ISSN: 3043-467X

GeoGebra Software and Students' Performance in Coordinate Geometry in Warri South, Delta State, Nigeria.

By

EFOR, Benjamin
Email: benjaminefor@gmail.com

University of Port Harcourt, Port Harcourt, Rivers State, Nigeria

ABSRACT

This research investigated the impact of Geogebra software on students' performance in Coordinate Geometry in secondary schools within the Warri South, in Delta State, Nigeria. A quasi-experimental design and descriptive survey approach were adopted with a pretest - posttest control group structure. The population of the study comprised 2,150 Senior Secondary School (SSS 3) Mathematics students from which a sample size of 80 SS 3 Mathematics students was conveniently selected from two schools using purposive sampling technique. Participants were divided into two groups: the experimental group which was taught using Geogebra –assisted instruction, and the control group, which received instruction through the conventional lecture method. The instrument for data collection was the Coordinate Geometry Performance Test (CGPT). Mean and standard deviation were used to answer the two research questions while Analysis of Co-variance (ANCOVA) was used to test the two hypotheses formulated for the study at 0.05 level of significance. The findings of this study show that the Geogebra-assisted teaching method is effective in improving students' performance on Coordinate Geometry. The method was shown to be more impactful than the conventional lecture method, fostering greater engagement and understanding among students. Although male students demonstrated slightly higher gains in performance compared to female students, the differences were not statistically significant. The study among others recommended the use of Geogebra – assisted instruction in Mathematics teaching.

Keywords: Geogebra Software, Students, Performance, Coordinate, Geometry

Introduction

Today, we live in a technological age and as such it is inevitable that technology impacts how we teach and how we learn. Due to many research studies for new approaches to the process of teaching-learning, that have been conducted for many years, new supportive techniques that enable effective teaching and learning have been developed. One of these techniques is the integration of technology into the education field. The utilization of computer-assisted instruction and innovative devices in teaching are picking up much acknowledgement in the 21st century. In many facets of real life, mathematics is essential because it serves as the basis for logical thinking, problem-solving, and decision-making in a wide range of domains. Bassey (2020) asserts that mathematics is the cornerstone of both national and international development and that it is necessary for comprehending and utilizing science and technology. Due to its applications in everyday life, such as transportation, all forms of commerce, and contributions to scientific and technical growth, mathematics is significant for both literate and illiterate segments of society (Golji and Dangpe, 2016). In order to solve problems, apply what they have learned in the real world, and develop mathematical skills—all of which are goals of learning mathematics—students must first understand mathematical concepts (Herawati, Hidayati, & Iffah, 2023).

Technology has a crucial role in the growth of a country; in the modern world, technological advancement supports both social and economic advancement. In today's world, science and technology have taken over as the primary instruments for power development. Due to their scientific and technological achievements, nations like China, Japan, America, and Russia are examples of developed nations. Geogebra is a technical instrument that incorporates every aspect of mathematics. Many interactive geometry teaching tools are included in the program (Dahal, Shrestha, & Pant 2019). Teachers are encouraged to use Information Communication Technology (ICT) into their teachings by the Nigerian educational system. Students at all levels are engaged when ICT is incorporated into mathematics

instruction, claim Bhagat and Chang (2015). Students' attention is piqued and discovery learning is promoted when ICT is used in mathematics instruction. Students learning mathematics, especially geometry, must be able to recall, create, and comprehend not only the theoretical information but also the practical applications of what they are learning. Since then, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) has endorsed this. The capacity to solve mathematical problems and memorize rules and formulae by heart are only two aspects of mathematics knowledge; practical conceptual understanding and intuitive insight are also essential for actual mathematics learning. Mathematical problem-solving is a crucial ability that improves logical reasoning and aids in making wise decisions in both personal and professional settings, claims Sriyaman (2021). The foundation of technology is mathematics. Mathematical ideas like algorithms, calculus, and linear algebra are essential to disciplines like computer science, engineering, and data science. Its significance goes beyond routine tasks to cutting-edge scientific investigations and technological advancements.

According to Mollah (2017), mathematics is considered the mother of all disciplines, and without mathematical knowledge and abilities, the cosmos could not function. It gives people the skills to approach challenges methodically and make wise conclusions, and it is a tool for the advancement of any science-based field. Mathematical concepts like algebra, statistics, and probability are crucial tools for project planning, data analysis, and financial budgeting.

