a pie chart

5 minutes Teacher introduces the concepts of a pie chart and together with the learners' state objectives of the lesson.

10 minutes Activity: Learners give their mathematics grades in the previous examinations they are tallied and used in the construction of a pie chart.

5 minutes Learners go through the process of drawing pie charts and examine it critically.

10 minutes Learners construct other pie charts using other examples and make conclusions and generalisations.

5 minutes Learners test their conclusions and generalisations on new situations.

5 minutes Conclusion

Lesson 6

Sub topic: Bar Graph

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

i. Represent data in form of a bar graph
ii. Interprete a bar graph.

5 minutes Brainstorming on concepts of previous lesson. Teacher introduces the topic to learners.

10 minutes Teacher demonstrates to learners how to construct a bar graph using a student's marks in some subjects. Students observe, take notes and put down questions.

5 minutes Learners go through the construction of bar graphs analysing it critically.

10 minutes Learners construct bar graphs using their own data and draw conclusions.

5 minutes Learners work on new problems to test their conclusions.

5 minutes Conclusion

WEEK 3

Lesson 1

Topic: Pictogram and Histogram (with equal class interval)

Objectives By the end of the lesson the learner should be able to represent data in form of a pictogram histogram.

5 minutes Teacher introduces the concept of Pictogram and Histogram with equal class intervals. Teacher and learners put down objectives of the lesson.

10 minutes Teacher and learners use pictures/drawings to represent certain values of data.

Teacher constructs histogram as learners observe, take notes and put down questions.

5 minutes Learners reflect on the experience and analyse.

10 minutes Learners construct pictograms and histograms from given examples, make generalisations and questions noted during concrete experience.

5minutes learners apply knowledge learnt in new situations. Try to solve other problems and check on applicability of the conclusions made to real life.

5 minutes conclusion

Lesson 2

Topic: Histogram with varying class intervals

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

i. Represent data in for of a histogram with varying class intervals
ii. Calculate frequency densities

5 minutes Brainstorming on concepts of Histogram with equal class intervals. Teacher and learners state objectives of the lesson.

10 minutes Teacher demonstrates how to draw histograms with unequal class intervals. Learners observe and take notes. Teacher discusses with learners how to calculate frequency densities.

5 minutes Learners reflect on the experience.

10 minutes Learners practice constructing histograms with unequal class intervals and calculate frequency densities. Make generalisations and conclusions on the concepts.

5 minutes Test generalisations and conclusions in new situations.

5 minutes Conclusion.

Lesson 3

Topic: Frequency Polygon

Objectives By the end of the lesson the learner should be able to represent data in form of a frequency polygon.

5 minutes Brainstorming on concepts of previous lesson and introduction to frequency polygons

10 minutes Learners with the guidance of the teacher construct frequency polygons.

5 minutes Learners reflect on the learning experience

10 minutes Teacher helps learners conceptualise the learning experience through more practice and problem solving.

5 minutes Learners test generalisations on new situations

5 minutes Conclusion

Lesson 4

Summary: Teacher and learners go over the topic in preparation of the MAT and MCT

Lesson 5 & 6 The MAT and MCT to be administered to learners

END OF THREE WEEKS

APPENDIX C: MATHEMATICS ACHIEVEMENT TEST

Admission number: ______________________________

Gender: Male ☐ Female ☐

TIME: 1 HOUR

INSTRUCTIONS

(a) Attempt all the questions

(b) Show your working and answers below each question

1. Forty eight pupils gave the number of children in their home as follows

3	**4**	**1**	**2**	**3**	**2**	**2**	**1**	**3**	**5**	**6**	**1**
3	**1**	**5**	**7**	**8**	**9**	**1**	**2**	**1**	**2**	**5**	**2**
2	**3**	**1**	**3**	**2**	**11**	**1**	**2**	**4**	**2**	**3**	**8**
8	**6**	**3**	**6**	**5**	**4**	**1**	**5**	**2**	**4**	**7**	**3**

   a) Make a frequency distribution table for the given data (2 Marks)
   b) Determine the Mode (1 Mark)
   c) Calculate the mean number of children (2 Marks)

2. The mean age of 15 boys in a class is 19 years. On a day when one of the boys was absent the rest gave their ages as follows:

   20, 22, 16, 18, 17, 21, 18, 20, 17, 18, 19, 20, 19, 21

Find the age of the absent boy. (3 marks)

