



## **EFFECTS OF GEOGEBRA SOFTWARE PACKAGE ON SENIOR SECONDARY SCHOOL STUDENTS' ACADEMIC PERFORMANCE IN ALGEBRA IN EDO STATE, NIGERIA**

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### **Abstract**

This study investigated the effects of GeoGebra software package on senior secondary school students' academic performance in Algebra in Edo State, Nigeria. The study employed pretest posttest quasi experimental research design. A total of 2,413 public senior secondary one (SS1) students in Akoko Edo Education zone, Edo State, Nigeria constituted the population of the study. . Through multi-stage sampling techniques, a sample size of 100 senior secondary one (SS1) students was drawn from two public schools and used for the study. This study used an instrument called Algebra Concepts Performance Test with the acronym ACPT, The ACPT was constructed by the researchers and validated by experts in the field of Mathematics Education and Measurement and evaluation. The ACPT was used to measure the ability of students' academic performance in Algebra. The Reliability coefficient of 0.85 was established using the Split half method. Two research questions and two null hypotheses were stated and formulated to guide the study. Data obtained were analyzed using descriptive statistics (Mean and Standard deviation) to answer the research questions while inferential statistics (ANCOVA) was used to test the null hypotheses at 0.05 level of significance. The findings of the study revealed that there was a significant difference between the mean performance scores of students who were taught Algebra using GeoGebra software package (GSP) and those who were taught using conventional instructional method ( $F = 34.882, p = .000 < \alpha = 0.05$ ) This indicates that students taught Algebra with Geogebra software package (GSP) performed better than those taught with conventional instructional method (CIM). There was no significant difference between effect of the use of GSP to teach the male and the female students Algebra ( $F = .060, p = .809 > \alpha = 0.05$ ). The study therefore, recommended that, mathematics teachers should use technology (Geogebra software) and other innovative instructional strategies should be embraced to continuously improve students' academic performance. Also, mathematics teachers should make sure that both the male and the female students

are meaningfully involved or engaged in the class during classroom instruction so as to avoid gender biased

**Keywords:** Geogebra software package, Senior Secondary school students, Academic Performance, Algebra, Gender

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### **Introduction**

Mathematics is an inevitable school subject which is utilized in every aspect of human activities. Ozofo and Onos (2018) asserted that mathematics affects every area of human endeavor or activity and as such its teaching in school should be carried out so as to improve the problem solving skills of students. The knowledge of mathematics helps to develop in students the skills of clarity, brevity, accuracy, logical and creative reasoning, precision and certainty in expression and solution to basic and applied problems. The capability of students to develop the aforementioned skills is focused and directed towards both ability and disability students. This is because the main objective of the secondary school mathematics curriculum is to prepare every student for higher education or a successful work life.

There are various methods of teaching mathematics in schools. The particular method employed by the teacher depends on factors such as the topic to be taught, the ability level of the students, the class size (Anyaozu, 2017). The method of teaching mathematics is broadly classified into the traditional teaching method and the innovative teaching methods. The use of traditional teaching method to teach students mathematics has left us with nothing more than to produce students who dwell in memorization of mathematical facts and processes. The traditional teaching method makes students to understand mathematics concepts instrumentally without knowing the how and why of doing the mathematics process. This may suggest why Saye (2010) opined that traditional teaching method has impacted negatively on students and this has contributed to the poor performance of students in the subject. The method of teaching mathematics changes from time to time and in line with the societal trend and wave. Thus Charles-Ogan and George (2015) opined that the mathematics curriculum should always be revisited by curriculum planners to reform and address the call of trending societal problems. The world is presently functioning at the technological and digital level; an era where technological gadgets are integrated into our daily activities in all sectors. Thus, Ebisine (2013) asserted that reengineering mathematics education for technological development in Nigeria will be of great benefit to the economy.

