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Effects of the Computer Animated Geogebra Technique in Geometry during Instruction on Secondary School Students' Mathematics Achievement in Kitui County, Kenya

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Abstract:
Student's poor mathematics achievement at KCSE examinations in Kenya's secondary schools have continued despite the government's effort. The reasons for the dismal achievement are attributed to several factors, which include: poor teaching methods, lack of teaching and learning resources, and abstract nature of mathematics. Some mathematics topics among them Geometry has consistently been labelled "too hard" to teach and learn hence its poor performance. The study sought to investigate effects of using Computer Animated Geogebra technique on geometry during instruction on students' achievement in the mathematics topic. It was hoped that the use of ICT would improve the sorry state of mathematics achievement. 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 geometry concepts to augment the teaching of Geometrical concept. Solomon Four, Non-Equivalent Control Group Research Design was used. To ensure that there were 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 Geogebra 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 Geometry was used. The instruments were pilot tested to estimate their reliability. The instrument was validated by four experts from the Department of Curriculum, Instruction and Educational Management of Egerton University and three mathematics examiners. The reliability coefficient of the instrument was computed to be 0.8826 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.

Keywords: *Computer Animated Geogebra technique, mathematics achievement, Geogebra,*

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). 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). 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. 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). Mathematics helps the leaner in developing analytical and reasoning skills with the use of logical and structured thoughts.

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).

Despite the effort of the Kenya government on the development of mathematics teaching and provision of opportunities for the improvement of teaching, such as introduction of Strengthening Mathematics and Science in Secondary Education (SMASSE) programme, there are still problems of mathematics teaching and learning. If Kenya is to achieve the Vision 2030, whose aim is making Kenya a newly industrialised middle-income country (GOK, 2007), then we must excel in sciences, and the vehicle for this is mathematics.

In Kenya mathematics has consistently been ranked the last in performance in comparison with the other subjects offered at the KCSE (KNEC, 2008). Kiptum, Rono, Too, Bii and Too (2013), are of the view that mathematics is a subject favouring male student in Kenya due to factors like attitude, methods used for teaching among others. This has resulted to gender differences between male and female students in Mathematics performance. Several studies and reports carried out have established the causes of the appalling state of Mathematics (KNEC, 2006; O'Connor, Kanja & Baba, 2000; SMASSE, 1998). Some of the causes identified were: (a) Negative attitude of students towards Mathematics, (b) lack of appropriate teaching methodology (c) inadequate assignments to students and (d) inadequate coverage of syllabus. To remediate the poor mathematics performance, (SMASSE) project opted to organise National and District in service Education and Training (INSETS) for mathematics and science teachers that emphasised on the teaching approach.

A critical look at the students' overall performance in mathematics at the KCSE from the year 2010 to 2014 national examinations reveals that the students' performance persistently remained low with gender disparities in mathematics performance with boys doing better in overall performance at the KCSE national mathematics examinations., as shown in the Table 1.

Year	**2010**	**2011**	**2012**	**2013**	**2014**
Grade Total KCSE Mean% Scores	23.04	24.79	28.66	27.56	24.02

Table 1: KCSE Mathematics Examination Mean Scores for Years 2010 to 2014
Source: KNEC, 2013 pp (xii) & 2015 pp 10

The KCSE mathematics examination results from Kitui County shown in Table 2 indicate that the performance index was below 4 points out of 12 points for four consecutive years. This shows that the poor performance in mathematics has persisted in the County. Despite the effort of the stake holders, among them: students, teachers, principals, education officers, SMASSE District trainers and parents, Kitui County has persistently been doing poorly in mathematics at KCSE. Among the factors attributed to this poor performance in mathematics are: poor teaching methods; inadequate teaching and learning resources both human and physical; abstract nature of mathematics; insufficient monitoring of teaching and learning (CEMASTEA, 2012).