Mathematics is crucial to providing efficient healthcare, from figuring out medication dosages to simulating the spread of illnesses. For example, the management of public health during the COVID-19 epidemic has relied heavily on the application of mathematical modeling and biostatistics. Predicting the virus's spread, improving immunization plans, and assessing the results of therapies have all benefited greatly from mathematical models. Coordinate geometry, sometimes referred to as analytical geometry, is a field of mathematics that describes and examines geometric figures and their characteristics using

algebraic equations. Through the use of a coordinate system, usually the Cartesian coordinate system, this area combines algebra and geometry by enabling the algebraic solution of geometric problems.

Coordinate geometry is useful in everyday situations. It has applications in engineering, architecture, sports, art, and many other fields. One of the subjects taught to Senior Secondary School (SS3) students is coordinate geometry, which is included in the mathematics exam that is prepared by the National Examination Council of Nigeria (NECO) and the West African Examination Council (WAEC) virtually annually. As a result, it uses line and curve graphs to establish a connection between geometry and algebra. This study aims to examine how students' performance is affected when Geogebra is incorporated into the teaching of coordinate geometry.

Purpose of the Study

The main purpose of this study is to determine the impact of Geogebra software on students' performance in Coordinate Geometry in Warri South, Delta State.

Specifically, the study determined:

1. difference in the mean performance between students taught using Geogebra software and those taught using conventional instructional material.
2. Difference in the performance of male and female students taught Coordinate Geometry using Geogebra.

Research Questions

The following research questions were raised in order to guide the study:

1. What is the difference in the mean performance between students taught using Geogebra software and those taught using conventional instructional methods?
2. What is the difference in the performance of male and female students taught Coordinate Geometry using Geogebra?

Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance:

1. There is no significant difference in the mean performance of SS 3 Mathematics students, taught using Geogebra software and those taught using conventional instructional methods.
2. There is no significant difference in the performance of male and female SS 3 Mathematics students taught using Geogebra software.

Methodology

This study employed a quasi-experimental design with a pretest – posttest control group structure. The design compared the effects of Geogebra-assisted instruction (experimental group) with conventional teaching methods (control group) on students' performance in Coordinate Geometry. Quasi-experimental design is a partly true experimental design in which study participants are assigned to groups.

Two out of twenty-one schools in Warri South Local Government Area were purposively selected due to the availability of functional computers in the laboratory. One of the schools was used as experimental group while the other school was used as the control. Two intact classes one from each school was used for the study. A sample of 80 S.S.S 3 Mathematics students was conveniently selected because they were easily accessible and used for the study. The design has the experimental group (EG) and the control group (CG). The experimental group was made to undergo an intervention where they had to learn coordinate Geometry using Geogebra software for five weeks whilst the Control group learnt Coordinates Geometry using traditional teaching methods not involving Geogebra. The test-retest method was adopted to establish the instruments' reliability. The researcher administered the instrument CGPT to 20 students at different periods who will not take part in the main study and the data collected. A reliability coefficient of 0.89 for the instrument coordinate Geometry performance test (CGPT) was obtained using Kidder Richardson (KR-21) formula.

Data obtained were analyzed using descriptive statistics (Mean and Standard deviation) to answer the research questions while inferential statistics, Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

Results

Research Question 1: What is the difference in the mean performance between students taught using Geogebra software and those taught using conventional instructional methods?

Table 1: Mean and Standard deviation values of students' performance based on Teaching Mode

Methods		Pretest	Posttest	Mean Gain
Geogebra assisted instruction	Mean	49.78	57.18	7.40
	N	45	45	
	Std. Deviation	6.20	6.75	
Conventional method	Mean	47.57	50.46	2.89
	N	35	35	
	Std. Deviation	6.96	7.18	

Table 1 presents the mean and standard deviation values of students' performance in the pretest and posttest, based on the teaching mode, as well as the mean gain for each method.

Research Question 2: What is the difference in the performance of male and female students taught Coordinate Geometry using Geogebra?

Table 2: Mean and Standard deviation values of students' performance based on gender

Gender		Pretest	Posttest	Mean Gain
Male	Mean	49.16	57.32	8.16
	N	19	19	
	Std. Deviation	6.18	6.81	
Female	Mean	50.23	57.08	6.85
	N	26	26	
	Std. Deviation	6.29	6.84	

Table 2 presents the mean and standard deviation values of students' performance in the pretest and posttest based on gender, along with the mean gain for each group.

Hypotheses

Hypothesis 1: There is no significant difference in the mean performance of SS 3 Mathematics students, taught using Geogebra software and those taught using conventional instructional methods.