Eyyam and Yaratan (2014) opined that the use of technology to carry out instruction in mathematics is critical because it allows teachers to provide immediate feedback, individualization of learning opportunities, motivation of students, flexible and collaborative learning. Mathematics softwares which are oriented to teach different mathematical concepts abound. Examples of mathematics softwares are Geometer Sketchpad, GeoGebra, maxima, Colour mathematics, Graph Sketch, REDUCE, Maple 15, Dplot Graphing, Mathematica, MatLab, Origin, Sage math et cetera. GeoGebra software is a mathematics software which was invented for the educational purpose to execute mathematical problems related to trigonometry, algebra, statistics, calculus application and Geometry. It possesses components that make it interactive and user friendly and as such can be used to teach and learning of mathematics from primary school to tertiary institution (Gamage & CharlesOgan, 2019).

Since GeoGebra software is user friendly and interactive, it then becomes essential that it can be integrated in the teaching of trigonometry to students. Employing innovative instructional strategies therefore becomes the response to this situation. In the context of this study, gender as a variable refers to male and female students in senior secondary schools. Gender issues have been associated with students' academic achievement. According to Yang (2010), gender refers social attributes and opportunities associated with being male or female and the relationship between men and those with women, boys and girls as well as the relations between men and women. Worldwide, there have been debates on students' academic performance in mathematics, with respect to gender which has continued to be of interest (Akani, 2017)

Several studies related to the present study have been conducted by other researchers with empirical findings. The research findings of Emaikwu, Iji and Abari (2015) on the effect of GeoGebra on senior secondary school students' interest and achievement in Statistics in Benue state, Nigeria found that students who were taught with GeoGebra had a higher interest and achievement than those taught with the conventional method. Adelabu, Makgato and Ramaligela (2019) researched on the dynamic geometry computer software and learners' performance in geometry and the result revealed that the use of technology had a positive effect on the performance of those taught with it than those without technology. The findings of Onaifo and Ekwueme (2017) who conducted a study on the effect of innovative strategy in the teaching and learning of plane geometry using GeoGebra software showed that there was no significant difference in the performance of students who were taught with GeoGebra with respect to gender. Oti and George (2020) investigated the effects of

GeoGebra software package on the mathematics performance of senior secondary students with dyscalculia in Bayelsa State Nigeria. Two research questions and two null hypotheses were answered and tested at 0.05 significant level respectively. The pretest posttest quasi experimental research design was employed. Wechsler Intelligence Scale for Children- Fifth Edition (WISC-V) was used to identify and select a sample of 38 students with dyscalculia. TCAT was used to measure students' performance in Trigonometry. The KR-21 was used to obtain a reliability index of 0.81. The descriptive statistic and Analysis of Covariance (ANCOVA) were employed for statistical data analysis. The study found that the use of GeoGebra software package improved the performance of dyscalculic students in trigonometry than those who were taught with deductive teaching method. The study also found that there is no significant difference between effect of the use of GSP to teach the male and the female dyscalculic students trigonometry over the use of DIM. It was therefore recommended that mathematics teachers should embrace the use of technology (Geogebra software) and other innovative instructional strategies to enhance the academic performance of students with dyscalculia.

Regarding gender, some researches have revealed that male students performed better than their female counterparts; Achuonye, (2009) and Njoku, (2000) revealed significant difference in academic achievement of male and female students taught using computer assisted instruction (CAI) in favour of male students. Also, in a study conducted by Iwondi (2012) found no gender difference in academic achievement of male and female students in mathematics. This study therefore sought to further investigate the effect which GeoGebra software package could have on senior secondary school students' academic performance in Algebra in Edo State, Nigeria in particular.