Year	**2012**	**2013**	**2014**	**2015**
Mean score (out of 12 points)	3.334	3.111	3.586	3.507

Table 2: KCSE Mathematics Result for Kitui County for the years 2012 to 2015
Source: KCDO, 2014, Pp 10

1.1. The Concept of Geometry in Mathematics

Vashist (2007), defines Geometry as that branch of mathematics in which such figures as squares, triangles, cubes, among others are studied; specifically, students construct and measure the angles, length of various geometric figures and study the relationship that exist between their parts. According to Gale and Davidson (2006) geometry is used in such fields as astronomers, surveyors, architecture and engineering. According Shinwha and Noss (2001) locus is a path traced by a point as it moves so as to satisfy certain conditions. Locus can be a line, an area or region in two dimensions or a volume in three dimensions (Kibui & Marcrea, 2005). In Kenyan secondary schools, the topic loci are taught to form four students. The prerequisites to loci are taught in form one as geometrical construction, in form two is angle properties of circle and in form three is tangent and circle. The common types of loci among them: locus of points equal distance from a fixed point; angle bisector locus; constant angle locus; loci of chord, loci involve inequalities and intersecting loci (MOE, 2006) plays a key role in loci problem solving.

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

Table 3: KCSE Mathematics Item Analyses Paper One 1994 Number 19
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 as a subset of Geometry 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.

1.2. 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' poor performances in the subject have been argued to be unsuitable 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 geometry that is taught to form four students. 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, computer animated Geogebra technique was used during instruction of geometry 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 investigated the effects of Computer Animated Geogebra Technique during instruction on secondary school students' mathematics achievement in the mathematics topic geometry in Kitui County, Kenya.

1.3. Purpose of the Study

The purpose of this study is to investigate the effects of Computer Animated Geogebra Technique on the mathematics geometry topic during instruction on secondary school students' mathematics achievement and misconceptions in the mathematics topic geometry in Kitui County, Kenya.

1.4. Objectives of the Study

The following objectives guided the study:

i. To establish the effects of Computer Animated Geogebra Technique during instruction on secondary school students' mathematics achievement**,** in "Geometry".

1.5. Hypotheses of the Study

The following null hypothesis was statistically tested at coefficient alpha (α) level value equal to 0.05.

H_O1: There is no statistically significant difference in the mathematics achievement scores between students exposed to Computer Animated Geogebra Technique and those not exposed to it during mathematics instruction.

1.6. 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, affect 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.

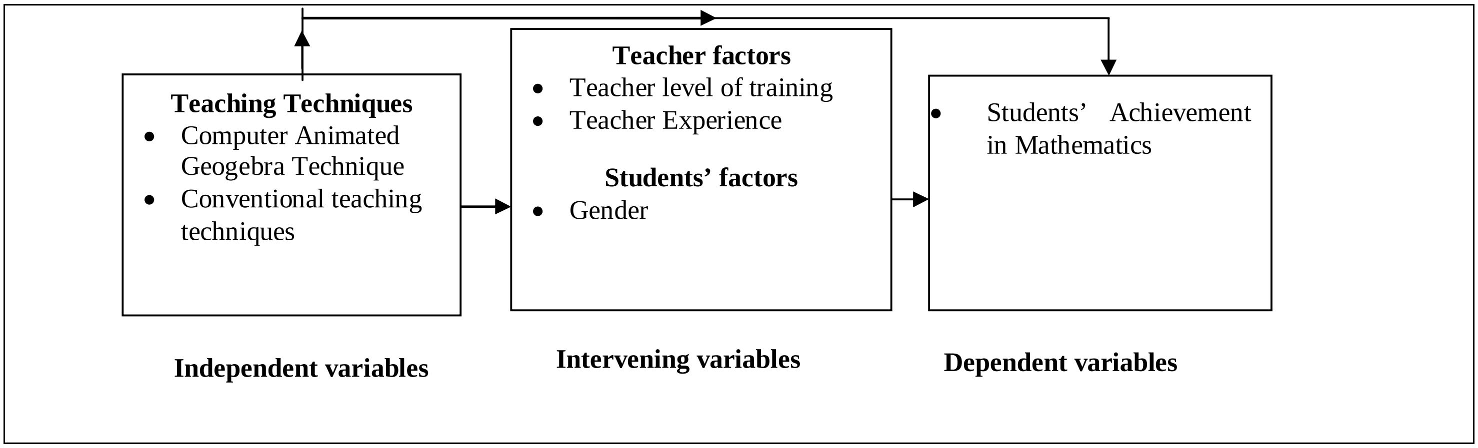

Figure 1: The Diagrammatic Representation of the Relationship between the independent, Intervening and dependent variables of the Study

2. 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_1 and O_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).

2.1. 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 forms four students in Kitui County out of which 10,630 are in Mixed Sex Sub-County schools (KCEO, 2015).

2.2. 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.

2.3. 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.

