Effects Of The Use Of Computer Animated Technique On Loci During Instruction On Secondary School Students' Mathematics Misconceptions In Kitui County, Kenya

Bernard Nyingi Githua, Johnson Changeiywo, Simon Warui Mwangi

Abstract: Kenyan secondary school students have continued to perform poorly in mathematics in Kenya Certificate of Secondary Education (KCSE) examinations. The reason for the poor performance in mathematics has been attributed to several factors, which include: poor teaching methods, lack of teaching and learning resources, and abstract nature of mathematics. Some mathematics topics have been labeled hard to teach and learn by the teachers and the students respectively. Loci is a topic in the form four syllabus that is labeled hard or difficulty to teach and learn. The students' performance in the topics has consistently been poor. This study sought to investigate effects of using Computer Animated technique on Loci during instruction on students' misconception made in the mathematics topic. It was hoped that the use of ICT would improve the sorry state of mathematics misconceptions. ICT has been used in teaching and learning of chemistry with remarkable improvement. The theoretical frame work to guide the study was based on constructionist theory of learning where the students constructed new knowledge from real life experiences. The researcher constructed Computer Animations on Loci concepts to augment the teaching of loci. Solomon Four, Non-Equivalent Control Group Research Design was used. To ensure that there was no interactions between groups a Simple random sampling was used to assign each group to a specific sub-county out of sixteen Sub-Counties in Kitui County. A purposive random sampling was used to choose a school for each group that had graduate teachers teaching form four and had a computer laboratory. The study was carried out in a mathematics classroom setting. The two experimental groups were exposed to Computer Animated Loci technique as the treatment while the two control groups were taught using the conventional teaching/learning methods. The sample size was 207 students consisting of 95 girls and 112 boys. A Mathematics Achievement Tests (MAT), adopted from KCSE past Examinations on Loci was used. Misconception that a student made on Loci concepts in MAT were noted and awarded one mark. The instruments were pilot tested to estimate their reliability. The instrument was validated by experts from the Department of Curriculum, Instruction and Educational Management of Egerton University and mathematics examiners. The reliability coefficient of the instrument was computed to be 0.8157 using K-R 20 formula. A Pre-test was administered to the two groups, one experimental and one control before intervention and then the same MAT was administered to all the four groups after intervention as a Post-test. The Statistical Package for Social Sciences (SPSS) version 21.0 was used to analyse the collected data. The t-test and ANOVA were used to test hypotheses at Coefficient alpha (ά) level of 0.05. The findings are expected to be useful to students, teachers, Policy makers, teacher training colleges and curriculum developers in secondary schools because they may be able to identify a teaching/learning technique which may improve the quality of education in the country.

