

EFFECT OF GEOMETRIC CONSTRUCTIONS TEACHING STRATEGY ON STUDENTS' ACHIEVEMENT AND INTERESTS IN LEARNING GEOMETRY IN PUBLIC SECONDARY SCHOOLS IN JALINGO LOCAL GOVERNMENT AREA, TARABA STATE, NIGERIA

ACHANGFA, KEFAS DANIEL

Kefasachangfa13@gmail.com; 08026028450

&

Dr. ALLAHOKI, NIMPHAS DANUSA

nim1963phas@gmail.com; 08069095411

Department of Mathematics,

College of Education Zing, Taraba State

Abstract

This study assessed the effectiveness of mathematics Geometric construction on cognitive learning outcomes of public secondary school students in geometry concepts. The study adopted quasi experimental research design using mathematics Geometric construction and the conventional strategy. The population of the study consists of all the ss 2 students in all the public schools in Jalingo local government area of Taraba state. A random sampling technique was used to select 100 students drawn from five (5) selected public secondary schools in Jalingo local Government Area of Taraba State. Three (3) schools were selected from the urban areas, while two schools were selected from the rural areas, with 20 students from each selected school. Conventional teaching method and a validated item of Geometric construction Achievement Test (GAT) instrument for students with reliability of 0.93 was used to collect data from the subjects. Three research questions and two null hypotheses were postulated and tested at 0.05 significant level using. Descriptive statistics of mean and standard deviation and Inferential statistics of t-test were used in analyzing the data. The experimental group that utilized mathematics Geometric constructions performed better than the control group. School types and gender was found to have no significant effect on the mean achievement scores of the students. The mean achievement scores of both male and female students were better improved on the use of mathematics Geometric constructions establishing that the use of Geometric constructions was independent of gender. The researchers recommended that mathematics Geometric constructions instructional strategy should be given more emphasis when teaching geometry concepts.

Keywords: Geometry, Constructions Teaching Method, Student Achievement, Conventional Method.

Introduction

Mathematics education is under threat, many learners see it boring and difficult. For example, Ncube and Luneta (2024) found that mathematics learning challenges often include “boredom and attitude” and highlighted that a lack of engaging activities can increase learners’ disinterest in the subject. Teaching mathematics is much like building a house. If the foundation is weak, many difficulties will appear later. Students’ understanding of basic mathematical concepts helps them move to the next logically connected concepts. Conventional lectures method used in most of mathematics classes does not allow students enough time to fully reach that understanding. For instance, Oribhabor (2020) found that secondary school students exposed to an activity-based teaching method significantly outperformed peers taught by the traditional lecture method in posttest mathematics achievement, after controlling for pretest differences. Geometric constructions lead the students to formation of concepts out of experiences with discrete objects. In this case, the vague theories and imaginary objects take real shape and the students understand better and perform better. It also strengthens students’ understanding of mathematics, specifically in geometry. From teachers’ daily teaching experience, it is common for us to notice that students are quite reluctant in constructing geometric proofs for a number of reasons which include their lack of confidence and insufficient experience. As geometric constructions require students to think of the necessary steps for the constructions, the activities may help students improve their ability in writing up geometric proofs.

Agbo and Uzor(2020) pointed out that geometry interpretations provide useful and initiative understanding of most areas of mathematics and geometrical techniques, provide tools for solving problems in most areas of mathematics. In support of this, Agbo and Uzor (2020). Explained further that knowledge of shapes, numbers, and operations on the shapes help to describe and predict things about the world around us. Geometry has a long history (dated back to around 300BC) among various branches of

Mathematics. The word ‘geometry’ comes from two Greek root words, ‘geo’ meaning ‘earth’ and ‘metria’ for ‘to measure’. It is the study of space and a systematization of the way we view the space around us (Cheung, 2017). In layman terms, geometry describes the relationship between lengths, areas and volumes of physical objects. It is an important component of many aspects of human life from practical measurement and construction (for example in architecture and engineering) to styles of living. Even in the sporting fields, geometry plays a part from how lines are drawn on a sports field to how sportsmen are trained for the best performance and the strategies involved. Geometry is also involved in biochemical modeling for medicine and biology. Geometry is undoubtedly more than just shapes and figures on printed books. In the current Nigerian school mathematics curriculum, most geometry topics covered in elementary and secondary schools is ‘Euclidean geometry’, which stems from Euclid’s classical book of Elements, which was written in around 300BC. This Euclid’s book is a systematic account of the geometry and number theory of Euclid’s time. Euclid was famous for he has systematically organized the geometric knowledge into a clear framework which is highly coherent and logical. Euclid’s Elements has provided us with a perfect framework in learning geometry – from definitions to axioms and then theorems are constructed, i.e. start with truths and proceed by rigorous proof. For example, Emefo, Bot, and Binda (2023) found that the use of Problem-Based Learning led to significantly better performance among SS2 students in Bichi, Kano State compared to those taught with lecture methods. Similarly, Adewumi and Oloja (2025) demonstrated that Inquiry-Based Learning improves academic performance in geometry among senior secondary students in Ondo State. These findings indicate that when students are engaged actively through structured strategies, their understanding, retention and achievement in geometry are enhanced.

