

# APPLICATION OF GEOGEBRA INTO TEACHING AND LEARNING OF LINEAR AND QUADRATIC EQUATIONS AMONGST SECONDARY SCHOOL STUDENTS IN FAGGE LOCAL GOVERNMENT AREA OF KANO STATE, NIGERIA.

By

**Mamman, M. A & Isa, S. G**

*Faculty of Science and Technology Education Department of Computing and Mathematics Education  
Kano University of Science and Technology, Wudil.  
auwalmusa58@gmail.com*

## **Abstract**

*This study investigated the effectiveness of GeoGebra software in teaching and learning of linear and quadratic equations amongst senior secondary school students in Fagge Local Government Area, Kano State – Nigeria. Five research items were raised in objectives, research questions and hypotheses respectively. A random sampling method was used in selecting 398 students from a population of 2098 of SS2 students. The experimental group was taught using the GeoGebra software while the control group was taught using the conventional teaching method. The instrument used for the study was the mathematics performance test (MPT) which was administered at the beginning and at the end of the study. The results of the study revealed that students taught with GeoGebra software (experimental group) performed better than students taught with traditional teaching method. The t- test was used to analyze the data obtained from the study.*

**Key words:** *GeoGebra Software, Mathematics Performance, Mathematics Teaching, Random Sampling*

## **Introduction**

The study of mathematics in our secondary schools in Kano State, Nigeria has been faced with numerous challenges over the years. It is a well known fact that the importance of mathematics cannot be over emphasized especially at the grassroots, (primary and secondary schools). Students need to acquire a minimum of credit six (C<sub>6</sub>) in Mathematics and English language and four other related subjects to acquire admission into institutions of higher learning. The acquisition of its knowledge is therefore paramount and fundamental in every educational system that intends to prepare its students for a productive life after school.

The application of technology in classrooms in the teaching and learning of mathematics has not been quite successful. Majority of teachers have failed to acquaint themselves with the use of necessary mathematics software that will facilitate the understanding of the mathematics concepts. Seo and Bryant (2009) stressed that traditional educational environments do not seem to be suitable for preparing learners to function or be productive in the workplace of today's society. They claim that organizations that do not incorporate the use of new technologies in schools cannot seriously claim to prepare their students for life in the twenty first century.

In order to aid the understanding of mathematical concepts, experts across the globe have developed a number of mathematics software, some of which include Computer Algebra Systems, Dynamic Geometry Software, Spread Sheets. Of all these software, GeoGebra proved to be more outstanding and has made more impact in recent years.

GeoGebra which is also a Dynamic Mathematics Software (DMS) is designed for teaching and learning mathematics in secondary schools and colleges. The software combines the ease of use of a Dynamic Geometry Software (DGS) with certain features of a Computer Algebra Systems (CAS) and therefore, allows for bridging the gap between the mathematical disciplines of geometry, algebra and calculus Hohenwarter and Preiner (2007). Also, according to Hohenwarter and Fucks (2004), GeoGebra is an open source software freely available on the internet and can

be accessed using [www.goegebra.org](http://www.goegebra.org). It has different representations of some mathematical objects which are connected dynamically to allow users to go back and forth between them using the icons on the menu bar Preiner (2008).

### **Statement of the Problem**

In view of the poor performance of students at the Secondary School level due to poor method of teaching, this study adopted the use of technology in classrooms to facilitate the understanding of mathematical concepts. The study therefore, investigated the application of GeoGebra into teaching and Learning of linear and quadratic amongst secondary school students in fagge Local Government Area of Kano State, Nigeria.

### **Significance of the Study**

The study was expected to provide necessary information on:

- (i) The effectiveness of GeoGebra towards improving students' learning ability in mathematics.
- (ii) To also serve as a means of helping prospective teachers to change their attitude towards the teaching of mathematics.
- (iii) To reveal more clearly how the teaching of geometry is linked with algebra.

### **Objectives of the Study.**

The main objective of the study was to investigate the effect of applying GeoGebra software into teaching and learning of linear and quadratic equations amongst senior secondary school students in Kano State, Nigeria.

In view of this, the specific objectives of the study therefore, are to;

- (i). find out if there is any significant difference in the mathematics performance of the experimental and control group before intervention (i.e. before using the GeoGebra Software).
- (ii). determine whether there was any significant difference in the mathematics performance of the experimental and control group after intervention (i.e. after applying the GeoGebra software)
- (iii). investigate the extent to which the GeoGebra software will distinguish the performance based on gender within the experimental group.
- (iv). distinguish the performance based on female gender between the experimental and control group.