Index Terms: Loci, Misconception, Computer Animated technique on Loci,

1 INTRODUCTION

Mathematics is offered as one of the core subjects in primary and secondary school education in Kenya. At tertiary levels, general mathematics is offered in nearly all science based programmes where it is not a core subject (JAB, 2013). Mathematics is critical in fostering logical and rigorous thinking. According to Odhiambo, Maito and Ooko (2013) mathematics all over the world plays a pivotal role in student lives, it is a bridge to science, technology and other subjects offered in any formal educational system. The teaching of mathematical concepts and skills that the students encounter in school shapes their understanding, their ability to solve problems and their confidence in, and disposition toward mathematics (Too, 2007). Odili (2006) sees mathematics as a subject that helps students to form the habit of clarity, brevity, accuracy, precision and certainty in expression. Everybody requires a certain amount of competence in basic mathematics for the purposes of handling money, executing daily businesses, interpreting mathematical graphs and charts as well as thinking logically (Bandura, 1997). Despite the importance of mathematics to individuals and society globally, Miheso (2012) indicates that it is the subject that is poorly performed at national examinations by many secondary school students worldwide. Colwell (2000) studied the performance of American students in the international mathematics tests and noted that they were performing poorly. Perveen (2009) stated that 80 % of the unsuccessful students in the secondary school examination in Pakistan failed due to poor grades in mathematics. Jamaica registers low test scores at all levels in Mathematics of their education system suggesting that there are gaps in the system that negatively impact the learning outcomes of many students (King, 2012). According to Kaur (2005) since 1995, Singapore students have consistently been ranked among the top nations on the Trends in International Mathematics and Science Study (TIMSS). The role of Information and Communications Technology (ICT) in the schools classroom is becoming increasingly prominent in both primary and secondary education. According to Seyed and Sina (2013) ICT is among the most novel scientific achievements of mankind which have apparently presented numerous capabilities to the human society, and, it is expected that they can be effective and useful in alleviation of the current problems of human society. Mathematics is known to be of great practical value in scientific and technological fields (Ng'eno, Githua & Changeiywo, 2013). In mathematics education, technology is often viewed as a provider of learning devices and tools such as: calculators and computers which may be used in the classroom (Simonson & Thompson, 1997). The increased use of technology especially computer technology in educational processes has been incorporated as a way to improve educational opportunities, while enhancing student performance (Picciano, 1994).Thus, mathematics education must include key concepts and processes for a student to have the opportunity to be successful in the 21st century (English, 2002). One of the mathematical concepts that is key in the 21st century is use of technology in teaching and learning mathematics. For a country to compete effectively in the digital world, teachers need to play an important role in integrating computer technology into the curriculum (Magliaro, 2007). The Tables 1 shows KCSE analyses of question that tested loci as reported by KNEC (1995).

Table 1: *KCSE Mathematics Items Analyses Paper One 1993 Number 11*

Marks	0	1	2	3	4
% of candidates scoring the marks	80	1	17	0	2

Source: KNEC, 1995 Mathematics Report pp 12-13

The question tested candidates' understanding of loci. It was a compulsory question where 80% of students scored zero mark out of a possible maximum of 4 marks. The first mark was awarded for correctly identifying the common type locus which 80% could not identify. Only 2% of candidates were able to score the maximum 4 marks. The other candidates faced challenges in answering the question, implying the topic need more attention. Van der Sandt (2007) concedes that in South Africa geometry is regarded as a 'problematic topic' at secondary school level.