### **Statement of the Problem**

Many researches have reported poor students' academic performance in mathematics in spite of the importance ascribed to the subject in the National policy on education (Odili, 2006). The students' academic performance continues to deteriorate yearly (Odili, Ibid). This becomes a source of worry to all stakeholders in Nigeria education system, for the fact that no teacher in Nigeria that teaches any mathematics concept at any level, either from primary to tertiary can prove that all is well in the teaching of the subject. These teachers who teach the subjects requiring the application of mathematics complained of the challenges they usually face. one of these major challenges was ascribed to how mathematics teachers teach the students mathematics concepts without employing teaching methods that can cater for the needs and

interest of all students. The society is in the digital era where every activity carried out in all sectors is done in technological driven environment. Also, the students in today's classroom are all digital residents and as such, they love to use technology with all pleasure. Therefore, it is against this background, the researchers decided to investigate the effects that the use of GeoGebra software package can have on students' academic performance in Algebra. in Akoko-Edo Education Zone, Edo State, Nigeria

### **Objectives of the Study**

The objectives of this study were to:

The objective of this study was to investigate the effects of geogebra software package on senior secondary school students' academic performance in Algebra in Akoko-Edo Education Zone, Edo State, Nigeria. Specifically, the study sought to:

1. find out if there is any difference in the performance of students taught Algebra using GeoGebra Software Package (GSP) and those taught without GeoGebra software package but taught using conventional instructional method (CIM),
2. find out whether there is any difference in the performance of the male and the female students taught Algebra using GeoGebra software package (GSP).

### **Research Questions**

This study addressed the following questions:

1. What are the mean performance scores of students taught Algebra using geogebra software package (GSP) and those taught using conventional instruction method (CIM)?
2. What are the mean performance scores of the male and female students taught Algebra using geogebra software package (GSP).

### **Research Hypotheses**

The following null hypotheses were formulated in accordance with the research questions and tested at .05 level of significance:

1. There is no significant difference between the mean performance scores of students taught Algebra using geogebra software package (GSP) and those taught using conventional instruction method (CIM)?
2. There is no significant difference between the mean performance scores of the male and the female students taught Algebra using geogebra software package (GSP)

## **Methodology**

The study employed the pretest, posttest non randomized, nonequivalent intact class quasi experimental design. By justification, this design was employed from the fact that the experiment was carried out on students who are human beings. Two groups; Experimental and control were used comprised two subjects male and female students. The experimental group was taught using geogebra while the control group was taught using conventional instructional strategy. A total of 2,413 public senior secondary one (SS1) students in Akoko Edo Education zone, Edo State, Nigeria constituted the population of the study. A sample of 100 senior secondary one (SS1) students was used for the study drawn from two public schools. The sampled students were computer literate having 49 boys and 51 girls respectively. A multi-stage sampling techniques was used to draw the sample size from the school population. A 25-item multiple choice questions was constructed by the researchers in order to collect data for the study. The instrument was constructed by the researchers based on the basic Algebra concepts that were taught (numbers, variables, constants, expressions, equations, linear equations and quadratic equations). The instrument which was a Performance test was named Algebra Concepts Performance Test with the acronym ACPT. The 25 items in ACPT had four options (a, b, c, d). Only one out of the four options was the correct answer for each item of ACPT. Each correct answer carried 4 marks while each incorrect answer carried zero mark. ACPT was scored over a total of 100. To ensure an evenly distributed test items to measure the lower and higher order cognitive learning outcomes, a test blue print was used to prepare ACPT to determine the performance of students in Algebra.

Two different lesson plans were prepared by the researchers and used to teach the two groups. The lesson plan for the experimental group was used to teach the experimental group whereas, the lesson plan for the control group was used to teach students in the control group. The lesson plan for the experimental group was prepared by integrating the GeoGebra software package and the lesson plan for the control group did not integrate the GeoGebra software package but rather used the conventional instructional method (Lecture method). ACPT was validated by two experts in mathematics education and one expert from measurement and evaluation. The corrections/constructive inputs of the experts were used to modify the instrument before administration to the subjects (Sample). For reliability of the instrument, a pilot testing was done on twenty students who were not part of the study but have the similar characteristics of the sample while the Split half method was used to obtain a reliability index 0.88 for ACPT. In terms of Procedure for data Collection, the students were first given a pretest of ACPT. After the pretest, both