### **Research Questions**

Specifically, the study sought to answer the following research questions:

- (i). To what extent does the performance of the experimental group differ from the control group before intervention?
- (ii). How does the performance of the experimental group differ with that of the control group after intervention?
- (iii). Was there any difference in the mean scores of the gender within the experimental group?
- (iv). Was there any difference in the mean score of the male students in the experimental group and the control group?
- (v). Was there any difference in the mean scores of the female students in the experimental and control group?

### **Null Hypotheses**

Based on the research questions stated above, the following hypotheses stated in null form were tested at  $p \leq 0.05$  to determine the relationship between the variables in the study.

- (i).  $H_{01}$ : There was no significant difference in the mean performance of the experimental and control group before intervention
- (ii).  $H_{02}$ : There was no significant difference in the mean performance of the experimental and control group after intervention.
- (iii).  $H_{03}$ : There was no significant difference in the mean performance of the male and female students within the experimental group.
- (iv).  $H_{04}$ : There was no significant difference in the mean performance between the male students in the experimental and control group.
- (v).  $H_{05}$ : There was no significant difference in the mean performance between female students in the experimental and control group.

### **Literature Review**

The review of the related literature mainly focused on the impact made by GeoGebra software in mathematics classroom around the world. Chrysanthou (2008) revealed that skills, pedagogy and curriculum are the three main aspects in the use of GeoGebra in the classroom. Teachers need to know how it works and how it can effectively be integrated both within the classroom and within the curriculum. Thus, when incorporating GeoGebra in the classroom, these fundamental features should be taken into consideration. In success of GeoGebra has shown that noncommercial software packages have the potentials to influence mathematics teaching and learning worldwide Hohenwarter and Lavicza (2007). Also, Dogan and Icel (2010) conducted an experimental study using pre – test to evaluate the success of students learning using GeoGebra software in Istanbul, Turkey. It was a twelve hour course held for a period of twelve weeks involving two eighth grade classes and was observed that computer based activities can effectively be used in learning process using the GeoGebra software to encourage higher order of thinking skills. The software was also observed to have positive effect in monitoring students towards learning and retaining knowledge for a long period of time.

Hohenwarter and Fucks (2004) investigated the effect of GeoGebra on student conceptual and procedural knowledge of functions, the study involved 284 students from two upper secondary schools in Rokan Hulu, Riau Indonesia. Out of these students 138 were place in experimental group (use of GeoGebra software) while the remaining 146 students were placed in the control group. Data were collected using the conceptual and procedural test on the topic of function. The findings of the study revealed some positive impact of the software and that more support is needed to promote the use of the GeoGebra.

## **METHODOLOGY**

### **Research Design**

The study was quasi – experimental with an experimental and control group.

### **Population**

The population of the study consisted of all 2086 senior secondary school students in Fagge Local Government Area of Kano State, Nigeria.

### **Sample**

A total of 398 students randomly selected out of a population of 2086 from two girls and two boys' secondary schools selected. 200 students make up the sample for the experimental group while 198 make up the sample for the control group.

### **Sampling Technique**

Random sampling techniques was use at the level of selecting the schools as well as selecting students for the experimental and control group.

### Instrumentation

As a necessary requirement, permission was sought from the principals of the two selected schools for the study. Two mathematics teachers, one from each of the selected school were selected to serve as research assistants. They were trained for one working week (5 days) by the researcher, and were also given detailed plan and instruction on the study prior to the treatment.

A pretest was administered to the student before embarking on the treatment exercise. The pretest was aimed at ensuring that they have equal ability before the commencement of the treatment.

The second phase was the treatment exercise which lasted for two working weeks (10 days). The experimental group was taught using the GeoGebra software in the laboratory containing 50 desktops. Two students were paired per desktop. The treatment was in two separate sessions of 100 students in each session. The treatment for each session lasted for 40 minutes.

The control group was taught using the conventional teaching method and also lasted for the same duration of time as the experimental group.

At the end of the treatment, a post test was administered to both groups the results of both pretest and posttest were analyzed using the t – test statistical tool.