Table 2: *KCSE Mathematics Item analyses Paper One 1994 Number 19*

Marks	0	1	2	3	4	5	6	7	8
% of candidates scoring the marks	67	22	6	2	1	0	1	0	1

Source KNEC, 1995. Mathematics Report Pp 66-67

The question was optional and tested candidates' ability to construct simple geometric figures, and locus at a point. According to KNEC (1995), the question was poorly performed with a mean score of 0.59 out of 8. Loci is a challenging topic as indicated with 67% of the students who attempted this question being unable to score even a mark in the question. According to Salman (2005) students dislike certain topics in mathematics, because they believe that they are difficult to learn, while the teachers also dislike teaching certain topics which they find difficult to teach. Kinyua, Maina and Ondera (2005) noted that Loci is a topic that is sometimes labeled as difficult by many pupils. This is also supported by CEMASTEA (2009) who reported that teachers experience challenges in teaching and learners have difficulties in learning the topic Loci. According to Vashist (2007), there is no proof that any particular teaching method is the best in teaching a given subject at all situation across the topics. She farther notes that teaching/learning methods need to be blended to suit the situation. Some of the teaching methods used in the teaching of mathematics include lectures, demonstrations, group discussions, question and answer, problem solving, drill and practice, project work, programmed learning, experimentation, and games (Murphy & Moon, 2004). Harbor (2001) asserted that the issue of poor performance in mathematics examinations was due to problem of teaching methods. Mathematics has traditionally been taught using paper, pencil and chalkboard (Brown, 2006). The use of computer has become increasingly popular in elementary and secondary schools over the past several decades. Anyagh (2006) noted that the ability to remember takes place more effectively when experiences are passed across to the learner via an appropriate instructional method. Instructional (CAI) package can be used to teach all subjects including sciences and mathematics. According to Sottilare and Gilbert (2011) CAI can be used to provide opportunities for students to learn using drill and practice, tutorial, games and simulation activities, animation, and many others. The National Council of Teachers of Mathematics (NCTM, 2000) emphasized the importance of the use of technology in mathematics education, stating that "technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning". PowerPoint and CD-ROM tutorials have been incorporated into teaching to address the unique characteristics of technologically-competent millennial learners who prefer active learning, group activities and instantaneous feedback (Hunter & McCurry, 2013). Computer technology has great potential to impact the teaching and learning of mathematics, but the presence of its hardware does not automatically produce desirable schooling outcomes in mathematics education (Li, 2004). Successful and effective use of technology for the teaching and learning of mathematics depends upon sound teaching and learning strategies that come from a thorough understanding of the effects of technology on mathematics education (Coley, Cradler, & Engel, 2000). Simulations and animations bridge the gap between the concrete world of nature and the abstract world of concepts and models (Yair, Mintz, & Litvak, 2001,). Students often hold strong misconceptions be they historical, mathematical, grammatical, or scientific. All pupils acquire a range of ideas during their learning of mathematics, which can lead to misconception (QCA, 2003). Computer simulations have been investigated as a means to help students confront and correct these misconceptions, which often involve essential learning concepts (Zietsman & Hewson, 1986). Studies by Jiang and Potter (1994) supported the potential of computer simulations to help accomplish needed conceptual change. This study addressed the students' misconceptions with a view of remediating it.

1.1. Statement of the Problem

Mathematics is important for understanding other academic disciplines such as science and technology, medicine, economics, and engineering among others. Despite the importance of mathematics it is generally performed poorly globally, regionally, nationally and specifically in Kitui County. Some of the reasons for the learners' dismal performances in the subject have been argued to be the abstract nature of mathematics, poor teaching methods and lack of teaching and learning resources among others. Some topics in mathematics are quite challenging to tech and learn among them being "Loci" that is taught to form four students. Simulations and animations have been used in some mathematics topics such as three dimension geometry, with promising results. In an attempt to seek a teaching technique that can improve learners' achievement and reduce misconceptions committed by students, computer animated technique was be used during instruction of "Loci" topic. Traditional approaches in learning geometry emphasize more on how much the students can remember and less on how well the students can think and reason. This research therefore investigated the effects of Computer Animated Loci Technique during instruction on secondary school students' mathematics misconceptions in the topic "Loci" in Kitui County,

1.2. PURPOSE OF THE STUDY
The purpose of this study was to investigate the effects of Computer Animated Technique on the mathematics Loci topic during instruction on secondary school students' misconceptions in the mathematics topic "Loci" in Kitui County, Kenya.

1.3. OBJECTIVES OF THE STUDY
The following objective guided the study: To establish the effects of Computer Animated Loci Technique during instruction on secondary school students' mathematics misconceptions**,** in "Loci"

1.4. HYPOTHESES OF THE STUDY
The following null hypotheses will statistically be tested at coefficient alpha (α) level value equal to 0.05.

H_O: There is no statistically significant difference between the mathematics misconceptions scores committed by students exposed to Computer Animated Loci Technique and those not exposed to it during mathematics instruction.