Table 3: Summary of Analysis of Covariance of students' performance based on methods using Pretest as Covariate

Dependent Variable: Posttest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2905.829[a]	2	1452.914	64.271	.000	.625
Intercept	353.780	1	353.780	15.650	.000	.169
Pretest	2016.605	1	2016.605	89.207	.000	.537
Methods	479.565	1	479.565	21.214	.000	.216
Error	1740.659	77	22.606			
Total	239983.000	80				
Corrected Total	4646.488	79				

a. R Squared = .625 (Adjusted R Squared = .616)

Table 3 reveals a value of $F_{1,77} = 21.214$, $p = 0.001$ ($p < 0.05$) for the difference in the mean performance. The null hypothesis is rejected.

Hypothesis 2: There is no significant difference in the performance of male and female SS 3 Mathematics students taught using Geogebra.

Table 4: Summary of Analysis of Covariance of students' performance based on gender using Pretest as Covariate

Dependent Variable: Posttest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	699.436[a]	2	349.718	11.254	.000	.349
Intercept	421.976	1	421.976	13.579	.001	.244
Pretest	698.810	1	698.810	22.488	.000	.349
Gender	9.452	1	9.452	.304	.584	.007
Error	1305.141	42	31.075			
Total	149123.000	45				
Corrected Total	2004.578	44				

a. R Squared = .349 (Adjusted R Squared = .318)

Table 4 reveals a value of $F_{1,42} = 0.304$, $p = 0.584$ ($p > 0.05$) for the difference in the performance of male and female SS 3 Mathematics students taught using Geogebra. The null hypothesis is therefore accepted.

Discussion

The findings of this study reveal a significant difference in the performance of students taught using Geogebra software compared to those taught using conventional instructional methods. Table 1 demonstrates that students who received Geogebra-assisted instruction had a higher mean gain compared to those taught using the conventional method. This significant difference is further supported by the ANOVA results presented in Table 4, which indicate a statistically significant difference in the performance.

These findings collectively suggest that Geogebra software is an effective instructional tool for teaching Coordinate Geometry, promoting equitable learning outcomes for both male and female students. The slightly higher mean gain for male students observed in this study could be attributed to contextual or individual differences but does not indicate a significant gender disparity in performance when using Geogebra. This reinforces the versatility and inclusivity of Geogebra as a gender-neutral instructional approach. The findings from the study reveal significant gender-based differences in students' performance in Coordinate Geometry when comparing the use of Geogebra-assisted instruction to the conventional lecture method.

These findings suggest that gender differences in performance may vary depending on the specific mathematical topic or context of Geogebra's application.

Conclusion and Recommendations

The findings of this study show that the Geogebra-assisted teaching method is effective in improving students' performance in learning Coordinate Geometry. The method was shown to be more impactful than the conventional lecture method, fostering greater engagement and understanding among students. Although male students demonstrated slightly higher gains in performance compared to female students, the differences were not statistically significant, highlighting the method's broad applicability across genders.

Based on the study's findings, the following recommendations are proposed

1. Teachers should integrate Geogebra-assisted instruction into the teaching of Mathematics, especially for topics like Coordinate Geometry, to enhance students' understanding and engagement.

2. Professional development programs should be organized for Mathematics teachers to equip them with the skills needed to effectively utilize Geogebra and other technology-assisted teaching tools.
3. Curriculum planners should incorporate technology-based instructional methods like Geogebra into Mathematics curricula to improve teaching and learning outcome

References

Bassey, S. A. (2020). Technology, environmental sustainability and the ethics of anthropoholism. *Przestrzeń Społeczna*, *2*(2/2020 (20)).

Bhagat, K., & Chang, C (2015). Incorporating Geogebra into Geometry learning – A lesson from India. *Eurasia Journal of Mathematics, Science & Technology*, 11 (1), 77-86.

Dahal, N., Shrestha, D., & Pant, B. P. (2019). Integration of Geogebra in teaching and learning geomet *Journal of Mathematics and Statistical Science*, *5*, 323-332.

Golji, G. G., & Dangpe, A. K. D. (2016). Activity-based learning strategies (ABLS) as best practice for secondary Mathematics teaching and learning. *International Advanced Journal of Teaching and Learning*, *2*(9), 106-116.

Herawati, T., Hidayati, W. S., & Iffah, J. D. N. (2023). Students' Higher Order Thinking Processing Solving Math Problems by Gender. *Mosharafa: Jurnal Pendidikan Matematika*, *12*(2), 255-266.

Mollah, K. (2017). *Mathematics Anxiety among the Secondary School Students. Pramana Research Journal, 7(11), 122–129. https://pramanaresearch.org/*

Sriyaman, K. (2021). Impact of digital technology on Mathematics education. *Journal of Educational Technology and Society*, 24(1),45-56.