3. Results of the pre-test on MAT

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

	C1	E1	C2	E2	TOTAL
TOTAL	59	51	45	52	207

Table 4: Number of students who participated in the research study in experimental and control schools

Table 10 shows the mean, standard deviations of pre-test scores in MAT. The groups C1 and E1 sat for pre-test MAT, which made it possible for the study to assess the homogeneity of the groups before treatment application as recommended by Gall, Borg and Gall (1996); Kumari (2013). Table 11 shows the t-test of pre-test scores in MAT

Variable	Group	N	Mean	SD	df	t-computed	t-critical	p-value
MAT	C1	59	26.86	17.137	108	0.158	1.9864	0.719
	E1	51	26.35	16.578				

Table 5: Independent sample t-test of pre-test scores on MAT based on groups E1 and C1

Not significant at p>0.05 level

The independent sample t- test for MAT pre-test mean score for groups E1 and C1 were not significantly different, t (108) = 0.719 and p > 0.05 as shown in Table 5, implying that the groups had similar characteristics and were suitable for the study.

3.1. Item Analyses

Two items were analysed to give insight as to what extent computer Animated Geogebra technique can make difficulty or abstract mathematical concepts more clearly for students to understand and hence improve on their mathematical achievement.

3.2. Test Item1

- Describe and Sketch the Loci traced by axle of a bicycle wheel as it moves forward on a level ground (4 marks).

<u>3.2.1. Pre-Test Results</u>

Before the teaching started the students were given the test to find out their entry behaviour and ascertain whether the groups were homogeneous and comparable. The students were given some times to think and put their solutions in writing. Some of the solutions that students presented are as in figure 3

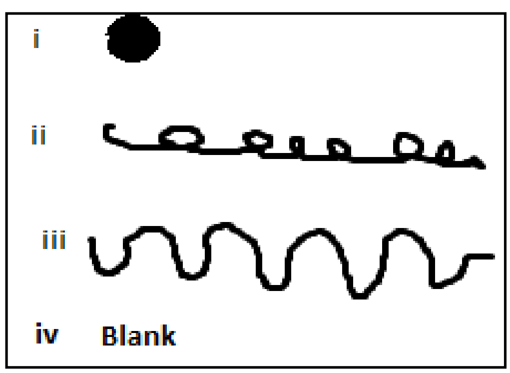

Figure 3: Some pre-test solutions from MATTest Item 1

The highest score for the item was four marks and the lowest was zero. Majority of the students in both the control and experimental groups for pre-test got zero mark and no student got all the marks in the question. Table 6 shows the percentage distribution of the marks.

Marks	**0**	**1**	**2**	**3**	**4**
Control group: % of candidates scoring the marks	80	13	7	0	0
Experimental group: % of candidates scoring the marks	78	17	5	0	0

Table 6 shows the pre-test analyses of the students' scoring in the item 1

Before the intervention both the students in control and experimental groups had their performance in the item similar hence comparable.
During instructions in the experimental group the students were presented with a Geogebra animated moving bicycle with it rare wheel's axle tracing locus. The control group were taught using the other conventional methods other than Computer Animated Geogebra method. Figure 4 shows the locus traced by the axle of a bicycle wheel as it moves forward on a level ground. The students interacted with the animation where they would animate, stop and reset the animation. The locus represents a line parallel to the level ground.

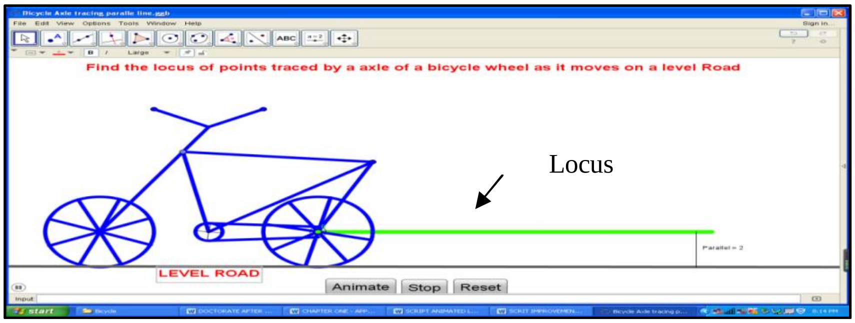

Figure 4: Geogebra animation of an axle of a bicycle wheel as the bicycle moves on a level ground

3.2.2. Post Test Results
After the intervention, all the students sat for a post-test of the same MAT. On Test Item1the students were expected describe and sketch the locus traced by the axle of a bicycle as it moves on a level ground. Table 7 shows the marks distribution on the test item. From the table, the students who used computer Animated Geogebra technique performed better than those who used the conventional teaching methods.