2. Conceptual Framework
A conceptual framework is described as a set of broad ideas and principles taken from relevant fields of enquiry and used to structure a subsequent presentation (Reichel & Ramey, 1987). From a social constructivist perspective about learning (Kafai & Resnick, 1996), knowledge is personally and socially constructed; learning is learner centred, and is achieved by designing and making personally meaningful artifacts; and multiple perspectives and representations of knowledge should be encouraged during learning. The effective use of technology encourages a move away from teacher-centred approaches and towards a more flexible and student-centred environment. A technology rich learning environment is characterized by collaborative and investigative approaches to learning, increasing integration of content across the curriculum and a significant emphasis upon concept development and understanding. Teachers using Computer Animated Geogebra Technique were trained by the researcher for five days on the use of the Technique. The Hawthorne effect can arise as a result of "researcher's demand effects" whereby experimental subjects attempt to act in ways that is to please the experimenter (Levitt & List, 2007). To avoid Hawthorn effect the students were taught by their teachers. In cases where there was more than one stream all of them were taught the same way and only one stream was included in the study. The teaching of loci topic took three weeks as stipulated by KIE (2002). For the school factors the researcher studied Mixed Sex Sub-County Secondary Schools. The study focused on form four students in the sub-county who were assumed to be of relatively the same age. Figure 1 shows the representation of the relationships among variables within the conceptual framework. The independent and intervening variables have two categories each.

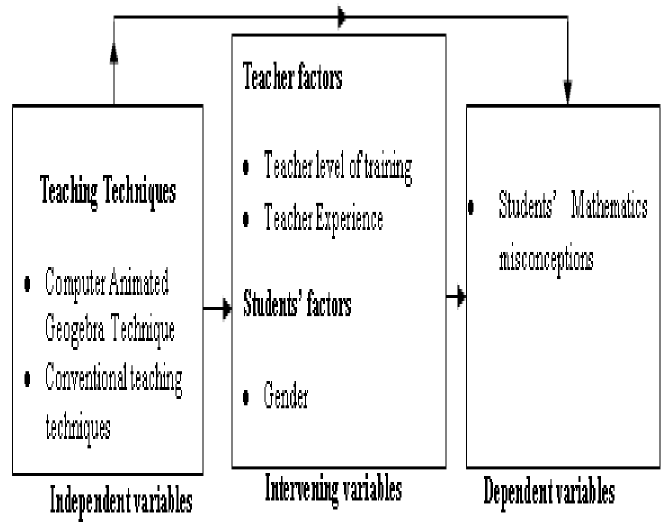


Figure 2: *The Diagrammatic Representation of the Relationship Between the independent, Intervening and dependent variables of the Study.*

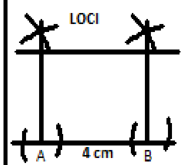
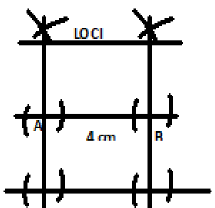
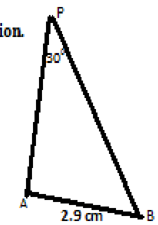
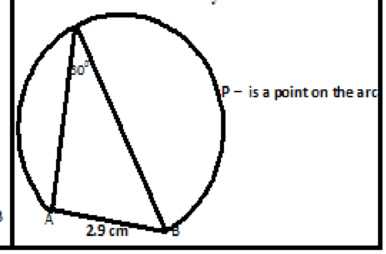
2.1. Mathematics' Misconceptions
Misconceptions are Systematic and recurrent wrong responses methodically constructed and produced by students (Green,et al., 2008). Characteristically, misconceptions are intuitively sensible to learners and can be resilient to instruction designed to correct them (Smith, diSessa & Roschelle, 1993). According Kakoma and Makonye (2010) misconceptions show that there is structure in the misconceptions learners have and that these misconceptions emanate from prior acknowledge as learners attempt to construct mathematical meanings. According to Koshy and Murray (2002), a large number of misconceptions originate from reliance on rules which have not been understood, forgotten or only partly remembered. Students do not come to the classroom as "blank slates" (Resnick, 1983), instead, they come with theories constructed from their everyday experiences. They have actively constructed these theories and activities crucial to all successful learning. Some of the theories that students use to make sense of the world are, incomplete or half-truths (Mestre, 1986). All pupils acquire a range of ideas during their learning of mathematics, which can lead to misconception (QCA, 2003). According to Dickson, Brown and Gibson (1984), many of the misconceptions that children make about mathematics concepts are due to primarily inadequate teaching. Misconceptions are a problematic to students for many reasons among them being: They interfere with learning when students use them to interpret new experiences; students are emotionally and intellectually attached to their misconceptions, because they have actively constructed them; students give up their misconceptions, which can have such a harmful effect on learning, only with great reluctance; repeating a lesson or making it clearer may not help students who base their reasoning on strongly held misconceptions (McDermott, 1984). Misconceptions often interfere with understanding and interpreting the new recommendations on sound early childhood mathematics education, and become subtle (and sometimes overt) obstacles to implementing the new practices