Statement of the problem

Evidence of poor performance in geometry by secondary school students point to the fact that teaching and learning of geometry across Secondary Schools in Nigeria are faulty (Chikwere & Ayama (2024)). It means that teachers are still inclined to the traditional rote learning of geometry and teaching materials that are alien to the students' cultural background. This makes it paramount to seek for a strategy for teaching geometry that aims at improving its understanding and performance by students. According to Chikwere & Ayama (2024), Lack of geometric constructions in teaching geometry is one of the major factors that contribute to poor achievement in geometry by secondary school students. one way to strengthen students' understanding of geometry is the use of manipulatives in which geometric constructions is one. Therefore, the study is designed to find out the effects of using geometric constructions in teaching on students' academic achievement in geometry and interests towards learning geometry in Secondary Schools.

Purpose of the study

The purpose of this study is to investigate the effects of using geometric constructions in teaching geometry in secondary schools. Specifically, the study sought the following:

1. To investigate the extent to which learning mathematics through geometric constructions will enhance students' achievement in mathematics.
2. To compare the achievement of urban schools and rural schools mathematics students taught through geometric constructions
3. To ascertain the extent of use of geometric constructions teaching strategy in learning geometry in public secondary schools by secondary school teachers.

Research Questions.

The following research questions will guide the conduct of the research;

1. To what extent does the use of geometric constructions teaching strategy enhance the achievement of mathematics students in public secondary schools?
2. Is there any difference between the achievement of urban schools and rural schools mathematics students when taught through geometric constructions teaching method?
3. To what extent is geometric constructions teaching method used in public secondary schools by secondary teachers?

Research hypotheses:

Ho1: There is no significant difference between mean achievement scores in geometry of mathematics students who were taught through geometric constructions and those taught with conventional lecture method.

Ho2: There is no significant difference in the means achievement scores of urban schools and rural schools mathematics students who were both taught using geometric constructions teaching strategy in public secondary schools

Methods

The study adopted quasi experimental research design using Geometric constructions teaching strategy and the conventional teaching strategy. A pre-test was administered to both the control class and the experimental class at the same time before the introduction of the treatment (geometric constructions teaching strategy). Similarly, questions to the pre-test were used for the post-test after the introduction of the treatment (geometric constructions teaching strategy). The treatment group was exposed to basic geometric constructions (2-dimensional and 3-dimensional shapes) for a period of four weeks, while the control group received the lecture teaching method. The conditions for both tests were the same to the two groups. The pre-test and post -test scripts were marked both out of 100%. The pre-test and post -test scores were recorded as shown in table 2, 3, 4 and 5 respectively. The population of the study consists of all the SS 2 students in all the public schools in Jalingo local government

area of Taraba state. A random sampling technique was used to select 100 students drawn from five (5) selected public secondary schools in Jalingo local Government Area of Taraba State. Three (3) schools from Urban area and two (2) schools from rural area, with 20 students from each selected school. The 100 students selected were given serial numbers from 001 to 100. Students with even serial numbers formed the experimental group, while those with odd serial numbers formed the control group. Hence, experimental group has 50 students and control group also has 50 students as shown in table1 below

Table 1: experimental designed

Group	N	Pre-test	treatment	Post-test
Experimental group	50	O_1	X_1	O_2
Control group	50	O_1	X_0	O_2

A validated item of Geometric constructions Achievement Test (GAT) instrument for students with reliability of 0.93 was used to collect data from the subjects. Three research questions and two null hypotheses were postulated and tested at 0.05 significant level using. Descriptive statistics of mean and standard deviation and Inferential statistics of t-test were used in analyzing the data.