3. The heights to the nearest centimetre 0f 50 students in a particular school were as follows.

165	160	148	174	169	148	143	163	188	180
180	184	158	172	186	165	158	142	140	190
174	170	156	159	167	175180	165	138	145	
135	184	168	155	148	168	175	182	180	150
156	183	182	140	147	182	158	186	175	175

a) Using a class interval of 10, make a frequency distribution table. (2 Marks)

b) From the table;

i) State the modal class (1 Mark)

ii) Calculate the mean height (2 Marks)

iii) Calculate the median Height (4 Marks)

4. The table below shows the height, measured in the nearest centimetre of 101 Mango trees.

Height in CM	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59
Frequency	2	15	18	25	30	6	3	2

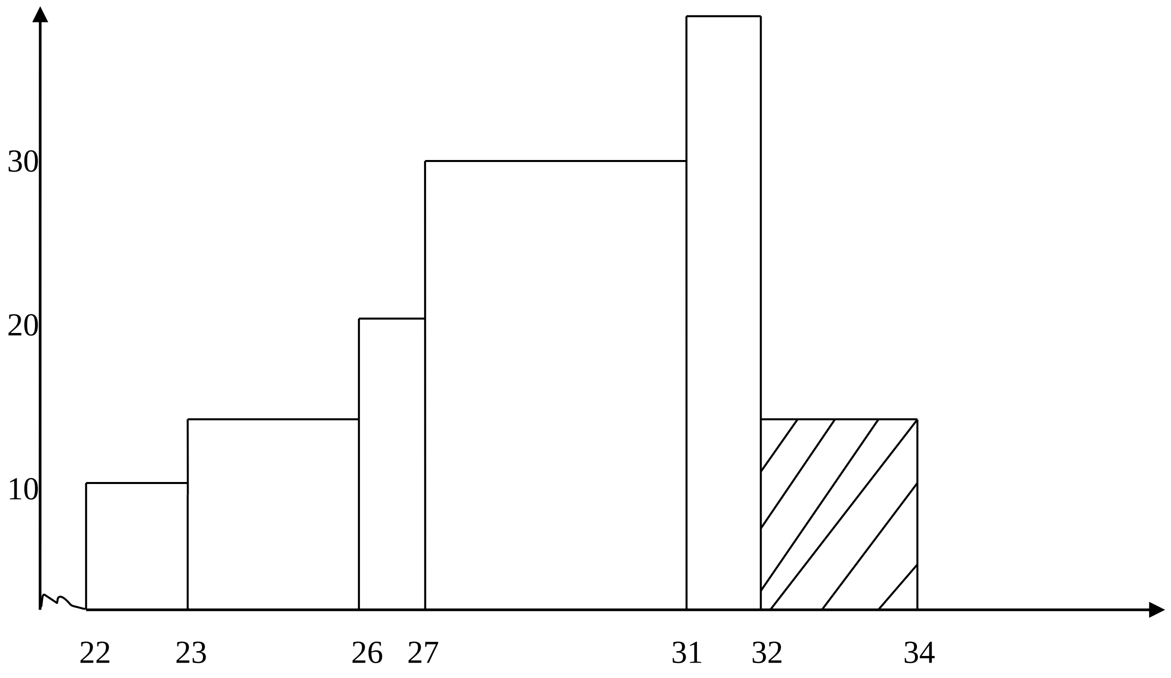
a) State the modal class (1 Mark)

b) Calculate to 2 decimal places;

i) The mean height (4 Marks)

ii)The difference between the median height and the mean height (5mks)

5. The histogram shown below represents the distribution of heights of seedlings of a certain plant



6. The frequency table below shows the daily wages paid to casual workers by a certain company.

Wages in Shs.	100-150	150-200	200-300	300-400	400-600
No. of workers	160	120	380	240	100

a) Draw a histogram to represent the above information. (2marks)

b) i. State the class in which the median wage lies. (1mark)

ii. Draw a vertical line, in the histogram, showing where the median wage lies (1mark)

c) Using the histogram, determine the number of workers who earn sh.450 or less per day. (3 marks)

7. The number of people who attended an Agricultural show in one day was 510 men, 1080 women and some children. When the information was represented on a pie chart, the combined angle for the men and children was 216°. Find the angle representing the children. (3marks)