in the classrooms (Richardson, 1996). Students who overcome a misconception after ordinary instruction often return to it only a short time later since students actively construct knowledge, teachers must actively help them dismantle their misconceptions. Teachers must also help students reconstruct conceptions capable of guiding their learning in the future. According to Swan (2005) teaching becomes more effective when misconceptions are systematically exposed. Bell (2005) suggests that when students face a challenge to their cognitive structure, they are much more willing to stretch themselves intellectually. Conceptual gains realised in this manner promote “transfer from the immediate topic to wider situations” (Bell & Swan, 2006). Bell (2005) argues that without exposure of pupils’ misconceptions and their resolution through conflict discussion, students may not know why a mistake occurred. Mathematics interventions should use a subtle process to expose flawed thinking and allow students to confront their own misconceptions and, consequently, discover for themselves the source of their mistakes (Bell & Swan 2006). There are general misconceptions about mathematics in the society among them are: mathematics is incorrectly viewed as a collection of rigid rules and mysterious procedures that seem to be unrelated to each other and require total mastery with little or no understanding; mathematics is perceived by many to be difficult and demanding and is considered to be a subject in which it is socially acceptable to do poorly; mathematical thinking is regarded as essentially unimportant to people that do not actually "do" mathematics in their employment capacity; the pervasive role of mathematics is underestimated in the world of everyday living. Misconceptions must be deconstructed, and teachers must help students reconstruct correct conceptions. Lochead and Mestre (1988) describe an effective inductive technique for deconstructing misconception involving: probe for and determine qualitative understanding; probe for and determine quantitative understanding; probe for and determine conceptual reasoning. Sometimes misconceptions can even be hidden in correct answers (Smith et al., 1993), when correct answers are accidental. Most teachers are unaware of mathematical misconceptions held by their learners (Riccomini, 2005). Students use of concrete materials in mathematical contexts help “both in the initial construction of correct concepts and procedures and in the retention and self-correction of these concepts and procedures through mental imagery” (Fuson, 1992). In this study the misconceptions made in Geometry in general and Loci in particular were sought.

2.2. Mathematical Misconception Analyses

Misconceptions analyses are useful for teaching and learning, they help students to understand where they are likely to go wrong and they avoid it. To learn about children's conceptual understanding and the strategies behind their answers, whether right or wrong, teachers need to engage children in a dialogue, which is 'flexible interviewing', asking the child to elaborate on his or her ways of interpreting and approaching a problem (Ginsburg, 1997). According to Wright (2008), the formula method relies heavily on arithmetic and remembering formulas accurately to solve problems, and leaves students with numerical values that lack clear meaning and conceptual understanding, thus leading to an increased incidence of misconceptions. Researches by Ayşen (2012); EChesa (2003); and Lim (2000) highlighted misconceptions in students’ thinking in various mathematics topics at the secondary level some of which are discussed in Table 3.

Table 3: *Mathematical Misconception in Geometry In General and in Particular Loci*

Topic	Concepts	Misconceptions	Remedial measure
Loci	Locating locus	Locate the locus of points 2.1 cm from a fixed line AB=4 CM Solution 	The students should recognize that loci from the line AB are on its two sides. 
Loci	link concept to geometrical properties	Locate to locus of points P such that angle APB = 300 given that AB = 4 cm Solution. 	The students locate only one point. They fail to relate the loci with angles subtended at the circumference of a circle by the same chord. 