RESULTS

Table 2: Pre-test scores for the control class and the experiment class

Marks	Control class		Marks	Experiment class	
	Frequency	Percentage		Frequency	Percentage
0 – 9	8		0 – 9	10	
10 – 19	30		10 – 19	28	
20 – 29	9		20 – 29	10	
30 – 39	3		30 – 39	2	
40 – 49	0		40 – 49	0	
50 – 59	0		50 – 59	0	
60 – 69	0		60 – 69	0	

70 – 79	0	70 – 79	0
80 – 89	0	80 – 89	0
90 – 100	0	90 – 100	0
	50		100%

Table 3: Summary of pre-test achievement scores of students in the two groups (control class and experimental class)

Group	No. of Students	Mean Achievement	Standard Deviation	Mean Difference
Experimental class (Those taught using geometric constructions)	50	15.3	7.5160	
Control class (Those taught with conventional method)	50	15.90	7.5620	0.60

Source: Pre-test achievement scores

Students in the control class and the experimental class were both pre-tested to determine their entering knowledge and equivalence in the topic. Table 2 above presents pre-test scores for the control class and the experimental class. The mean scores of students from the control class were (mean = 15.90, S.D = 7.5620), while, the mean scores of students from the experimental class were (mean = 15.30, S.D = 7.5160). The results indicated that none of the students from both groups scored above 50%. All the students performed below average. And none of the groups have gained better knowledge of the subject matters before now.

Table 4: Post-test scores for both the control class and the experimental class

Marks	Control class		Marks	Experimental class	
	Frequency	Percentage		Frequency	Percentage
0 – 9	0		0 – 9	0	
10 – 19	0		10 – 19	0	
20 – 29	10		20 – 29	0	
30 – 30	10		30 – 30	6	

40 – 49	13	40 – 49	10
50 – 59	15	50 – 59	16
60 – 69	2	60 – 69	9
70 – 79	0	70 – 79	7
80 – 89	0	80 – 89	2
90 – 100	0	90 – 100	0
	50	100%	50
			100%

Table 4 the results indicated that the students from both groups scored above average score, (thar is, above 50%).

Table5: Summary of post-test achievement scores for both the control and experimental class

Group	No. of Students	Mean Achievement	Standard Deviation	Mean Difference
Experimental class (Those taught using geometric constructions)	50	55.90	13.4027	13.60
Control class (Those taught with conventional method)	50	42.30	12.0017	

Source: Post-test achievement scores

After the treatment, (the geometric constructions teaching strategy), has been administered, the students in the control class and the experimental class were again both post-tested to determined knowledge gained. Table5 above presents post-test mean scores for both the control class and the experiment class. The mean scores of students taught using conventional teaching strategy were (mean = 42.30, S.D = 12.0017), while, the mean scores of students taught using geometric constructions teaching strategy were (mean =55.90, S.D =13.4027). The results showed great improvement in students' performance with mean difference of 13.60 in favor of geometric constructions teaching method. Majority of the students performed above average, indicating gained in knowledge.

Research Question One: What is the extent to which use of geometric constructions teaching strategy affect learners’ performance in public secondary schools in Jalingo local Government Area of Taraba state.

Table 6: summary of pre-test and post-test means achievement scores for both the control and the experimental groups

Group	n	pre-test results		Post-test results		Mean difference
		Mean	S. D	mean	S.D	
Experimental class	50	15.30	7.5160	55.90	13.4027	13.60
Control class	50	15.90	7.5620	42.30	12.0027	

A comparison of the geometric constructions teaching strategy class (experimental class) post-test mean achievement scores (55.90) and the conventional teaching strategy (control class) post–test mean achievement scorers (42.30) as revealed in table5 above, shows that, the geometric constructions teaching strategy (experimental class) improved students’ performance in geometry more than conventional method of teaching geometry in public secondary schools. The difference in the post – test means scores for the two classes (13.60) indicate the impact of the treatments in favor of the geometric constructions teaching strategy.

Research Question Two: Is there any difference between the achievement of urban schools’ students and rural schools’ students when taught using geometric constructions teaching strategy?

Table7: shows the pos-test mean achievement scores and the difference between the post-test means achievement of students in Urban schools and students in Rural schools who were both taught using geometric constructions teaching strategy.

School Types	No. of Students	Mean Achievement	Standard Deviation	Mean Difference
Urban schools' class taught using geometry constructions	60	53.30	14.5181	12.80
Rural schools' class Those taught with conventional method	40	40.50	14.5686	

Source: Post-test achievement scores

The post-test mean achievement results obtained in table 3 above shows that Urban schools students have mean achievement scores (mean =53.30, S.D =14.5181), while the Rural schools students have a mean achievement scores (mean =40.50, S.D = 14.5686) The mean difference between the two groups is 12.80, revealing that there is a significant difference in the means achievement scores of the two schools. Hence, school types have significant effect on the use of geometric constructions in teaching and learning of geometry concepts in public secondary schools. The results also show that Urban schools' students who were taught geometry concepts using geometric constructions teaching method performed better than the Rural schools students who were taught geometry concepts using the same teaching method. This may be attributed to lack of geometry teaching instructional materials and infrastructures in Rural schools.