8. The data below shows the total number of KCSE subjects passed in two schools.

No. of subjects		0	1	2	3	4	5	6	7	8
No. of candidates	School A	1	1	1	10	12	15	12	7	3
	School B	3	2	3	5	6	9	13	12	7

a) On the same axes, draw frequency polygons for the two schools. (5 marks)

b) If anyone with 6 or more passes qualified for higher education, how many candidates qualified in each school? (2 marks)

9. The following table shows the number of trees planted in a certain farm.

Year	1996	1997	1998	1999	2000
No. of trees	200	300	275	400	350

Represent the information on a pie chart. (3 marks)

APPENDIX D: MATHEMATICAL CREATIVITY TEST

Admission Number: ___________________________

Gender: Male ☐ Female ☐

INSTRUCTIONS

The items in this test give you a chance to use your imagination to think up ideas and problems about mathematical situations in statistics. The researcher wants to find out how creative you are in Mathematics. Try to think of unusual, interesting and exciting ideas, things that no one else in your class will think of.

ITEM 1

The mean of the following numbers is 7. Find all the possible values of a and b.

3, 4, a, 5, 7, a, b, 5, 8, 5, and **9.**

ITEM II

Suppose you are given the following set of raw data for marks of 40 students. List all the possible ways in which you can organise the data, represent it and use it to find measures of central tendency.

42	45	48	40	46	48	39	40	39	48
41	47	46	45	49	40	48	78	42	60
52	60	46	47	48	52	47	52	58	42
62	80	70	47	79	64	60	73	54	45

ITEM III

The situation listed below contains much information involving data. Your task is to make up as many problems as you can concerning the mathematical situation. You do not need to solve the problems you write.

The following enrolment figures for 40 primary schools were collected.

934	923	936	931	924	933	933	933	937	926
934	931	929	934	927	957	927	928	932	934
923	900	948	902	907	894	908	930	920	899
940	917	945	915	948	927	901	937	923	934

ITEM IV

Coffee pickings in Eliza Farm for the month June in kilograms are given below (five days a week).

200	220	280	230	250
305	200	210	230	200
250	210	260	350	300
210	250	270	290	320

Represent the data in as many ways as possible.

ITEM V

Write down every step necessary to solve the following mathematical situation.

Suppose you have a barrel of water, a seven cup can and an eight cup can. The cans have no markings on them to indicate a smaller number of cups such as three cups. How can you measure nine cups of water using only the seven cup and the eight cup can?

APPENDIX E: SCORING PROCEDURE FOR MCT ITEMS

The following procedure will be used to score the items in the Mathematical Creativity Test.

Fluency : One point for each relevant response

Flexibility: One point for each category expressed.

Originality: Zero, One or Two points for each category expressed, weighted according to the percentage sample population that will provide an answer within a particular category.

Elaboration: one point for every relevant step (detail) expressed.

APPENDIX F: RESEARCH AUTHORIZATION

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@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.

Date:

9th July, 2015

NACOSTI/P/15/7238/6513

Marcella Cherotich Chesimet
Egerton University
P.O Box 536-20115
EGERTON.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Effects of experiential learning approach on students' mathematical creativity and achievement among secondary school students of Kericho Sub-County, Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Kericho County** for a period ending **15th June, 2016.**

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

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

DR. S. K. LANGAT, OGW
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Kericho County.

The County Director of Education
Kericho County.

APPENDIX G: RESEARCH CLEARANCE PERMIT

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 5698

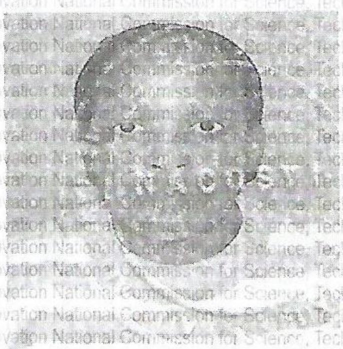
CONDITIONS: see back page

THIS IS TO CERTIFY THAT:
MS. MARCELLA CHEROTICH CHESIMET
of EGERTON UNIVERSITY, 0-20115 egerton,has been permitted to conduct research in *Kericho County*

on the topic: *EFFECTS OF EXPERIENTIAL LEARNING APPROACH ON STUDENTS' MATHEMATICAL CREATIVITY AND ACHIEVEMENT AMONG SECONDARY SCHOOL STUDENTS OF KERICHO SUB-COUNTY, KENYA*

for the period ending:
15th June,2016

Permit No : NACOSTI/P/15/7238/6513
Date Of Issue : 9th July,2015
Fee Recieved :Ksh 1,000



....
Applicant's Signature

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