3. RESEARCH METHODOLOGY

This study used Solomon Four, Non-Equivalent Control Group Design, which is quasi-experimental research (Githua & Nyabwa, 2008). The design was preferred because secondary schools’ classes once constituted exist as intact groups and the schools’ authorities do not allow such classes to be broken and re-constituted for research purposes (Borg & Gall, 1989). This design contains two control groups and two experimental groups, which serves to reduce the influence of intervening variables and allow the researchers to test whether the pre-test itself has an effect on the subjects (Kumari, 2013). The design helped to achieve the following purpose: to assess the effect of the experimental treatment relative to the control group; to assess the interaction and treatment conditions; to assess the effect of pre-test relative to post-test; assess the homogeneity of the groups before administration of the treatment(Borg & Gall, 1989). The non- equivalent groups, Pre-test and Post-test were used to partially eliminate the initial differences between the experimental groups and control groups.

Group	Pre-test	Intervention	Post-test
E_1	O_1	X	O_2
C_1	O_3	—	O_4
E_2	—	X	O_5
C_2	—	—	O_6

Figure 2: *Solomon four, non-equivalent control group research design*

In Figure 2, Group C_1 and C_2 represent sampled control schools that used Conventional teaching methods. Groups E_1 and E_2 represent the sampled experimental schools that received the treatment. O_1andO_3 denotes Pre-test while O_2,O_4, $O_5 and O_6$ indicate the Post – test for respective groups. X was used to denote Experimental treatment using Computer Animated Geogebra Technique. The dotted line (……) indicates the use of non-equivalent groups while (—) implies no treatment (Mugenda & Mugenda, 1999).

3.1. Population of the Study

Gall, Borg and Gall (1996), define target population as all members of a real or hypothetical set of people, events or objects from which researchers generate data for a study. According to information available at Kitui county Education office there are 380 secondary schools out of which 268 are Mixed Sex Sub-County Secondary Schools. The target population in this study was secondary school students. According to Yount (2006) it is usually not possible to reach all the members of a target population, one must identify that portion of the population which is accessible. The accessible population was form four students in Mixed-Sex Sub-County schools which had enough schools for the chosen research design. There were 16,532 form four students in Kitui County out of which 10,630 are in Mixed Sex Sub-County schools (KCEO, 2015).

3.2. Sampling Procedures and Sample Size

Best and Kahn (1981) define a sample as a small proportion of the population that is selected for observation and analysis. Sampling means selecting a given number of subjects from a defined population as representative of that population (Orodho, 2002). Four schools were chosen because the Solomon 4-Group Design requires four groups where each school forms a group. To ensure minimal interactions between the experimental and control groups, a simple random sampling was used to select four Sub-Counties out of sixteen Administrative Sub-Counties in Kitui County. Each group was assigned a Sub-County. A purposive random sampling was used to select schools in each sub-county that had even distribution of gender, had graduate teachers teaching form four and had a computer laboratory with at least ten computers. A simple random sampling was used to select the streams whose results were analysed. According to Levitt and List (2007) experimental group members may feel special simply because they are in the experiment, this may reflect on their performance. To avoid this effect all streams in the two experimental groups were given the same treatment, but only the selected streams had their results analysed. The sampling was appropriate because it ensured that all schools have equal chances of being included in the study sample.

3.3. Research Instruments

Instruments are the devices that researcher uses to collect data; they include a pen – and – paper test, a questionnaire, or a rating scale (Fraenkel & Wallen, 2000). In this study Mathematics Achievement Test on geometry (MAT), was used to collect the required data from the students. The items in instrument were adopted from KCSE past Examinations on Geometry. It had thirty one items that tested students' knowledge, comprehension, application to real life situations and mathematical skills on working out questions on loci, a topic taught to form four students. The administration of MAT took two hours, and was supervised by the mathematics teachers. A minimum of 0 score was awarded to a student who scored all the 31 items wrong and maximum score 100 was awarded to one who scored all the items correct. MAT was administered to one experimental and one control group as a Pre-test before intervention. All the four groups sat for the same MAT as a Post-test after the intervention.