Marks	0	1	2	3	4
Control group: % of candidates scoring the marks	51	22	10	13	4
Experimental group: % of candidates scoring the marks	28	17	15	22	18

Table 7: The post-test analyses of the students' scoring in the item 1

3.3. Test Item2

- Describe and Sketch the Loci traced by a point on the rim of a bicycle wheel as it moves forward on a level ground (4 marks).

3.3.1. Pre-Test Results
The teaching started with the students being given a pre-test to find out their entry behaviour and ascertain whether the groups are homogeneous and comparable. The students were given some times to think and put their solutions in writing. Some of the solutions that students presented are as in figure 6.

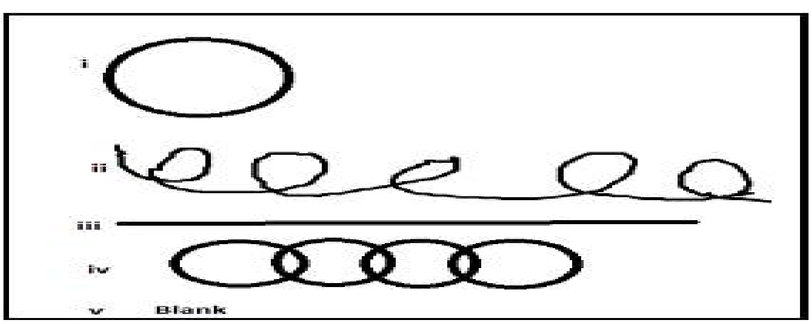

Figure 6: Some pre-test solutions from MAT item 2

Table 7 shows the marks distribution in the test item for the pre-test. From the table all the students in control and experimental groups, majority of the students could not get a mark in the test item. No student got the four maximum marks in the test item. The students were of similar characteristics hence comparable.

Marks	0	1	2	3	4
Control group: % of candidates scoring the marks	95	4	1	0	0
Experimental group: % of candidates scoring the marks	93	5	2	0	0

Table 7 shows the pre-test analyses of the students' scoring in the item 1

During instructions in the experimental group the students were presented with a Geogebra animated moving bicycle with a point on its rare wheel's rim tracing locus. The control group was taught using the other conventional methods other than Computer Animated Geogebra method. Figure 7 shows the locus traced by a point on the rim of a bicycle wheel as it moves forward on a level ground. The students interacted with the animation where they would animate, stop and reset the animation. The expected locus of points traced by the nozzle of the bicycle as the bicycle moves forward on a level ground is demonstrated in the Figures 7. The locus represents consecutive arcs.

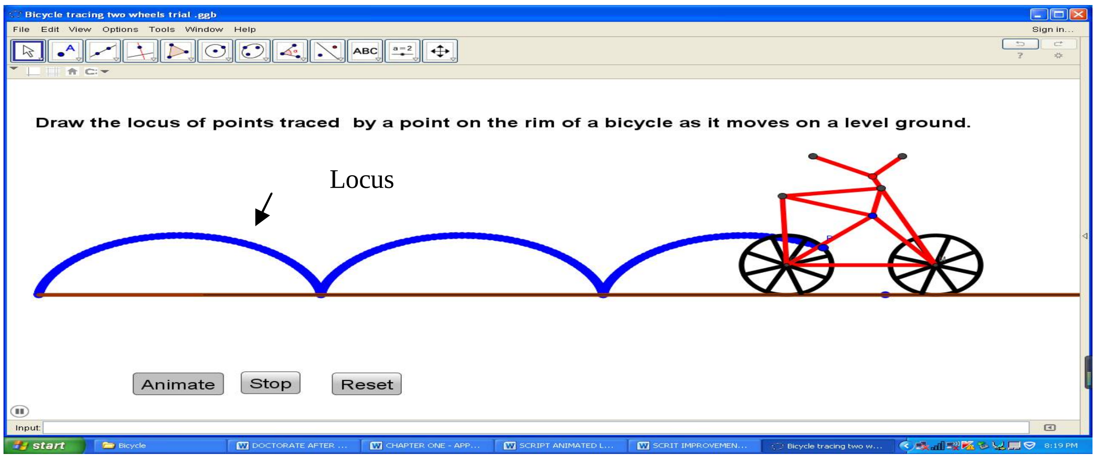

Figure 7: Geogebra animation of a point on the wheel of a bicycle as the bicycle moves on a level ground

3.3.2. Post Test Results

After the intervention, all the students sat for a post-test of the same MAT. On Test Item2 the students were expected describe and sketch the locus of points traced by a point on the rim of a bicycle wheel as it moves on a level ground. Table 8 shows the marks distribution on the test item. From the table, the students who used computer Animated Geogebra technique performed better than those who used the conventional teaching methods.