Research Question Three: To what extent is geometric constructions teaching strategy used by mathematics teachers in teaching geometry concepts in public secondary schools in Jalingo Local Government Area?

Table 8: extent to which geometric constructions teaching method used in teaching geometry concepts in secondary schools in Jalingo Local Government Area.

Group	n	highly used	moderately used	scarcely used	completely not used
Teachers views	10	0(0.0%)	0(0.0%)	8(80.0%)	2(20.0%)
Students' views	100	0(0.0%)	0(0.0%)	85(85.0%)	15(15.0%)

Findings in table 8 show that mathematics teachers unanimously agreed that geometric constructions teaching strategy for teaching geometry concepts were rarely used by teachers in public second schools in Jalingo Local Government Area, of Taraba State. Similar responses were obtained from the students.85.0% of the students acknowledged that they were rarely engaged by mathematics teachers in geometry constructions during geometry lessons. They attributed this to lack of geometry instructional materials/instruments in their schools.

Test of Research Hypotheses

Hypothesis one.

HO₁: There is no significant difference between means achievement scores in geometry of Students who were taught geometry concepts through geometric constructions teaching method and those taught with conventional method.

Table 9: Independent two sample t- test table of significance difference between those taught using geometry constructions (experimental group)and those taught using conventional method (Control group).

Group	n	Mean	S. D	t-cal	D, F	p-value	Decision
Experimental class (taught with geometry constructions)	50	55.9.	13.4027				
Control class (Taught without geometry constructions)	50	42.30	12,0017	19.566	98	0.000	Reject H ₀

Source: post Test / Control Group Achievement Scores.

Table 9 above sought to establish whether significant difference exist between the mean achievement scores of those taught geometry concepts using Geometry constructions teaching strategy and those taught the same lesson using conventional teaching method. The results obtained revealed that the experimental group (those taught using geometry constructions teaching strategy) had mean achievement scores of (mean =55.90, S.D =13.4027) the control group (those taught using conventional teaching method had mean achievement scores of (mean =42.30, S.D =12.0017). The results revealed further that the t-calculated value is 19.566; P-value is 0.000 with degree of freedom 98 at 0.05 level of significant. Based on this result, the null hypothesis is hereby rejected. Hence, significant difference exists between the means achievements scores of the two groups. Therefore, geometric constructions teaching strategy has significant impact on students’ academic achievements in secondary school mathematics.

Hypothesis two.

HO₂: There is no significant difference in the achievement of urban schools and rural schools’ mathematics students who were both taught using geometric constructions teaching strategy in teaching geometry concepts in public secondary schools.

Table 10: Independent sample t-test table of significant difference between the means achievement scores of urban schools and rural schools’ students taught using geometric constructions teaching strategy.

Group	n	Mean	S. D	t-cal	D, F	p-value	Decision
Experimental class (Taught with geometry constructions)	60	53.30.	14.5181	15.478	98	0.000	Reject H ₀₁
Control class (Taught without geometry constructions)	40	40.50	14.5686				

The results in Table 10 above revealed that the Urban schools mean achievements scores is (mean = 53.30, S.D = 14.5181) while the rural schools mean achievement scores is (mean = 40.50, S.D = 14.5686), the t-calculated value is 15.478, degree of freedom is 98, p-value is 0.000 at 0.05 level of significant. The results revealed further that the P-value (0.000) is less than the 0.05 level of significance. By implication, the null hypothesis is hereby rejected. Hence, there is significant difference between the means achievement scores of Urban schools' group and Rural schools' group which were both taught using geometric constructions teaching strategy. This also implies that schools' types have significant influence in the use of Geometric constructions in teaching geometry concepts in public secondary schools in the study area.

Discussion of Results

This study revealed clearly that Geometric constructions teaching method is very effective in facilitating students' achievement in geometry and that there is a significant difference between the mean achievements of students taught geometry using geometric constructions teaching method and those taught using the conventional method. It is also evident from the findings that the performance of Urban school's students and Rural schools students who were taught geometry using the geometric constructions teaching strategy differed significantly indicating that both Urban schools students and Rural schools students did not benefit equally from geometric constructions teaching strategy.