groups were taught Algebra using the two lesson plans that were prepared by the researchers. The intact class mathematics teachers were concisely trained by the researchers on how to carry out the teaching. The students in the experimental group were taught Algebra with the use of GeoGebra software package while the students in the control group were taught same Algebra concepts without the use of GeoGebra software package but rather with the conventional instructional method. After the treatment a post test of ACPT was administered to both groups in a reshuffled form. The pretest and posttest scripts were collated, marked and graded respectively. Also, descriptive statistics (mean and standard deviation) were used to answer the research questions while the Analysis of Covariance (ANCOVA) was used to test the hypotheses at .05 level of significance.

### Results

The results of data analysis were presented in accordance with the research questions and hypotheses;

**Research Question 1:** What are the mean performance scores of students taught Algebra using Geogebra software package (GSP) and those taught using Conventional instructional method (CIM)? Data used to answer this question is presented in Table.

**Table 1**

**Descriptive statistics on the Mean Performance Scores and Standard Deviations of Students taught Algebra using GSP and those taught using CTM in ACPT**

<i>Group</i>	<i>N</i>	<i>Pre-test</i>	<i>Post-test</i>
<i>Means</i>		9.27	39.63
<i>Experimental group (GSP)</i>	50		
<i>Std. Deviation</i>		5.518	10.537
<i>Mean</i>		6.64	15.29
<i>Control group (CIM)</i>	50		5.138
<i>Std. Deviation</i>		4.417	

Table 1 shows the mean performance scores and standard deviations of students taught Algebra using GSP and those taught using CIM. In experimental group, students had a mean scores of 9.27 and 39.63 in the pre-test and post-test respectively and corresponding standard deviations of 5.518 and 10.537 in that order. While in control group, students recorded a mean score of 6.64 and 15.29

in the pre-test and post-test with corresponding standard deviations of 4.417 and 5.138 in that order.

**Hypothesis 1:** There is no significant difference between the mean performance scores of students taught Algebra using GSP and those taught using CIM

**Table 2**  
**Summary of ANCOVA on the Mean Performance scores of Students taught Algebra using GSP and those taught using CIM**

Source	Type III Sum of Squares	Df	Mean Square	F	p-value	$\eta^2$
Corrected Model	7041.802a	2	3520.90	28.635	.000	
Intercept	4467.445	1	4467.445	36.333	.000	
Pre ACPT	2775.019	1	2775.019	22.569	.000	.003
Group	4280.049	1	4289.049	34.882	s.000	.284
Error	4303.592	97	179.966			
Total	132425.000	100				
<b>Corrected Total</b>	<b>11345.395</b>	<b>99</b>				

As seen in Table 3, that there was a significant effect of the use of geogebra software package (GSP) to teach students Algebra over the use of conventional instructional method (CIM) ( $F = 34.882, p = .000 < \alpha = 0.05$ , Partial eta squared = .284). The null hypothesis one was hence rejected at .05 level of significance. This shows that there was a significant difference between mean performances scores of students who were taught Algebra using GSP and those taught using CIM.

**Research Question 2:** What are the mean performance scores of the male and female students taught Algebra using GSP. Data used to answer this question is presented in Table.

**Table 3**  
**Descriptive statistics on the mean performance scores and Standard Deviations of the male and the female students taught Algebra using GSP**

Group	N	Pre-test	Post-test
Means		7.41	28.74
Male	26		
Std. Deviation Mean		4.512	10.364
Female	24	6.13	11.138
Std. Deviation		4.111	7.735

Table 3 shows the mean performance scores and standard deviations of male and female students taught Algebra using GSP. Male students taught Algebra with GSP had a mean performance scores of 7.41 and 28.74 in the Pre-test and Post-test in that order with corresponding standard deviations of 4.512 and 10.364 respectively.