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4.0. Results of the pre-test on MAT

Table 4: *shows the number of students who participated in the study by school and by gender.*

Groups	C1	E1	C2	E2	TOTAL
TOTAL	59	51	45	52	207

4.1. Results of the pre-test on Misconception scores

TABLE 5: *MEAN SCORES ON MISCONCEPTION IN MAT FOR GROUPS E1 AND C1*

Group	N	Mean	Std. Deviation	Std. Error Mean
C1	59	36.02	10.212	1.330
E1	51	33.55	9.151	1.281

The groups C1 and E1 sat for pre-test mat where misconceptions made were assessed; this made it possible for the study to assess the homogeneity of the groups before treatment application as recommended by Kumari (2013). there was no statistically significant difference in misconceptions made in mat between the two groups before intervention, $t(108) = 0.188$ and $p > 0.05$ as shown in table 6. this implied that the two groups were comparable and suitable for the study.

Table 6:*Independent sample t-test of Pre-Test Scores on Misconceptions in MAT Based on Groups E1 and C1*

Variable	Group	N	Mean	Sd	Df	T-Computed	T-Critical	P-Value
Mat	C1	59	36.02	10.212	108	0.188	1.9864	0.270
	E1	51	33.55	9.151				

Not significant at p>0.05 level

4.2. EFFECTS OF COMPUTER ANIMATED LOCI TECHNIQUE ON STUDENTS' MISCONCEPTION IN LOCI TOPIC OF MATHEMATICS

Analyses were performed with Hypothesis H_O that sought establish whether there was a statistically significant difference between the mathematics misconceptions scores committed by students exposed to Computer Animated Loci Technique and those not exposed to it during mathematics instruction.

Table 7: *Post –Test Misconception mean scores obtained by the students in the study groups*

	E1	C1	C2	E2
Mean	27.94	33.32	36.73	27.08
N	51	59	45	52
Std. Deviation	8.327	8.961	7.557	8.865
Std. Error of Mean	1.166	1.167	1.127	1.229

Table 7 shows a lower misconception mean score for experimental groups with Computer Animated Loci Technique compared to control groups. A one- way ANOVA procedure was used to establish whether there was a statistically significant difference in mean scores among the four groups. The results are shown in Table 8

TABLE 8: *One- way ANOVA of the post-test scores of Misconceptions on MAT*

Source of variance	Sum of squares	df	Mean square	F- computed	F- critical	P-value
Between groups	3068.885	3	1022.962	14.180	2.6519	0.0000
Within groups	14644.197	203	72.139			
Total	17713.082	206				

Significant at p< 0.05 level

Table8 indicates that differences in misconception scores between the four groups were statistically significant different, F(3,203) = 14.180 and p < 0.05. After establishing that there was a significant difference between misconceptions scores in MAT, it was important to carry out further test on various combinations of means to find out where the difference occurred. The post hoc test of multiple comparisons using Scheffe's method was used. The Scheffe's method is preferred since the sample sizes selected from the different populations were not equal (Githua and Nyabwa, 2008). Table 9 shows the results of Scheffe's post hoc multiple comparisons.

TABLE9: *Scheffe's post hoc comparison of the post-test Misconception Mean Scores on MAT for the Study Groups*

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.
E1	C1	-5.381*	1.624	.013
	C2	-8.792*	1.737	.000
	E2	.864	1.674	.966
C1	E1	5.381*	1.624	.013
	C2	-3.411	1.681	.252
	E2	6.245*	1.616	.002
C2	E1	8.792*	1.737	.000
	C1	3.411	1.681	.252
	E2	9.656*	1.729	.000
E2	E1	-.864	1.674	.966
	C1	-6.245*	1.616	.002
	C2	-9.656*	1.729	.000

* The mean difference is significant at the 0.05 level.