Majority of the participants acknowledged that geometric constructions teaching method is scarcely used in teaching geometry concepts in public secondary schools. According to Shadaan and Leong (2015) helps participants to have better interaction with their teacher, classmates, and technology. Agbo and Uzor (2020) pointed out that geometry interpretations provide useful and initiative understanding of most areas of mathematics and geometrical techniques, provide tools for solving

problems in most areas of mathematics. In support of this, Agbo and Uzor (2020). Explained further that knowledge of shapes, numbers, and operations on the shapes help to describe and predict things about the world around us. The finding concurred with the findings of previous studies on teaching geometry theorems integrated with ARCS strategies (Main & Wah, 2015). The results indicated that the use of geometric constructions improved learners' motivation and understanding. The researcher also found that giving learners an opportunity to solve geometry theorem problems with increasing levels of complexity will not only improve confidence, but will allow learners to develop their critical thinking skills.

Similar results were obtained by Rahmiati (2016) who reports that, "Geometry activities is also able to increase confidence and competitive attitude towards learners to build a flat figure in geometry theorems".

Conclusion

In order to improve learners' knowledge of mathematics concepts, the use of Geometry constructions teaching strategy should be considered in mathematics classrooms. Geometric constructions teaching method have the potential to develop learners' motivation levels in teaching and learning geometry concepts. Learners can be motivated directly by grabbing their attention through the use of attractive and stimulating instructional materials like Geometrical instruments. It is essential in arousing and sustaining learners' attention and interest in the learning process.

Recommendations

The study recommends the following;

1. Mathematics teachers in public secondary schools should incorporate geometric construction strategies into their teaching of geometry, as it enhances both students' achievement and their interest compared to conventional lecture methods.

2. The Ministry of Education and school administrators should organize regular professional development programs to equip teachers with skills and techniques for effective implementation of activity-based and construction-oriented teaching methods.
3. Curriculum planners should integrate more hands-on activities, such as geometric constructions, into the mathematics syllabus to ensure students engage with concepts actively rather than passively.

REFERENCES

- Adewumi, A.J. & Oloja, O.A. (2025). The Effect of Inquiry-Based Learning on the Academic Performance of Senior Secondary School Pupils in Geometry in Ondo State, Nigeria. *Asian Journal of Education and Social Studies* 51 (3), 322–327.
- Agbo, L.P, & Uzor, F.C. (2020). Improving achievement in geometry through the use of GeoGebra software among secondary school students in Udenu Local Government Area of Enugu State. *Unizik Journal of Educational Research and Policy Studies* vol7; <https://unileros.org>
- Akintode, C.A., Ogunrinade, S.O. and Awe, I. A. (2024). Effectiveness of Geometrical Instructional Teaching Strategy on Junior Secondary School Students' Achievement, Gender and Attitude in plane Geometry in Odeda Local Government Area, Ogun State, Nigeria. *International Journal of Science and Research Archive*, 2024, 11(02) 1606-1315.
- Chikwere, P. & Ayama, K. (2016). Teaching of Geometric Constructions in Junior High School. An Intervention, Klo- Agogo, Eastern Region, Ghana. *Journal of Elementary Education* Vol.26,no.1pp139-146.
- Courtney, S. A. & Armstrong, B. (2021). Promoting Geometric Reasoning through Artistic Constructions. Kent State University, USA. *European journal of STEM Education*, 6(1), 09.

- Cheung, H. C. (2017). Enhancing students' ability and interest in geometry learning through geometric Constructions. Dissertation presentation in partial fulfillment of the requirements of the degree Of Master of Education, University of Hong Kong. August 2017
- Emefo, C.N, Bot, T.D. & Binda, S.I. (2023). Effect of Problem-based Learning Strategy on Senior Secondary Two Students' Achievement in Geometry in Bichi, Kano State, Nigeria. *Journal of Advances in Mathematics and Computer Science*, 38(10), 209-217.
- Ncube, M., & Luneta, K. (2024). Addressing mathematics learning challenges through concept-based instruction: A study in Limpopo Province, South Africa. *LUMAT*, 12(4), 7.
- Oribhabor, C. B. (2020). Evaluating the effect of activity-based method of teaching mathematics on Nigerian secondary school students' achievement in mathematics. Unpublished M.Sc Thesis.
- Robert, S. (2016). Retrieved from www.instructionaldesign.org/theories
- Siwale, P. & Jacob, H. (2019). Use of geometrical instruments in the teaching and learning of geometry in secondary schools: a case study of Masaiti district. *Zambia Journal of natural sciences research*, vol. 9, no.16, 2019
- White, K. M. (2012). The effect of instructional model utilizing –on learning and manipulatives on mathematics achievement on middle school students in Georgia. PhD dissertation, Liberty University.