While female students taught Algebra with GSP had a mean performance scores of 6.13 and 11.138 in the pre-test and post-test respectively with a corresponding standard deviations of 4.111 and 7.735 in that order.

**Hypothesis 2:** There is no significant difference between the mean performance scores of the male and the female students taught Algebra using GSP.

**Table 4**

**Summary of ANCOVA on the Mean Performance Scores of the Male and the Female students taught Algebra using Geogebra software package (GSP)**

Source	Type III Sum of Squares	df	Mean Square	F	p-value	$\eta^2$
Corrected Model	595.5866	2	297.793	1.655	.220	
Intercept	6096.727	1	6096.727	33.877	.000	
Pre ACPT	560.377	1	560.377	3.114	.096	.003
Gender	10.820	1	10.820	.060	.809	.000
Error	3059.414	47	179.966			
Total	92100.000	50				
<b>Corrected Total</b>	<b>3655.000</b>	<b>49</b>				

As seen in Table 4, there was no significant effect of use of the GSP to teach the male and the female students Algebra over the use of CTM ( $F = .060$ ,  $p = .809 > \alpha = 0.05$ , Partial eta squared = .000). The null hypothesis two was thus retained at .05 level of significance. This shows that there was no significant difference between the mean performance scores of the male and the female students who were taught Algebra using GSP.

### Discussion of Findings

The result presented in Table 1 showed that the students who were taught Algebra using GSP had a higher mean performance than those who were taught using CTM. This finding has specifically shown that the use of Geogebra Software Package had the ability to enhance the performance of students in Algebra concept of Mathematics. Putting this finding to hypothesis testing (statistical test), Table 2 showed that there was a significant difference between mean performance scores of students who were taught Algebra using GeoGebra software package and those who were taught using

conventional teaching method. This finding is in consonance with the findings of Oti and George (2020), Emaikwu, Iji and Abari (2015); Adelabu, Makgato and Ramaligela (2019); Onaifo and Ekwueme (2017); Bwalya (2019) and Charles-Ogan and gamage (2019) which examined the use of mathematical softwares to teach students varied mathematical concepts. However this finding disagrees with the finding of Amerta and Yellan (2018) who indicated that the use of mathematics software had no significant effect on students' academic performance in Mathematics. From Table 2, the result showed that the male students who were taught Algebra using the GSP performed better than their counterparts. This finding explicitly revealed that the male students who were taught using GSP performed better than their female counterparts. This result shows that the use of Geogebra Software Package specifically made male students to perform better than female students. In other words, the use of geogebra software package is gender biased in favor of male students. When subjected to hypothesis testing (statistical test), there was no significant difference between the mean performance scores of the male and the female students with who were taught Algebra using GeoGebra software package. This finding is in line with that of Iwondi (2012) who found no gender difference in academic achievement of male and female students in mathematics. However, the finding disagreed with the earlier findings of Onaifo and Ekwueme (2017); Adelabu, Makgato and Ramaligela (2019) Bwalya (2019); Pavethira and Leong (2017); Achuonye, (2009); Njoku, (2000) and Akanmub (2015) who in their separate studies found significant difference between) who found significant difference in academic achievement of male and female students taught using computer assisted instruction (CAI) in favour of male students

### **Conclusion**

Conclusively, the use of GeoGebra software package is more efficacious than the conventional strategy in teaching Algebra to students. Also, there was no significant difference in the performance of the male and the female students who were taught Algebra using Geogebra software package (GSP).

### **Recommendations**

Based on the findings therein, the researchers gave the following recommendations:

1. Generally, Mathematics teachers should use technology (Geogebra software) and other innovative instructional strategies should be embraced to continuously improve students' academic performance in schools.

2. Mathematics teachers should make sure that both the male and the female students are meaningfully involved or engaged in the class during classroom instruction so as to avoid gender biased.

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