The results in Table 9 indicated that the pairs of misconception scores of groups E1 and C1; E2 and C1; E1 and C2; and E2 and C2 are significantly different at α = 0.05 level. However, the mean scores of groups E1 and E2, and C1and C2 are not significant different at α = 0.05 level. This study involved non-equivalent control groups it was necessary to confirm the results by performing Analysis of Covariance (ANCOVA) using pre-test scores as the covariate. According to Campbell and Stanley (2015), the threat to internal validity of non-equivalent control group experiments is the possibility that group differences on the post-test may be due to initial or pre-existing group differences rather than to the treatment effect. According to Wilcox, (2015), ANCOCA reduces the effects of initial group differences statistically by making compensating adjustment to post-test means of the group involved. With nonrandomized designs, the main purpose of ANCOVA is to adjust the posttest means for differences among groups on the pretest, because such differences are likely to occur with intact groups.

TABLE10: *Observed and Adjusted MAT post-test Misconceptions mean Score for ANCOVA with pre-test Misconceptions mean Score as the covariate*

Group	N	Observed MAT Mean score	Adjusted MAT mean score	Standard error
E1	59	33.55	34.98	1.964
C1	51	36.02	35.26	2.009

The results from Table 10 and Table 11 confirmed that the differences in mean scores in the experimental group E1 and control group C1 are statistically significant.

TABLE 11: *Summary ANCOVA of the Post –test Misconception mean scores with pre-test Misconception mean scores as covariate*

	Sum of squares	df	Mean square	F	P
Computer Animated Loci Technique	558.51	1	558.51	8.56	0.004197
Between regressions	5.16	1	5.16	0.08	0.777849
adjusted error	6978.1	107	65.22		
adjusted total	7536.61	108			

A further comparison was done to check the mean gain of the students in the pre-test and post- test for the experimental group E1and the control group C1 as shown in Table 12

TABLE 12: *Comparison of misconception mean scores in pre-test and misconception mean score gain obtained by students in the MAT*

Overall (N= 110)	Experimental group E1	Control group C1
Pre –test mean	33.55	36.02
Post –test mean	27.94	33.32
Mean gain	5.61	2.70

Table12 shows that the experimental group E1 had a higher drop misconception mean score as compared to control group C1. The group that was taught using Computer Animated Loci Technique had lower misconceptions mean score drop than the control group. The hypothesis that there is no statistically significant difference in mathematics misconception mean score between students taught using Computer Animated Loci Technique and those taught through the conventional teaching methods was rejected at the 0.05α level. Therefore, using computer Animated Loci Technique improves students' misconception in the topic Loci in particular and mathematics in general more than when the students are taught using the conventional teaching methods. According to Salih, Erol and Kose(2006) who studies misconception related to photosynthesis and respiration in plants, the pre-test results showed that students had misconception at the rate of 46% and 27% in the experiment group and 37% and 26% in the control group. After treatment, the rate of misconceptions decreased to15% and 4% in the experiment group; 29% and 15% in the control group, respectively. This implied that computer animation reduced the misconceptions. This agrees with Ramazan and Osman (2012) who found out that the results of the computer Animations help remediate misconception in probability examinations more effectively than traditional teaching methods. Han-Chin (2005) investigated students' misconceptions and understanding of electrochemistry and found that student who used computer animation had less misconceptions compared to those who used convectional teaching method. According to Green,*et al*.(2008) the student who use computer animation to learn geometry are less likely to make misconceptions as compared to those who learn geometry using convection methods. However the mere presence of computer animations programmes does not does not reduce the misconceptions that students have in Geometry. The effectiveness of animation depend the designer. When professional are involved in making the animations then the animations are likely to be more reliable Ramazan and Osman (2012)

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