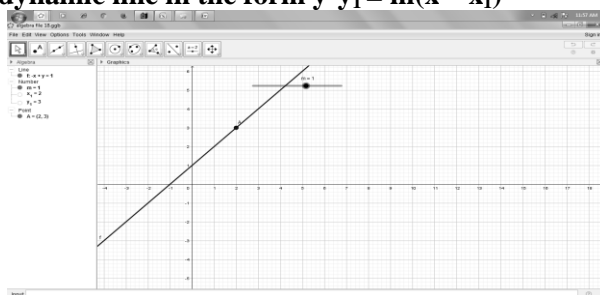
### Manual Guide Used for the Experimental Group with the GeoGebra Software

The researcher projected the GeoGebra window on the screen using a projector which enabled him to explain and demonstrate the construction process using the GeoGebra tools, commands and features while the students pay attention and take notes. After repeated constructions, demonstration, and solution to some exercises, the participants were allowed to redo some the exercises with little guidance by the researcher and the regular mathematics teacher.

The researcher again demonstrated step – by – step the construction work and some exercise while the participants were encouraged to work along with him. Thus, every participant will keep up with the pace of the researcher, although questions could be posed in between.

Finally, the researcher introduced a new task and encouraged the participants to find their own solution using the GeoGebra software.

### How to generate a dynamic line in the form $y - y_1 = m(x - x_1)$

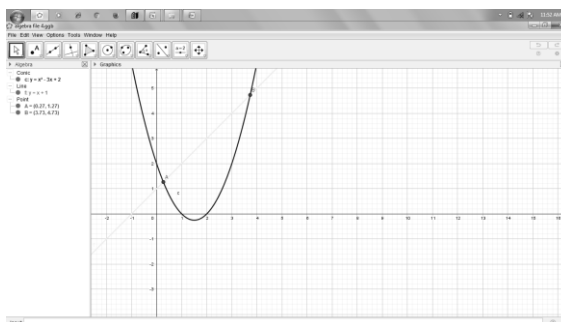


#### *Adding a point $(x_1, y_1)$ , a slider, $m$ , for the gradient and the line*

- Click on the 2<sup>nd</sup> menu to add a point A.
- In the input bar type  $x_1 = x(A)$  and press enter.

- Also type  $y_1 = y(A)$  and press enter.
- Click on the 10<sup>th</sup> menu to add a slider and name it **m**.
- In the input bar type  $y - y_1 = m(x - x_1)$  and press enter.

### Intersection of a line and a curve



- Open a new GeoGebra file.
- In the input bar type  $y = x^2 - 4x + 1$  and press enter.
- Again type in the input bar  $y = x - 3$ .
- Click on the 2<sup>nd</sup> menu to select the intersect icon and obtain the points of intersection of the line and the curve.

### Questions.

- What is the relationship between the x-coordinates of the points of intersection and the equations of the line and curve?
- Find the exact values of the coordinates of the points of intersection of the following. ( Use pencil and paper first before using the software.)
  - $y = x - 1$  and  $y = 2x + 3$
  - $y = x^2 - 3$  and  $y = 3 - x$
  - $y = x^2 - 3x + 6$  and  $y = 3x + 2$ .

### Data Analysis Techniques

A t-test was used to analyze the data obtained from the study.

#### Data Presentation and Analysis

**H<sub>01</sub>** There was no significant difference in the mean performance of the experimental and control group before intervention.

**Table I. Descriptive Statistics table for Experimental and Control group before intervention**

Group	N	X	SD	DF	t-Cal	t-Crit	Decision
Experimental	200	74.43	10.51				
Control	198	74.52	10.54	396	8.24	8.72	Not significant

The result from table I showed that t-calculated value was less than t-critical value, hence the null hypothesis was retained. This implies that the two groups have the same mathematics capability before the treatment was conducted.

**H<sub>02</sub>:** There was no significant difference in the mean performance of the students in the experimental and control group after intervention.

**Table II. Descriptive Statistics table for Experimental and Control group before intervention**

Group	N	X	SD	DF	t-Cal	t-Crit	Decision
Experimental	200	78.32	10.24				
				396	9.62	7.14	Significant
Control	198	67.51	8.72				

Result from table II revealed that the t-calculated value is 9.62 while the t-critical value is 7.14 at 0.05 level of significance and degree of freedom 396, therefore the hypothesis is rejected. This implies that the students in the experimental group performed better than the students in the control group.

**H<sub>03</sub>:** There was no significant difference in the mean performance of the male and female students within the experimental group.