- The expected locus traced by a point on the rim of a bicycle as it moves on a level ground.

Marks	**0**	**1**	**2**	**3**	**4**
Control group: % of candidates scoring the marks	56	22	20	1	1
Experimental group: % of candidates scoring the marks	30	19	17	18	16

Table 8 shows the post-test analyses of the students' scoring in the item 2

4. Effects of Computer Animated Geogebra technique on Students' Achievements in Mathematics

To establish the effects of Computer Animated Geogebra Technique on students' performance in geometry, the Post-test scores of the MAT were analysed. Hypothesis HO_1 sought to establish whether there was a significant difference in achievement between students taught using Computer Animated Geogebra Technique and those taught using the conventional teaching methods. Table 9 shows the MAT mean scores obtained by the four groups.

	C1	**E1**	**C2**	**E2**	**Total**
N	59	51	45	52	207
Mean	36.10	48.20	31.91	52.98	42.41
Std. Deviation	16.879	14.630	16.661	17.529	18.425

Table 9: Post –test MAT mean scores obtained by the students in the study groups.

C1 = Control group 1 E1 = Experimental group 1
C2 = Control group 2 E2 = Experimental group 2

Table 9 shows a higher mean score for experimental groups with Computer Animated Geogebra 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 10

Source of variance	Sum of squares	df	Mean square	F- computed	F- critical	P-value
Between groups	14826.042	3	4942.014	18.204	2.6519	0.0000
Within groups	55110.054	203	271.478			
Total	69936.097	206				

Table 10: One- way ANOVA of the post-test scores on the MAT
Significant at p< 0.05 level

Table 10 shows that differences in achievement between the four groups were statistically significant different, F (3,203) = 18.204and p < 0.05. After establishing that there was a significant difference between mean scores in MAT achievement, 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 11 shows the results of Scheffe's post hoc multiple comparisons.

(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.
C1	E1	-12.094*	3.150	.003
	C2	4.191	3.261	.648
	E2	-16.879*	3.134	.000
E1	C1	12.094*	3.150	.003
	C2	16.285*	3.370	.000
	E2	-4.785	3.247	.539
C2	C1	-4.191	3.261	.648
	E1	-16.285*	3.370	.000
	E2	-21.070*	3.355	.000
E2	C1	16.879*	3.134	.000
	E1	4.785	3.247	.539
	C2	21.070*	3.355	.000

Table 11: Scheffe's post hoc comparison of the post-test MAT means for the study groups
* The mean difference is significant at the 0.05 level.

The results in Table 11 indicated that the pairs of MAT 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.

The main 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 (Gall *et al., 1996*). This study involved non-equivalent control groups, it therefore was necessary to confirm the results by performing Analysis of Covariance (ANCOVA) using pre-test scores as the covariate. According Dimitrov and Rumrill (2003), the purpose of using the pre-test scores as a covariate in ANCOVA with a pretest-posttest design is to (a) reduce the error variance and (b) eliminate systematic bias. According to Lowry, (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 post-test means for differences among groups on the pre-test, because such differences are likely to occur with intact groups.

Group	N	Observed MAT Mean score	Adjusted MAT mean score	Standard error
E1	59	48.20	48.39	2.049
C1	51	36.10	35.94	2.197

Table 12: Observed and Adjusted MAT post-test Mean Score for ANCOVA with pre-test MAT score as the covariate

The results from Table 12 and Table 13 confirmed that the differences in mean scores in the experimental group E1 and control group C1 are statistically significant.