**Table III. Descriptive statistics table of the male and female students within the experimental group.**

Group	N	X	SD	DF	t-Cal	t-Crit	Decision
Experimental	200	77.24	10.61				
				198	10.21	9.63	Significant
Control	98	74.12	10.02				

The result from table III showed that t-calculated is slightly higher than t-critical i.e.  $t\text{-cal} = 10.21 > t\text{-crit} = 9.63$  at 0.05 level of significance and with degree of freedom 198. This implies that the hypothesis is rejected, hence male students in the experimental group performed slightly better than the female students within the same group.

**H<sub>04</sub>:** There was no significant difference in the mean performance of male students in the experimental group and male students in the control group.

**Table IV. Descriptive statistics table of male students in the experimental and control group**

Group	N	X	SD	DF	t-Cal	t-Crit	Decision
Experimental (M)	102	78.23	10.92				
				200	10.82	8.40	Significant
Control(M)	100	64.41	7.83				

Table IV clearly revealed that male students in the experimental group performed significantly better than male students in the control. The experimental group obtained a standard deviation of 10.92 while the control group obtained 7.83. The t-cal was also greater than the t-critical indicating a rejection in the hypothesis.

**H<sub>05</sub>:** There was no significant difference in the mean performance of the female student in the experimental group and the female students in the control group.

**Table V. Descriptive statistics table of female students in experimental and control group:**

Group	N	X	SD	DF	t-Cal	t-Crit	Decision
Experimental	98	74.01	10.00				
				194	10.62	8.51	Significant
Control	98	68.20	8.92				

The result from table v indicated that t-calculated value is greater than t-critical value i.e  $t\text{-cal}=10.62>t\text{-crit}=8.51$ at 194 degree of freedom, which implies that the female students in the experimental group performed better than the female students in the control group.

### **Discussion**

The findings from this study, is consistent with the study by Hennessy, Fung and Scanlon (2001), Hannafin and Foshay (2008), Ahmad, Fauzi et. al. (2010) and Ahmad Tarmizi et. al. (2010). They found positive impact of utilizing mathematical learning software thus enhancing students learning and understanding. It clearly demonstrates the instructional effectiveness of GeoGebra as compared to the traditional construction tools. The findings revealed a significant difference on the performance of students when taught linear and quadratic equations using the GeoGebra software. The experimental group appears to be more effective when compared with the control group. Hohenwarter and Fucks (2004), on their research on function between the experimental and control group, the result of their findings showed that the use of GeoGebra in the teaching and learning process contributes to the enhancement of students' conceptual and procedural knowledge in the function. Their findings also revealed that male and female students have similar ability when taught using GeoGebra software. However, findings from this study revealed slight difference in the performance of male and female students. The male students slightly performed better than the female students, which is in line with the findings of Azlin and Suhaila (2008), that the use of technology in mathematics was more effective for male students. Although both the experimental and control groups gained from the study. The research established that the experimental group gained more. It also reveals that GeoGebra leads to better performance in mathematics examinations. It ensures a pictorial representations hence teachers and their students are able to make connections between the pictures, the mathematics concepts and the symbolic representation. By using it, learners are able to visualize the diagrams easily.

### **Conclusion**

This study brings to light, the effectiveness of using GeoGebra software for teaching and learning of mathematics in our classroom. Finding from this study reveals that the use of GeoGebra in teaching linear and quadratic equation impacts positively on the performance of both male and female students. The use of GeoGebra software can therefore be extended to other topics in mathematics teaching. The study concludes that GeoGebra is one sure way of eradicating poor performance of students in mathematics. Also, when it comes to gender equity, the study also concludes that technology benefited both girls and boys in learning mathematics even though boys performed slightly better than girls.

### **Recommendations**

- (i). There should be continuity in servicing mathematics teachers with regular information regarding the use of technology in the classroom.
- (ii). Studies should focus more on specific areas or topics of mathematics that students perform poorly rather than looking at mathematics from a general perspective.
- (iii). Government should further direct and support the use of computers for learning mathematics. This will make mathematics more exciting and interesting for the learners.
- (iv). It should be advocated that GeoGebra be incorporated in the teaching and learning of mathematics in our secondary schools.
- (v). In areas of mathematics where girls are challenged, the software is likely to improve attitude and hence improve their performance in mathematics. Teachers should therefore use appropriate technology in teaching girls.

(vi). During introduction of GeoGebra in the teaching and learning process, the teachers should be trained by organizing workshops and seminars.

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