	Sum of squares	df	Mean square	F	P
Computer Animated Loci Technique	4236.84	1	4236.84	35.93	0.0001
Between regressions	583.34	1	583.34	5.14	0.025410
adjusted error	12616.63	107	117.91		
adjusted total	16853.48	108			

Table 13: Summary ANCOVA of the Post –test MAT scores with pre-test as covariate

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 14

	Overall (N= 110)	Experimental group E1	Control group C1
Pre –test mean		26.35	26.86
Post –test mean		48.20	36.10
Mean gain		21.85	9.24

Table 14: Comparison of mean scores and mean gain obtained by students in the MAT

Table 14 shows that the experimental group E1 had a higher mean score gain as compared to control group C1. The group that was taught using Computer Animated Geogebra Technique had a higher mean score gain than the control group. The hypothesis that there is no statistically significant difference in mathematics achievement between students taught using Computer Animated Geogebra Technique and those taught through the conventional teaching methods was rejected at the 0.05α level. Therefore, using computer Animated Geogebra Technique improves students' achievement in the geometry in particular and mathematics in general more than when the students are taught using the conventional teaching methods.

5. Discussion

When the two experimental groups (E1 and E2) are found to be similar in post-test but not similar to the two control groups (C1 and C2), the differences may be attributed to the treatment conditions (Gall *et al., 1996*). If pre-test interacts with the treatment conditions, the difference between groups E1and E2 (4.78) should be significantly greater than that between groups C1 and C2 (4.19) (Gall *et al., 1996*). This is because a pre-test sensitization facilitates the learning of the experimental group but not the control group (Borg and Gall, 1989). The post-test achievement scores did not indicate any interaction between pre-test and the Computer Animated Geogebra Technique.

The study found that students who were taught using Computer Animated Geogebra Technique achieved significantly higher scores in MAT than those who were taught through the conventional teaching methods. This is an indication that the use of Computer Animated Geogebra Technique was more effective in improving students' mathematics achievement as compared to the conventional teaching /learning methods. These findings agree with Karacop and Doymus (2013) who found that the teaching of chemical bonding via the animation techniques was more effective than the traditional teaching method in increasing academic achievement. The same was observed by Westhoff, Bergman and Carroll (2010) who reported that computer animations increase the performance of high school biology students. The students understood a complex signal transduction pathway better after viewing a narrated animation compared with a graphic with an equivalent legend (O'Day, 2006). Comparing students lectured without any supplement teaching material to those who were taught chemical concepts using animation, O'Day (2007) found students using animations had significantly higher exam scores. Similarly, Wang, Vaughn, and Liu (2011) found that animation interactivity improved students′ performance in statistics. The same results were found by Gambari, Falode and Adegbenro (2014) that students exposed to computer animations had a better achievement score in geometry than those using traditional methods. However, this differs to the findings of Birgan (2010) who reported that there was no difference in achievements among students who utilized computerized animated homework and those who did not. Palmiter (1993) studied the use of animation to aid computer authoring tasks, in their findings, Animation initially assisted accuracy, speed and achievement, but after one week had elapsed, the subjects exposed to animations actually had regressed behind the non-animation subjects. Students whose teachers used technology to teach lower-order thinking skills were found to have lower achievement in mathematics (Tienken & Maher, 2008). While these findings are not surprising, it is clear that the use of technology alone is not a panacea for improved student achievement. Richtel's (2011) report on the standardized test scores of students in the Kyrene School District in Arizona detailed the lack of improvement in student achievement despite the $33 million investment in technology.

6. Implications of the Study

Computer Animated Geogebra Technique resulted in higher mathematics achievements in Mixed-Sex District Secondary Schools in Kitui County. Since majority of students in the county are in Mixed –Sex Secondary Schools (KCEO, 2014; 2015) the use of Computer Animated Geogebra Technique in teaching of the geometrical mathematics can improve the current trend of dismal performance in mathematics.

7. Recommendation

(i) Computer Animated Geogebra Techniquewas found to be effective as a teaching strategy for geometry instruction when compared with traditional method of instruction. Therefore, mathematics teachers should be encouraged to use it.

(ii) Mathematics educators should introduce a mathematics education unit where students make Computer animations for mathematics concepts. The problem of dismal performance in mathematics may be addressed by use of computer animations.

(iii) Mathematics Education stakeholders such as QASO and KICD should encourage teachers to use Computer animations in their teaching. This should be done with caution, because the success depends on how the animations are effectively used. Computer animations are more effective when they are used to supplement but not to entirely replace other methods of instruction.

(iv) In service courses organised by the Ministry of Education, such as CEMASTEA, TSC and KICD, should incorporate Computer animations in their teaching programmes. This is because the quality of teachers and the kind of training they have is a major determinant of the quality of education in any country. Teacher training programmes should equip the teachers with the knowledge and skills necessary to achieve the educational goals and objectives.

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