

## EFFECT OF MATHEMATICS CLINIC ON SENIOR SECONDARY SCHOOL STUDENTS ACHIEVEMENT IN GEOMETRY IN OGUN STATE, NIGERIA

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### Abstract

Mathematics offers crucial analytical tools for subjects like STEM and economics in today's classrooms, but students frequently struggle with abstract algebraic reasoning, which results in poor performance. This study examined the effect of Mathematics Clinic approach (incorporating individualized support and YouTube geometry videos) on SS2 students' performance in geometry. A quasi-experimental pretest-posttest design of 2x2x2 factorial matrix of treatment, gender and school location was adopted. Two intact classes of SS2 (experimental(73) and control groups (29)) from each chosen school (one urban (52) and one rural(50)) participated in the study. Seven hypotheses were formulated to guide the study. The Geometric Achievement Test (GAT) constructed by the researcher were used to gather data which was analyzed using ANCOVA.. Results showed [ $F(1, 93) = 15.09, p < 0.05$ ] and confirmed that the experimental group significantly outperformed the control group. Furthermore, both treatment and location were found to have a statistically significant impact on achievement [ $F(1, 93) = 10.92, p < 0.05$ ]. Ultimately, the study advocates for integrating Mathematics clinics into regular curricula and providing teacher training to bridge learning gaps and enhance students' confidence.

Keywords: Geometry, Geometry achievement, Mathematics clinics, Spatial Reasoning and Student Motivation

### Introduction

The study of mathematics is fundamental to both academic growth and the development of real-world problem-solving abilities that are necessary for individual and societal advancement. In the field of mathematics, geometry is important because it helps students develop their spatial reasoning, deduction, and critical thinking skills. Students' academic achievement and career prospects, especially in disciplines like engineering, architecture, and technology, are greatly impacted by their geometry achievement (NCTM, 2022). In addition to developing critical thinking and problem-solving abilities, mastery of geometric principles establishes the groundwork for comprehension of more complex mathematical ideas.(Melhem., Al-Zoubi., Al-Shannaq.,Shtaiwi and Melhem, 2025)

Although geometry is emphasized in Nigerian school mathematics curricula to promote critical thinking and problem-solving abilities, students often find it difficult to grasp these strategies and perceive the subject as a major obstacle (Adegun & Adegun, 2013). In areas like Ogun State, where the educational system struggles with crammed classrooms, a lack of resources, and a teacher shortage, this problem is made worse Bawalla (2021); Zando et al. (2025). As a result, a major obstacle to student success in the Southwest is still the discrepancy between curriculum objectives and classroom reality.

These difficulties frequently obstruct the delivery of efficient geometry education, impeding students' capacity to understand abstract ideas and apply geometric concepts to practical situations. Educational stakeholders, realizing how critical it is to solve these issues, are increasingly looking to creative ways to improve mathematics instruction, with a concentration on geometry. (Danlami., Zakariya., Balarabe., Alotaibi., and Alrosaa, 2025.) Furthermore, in Ogun State public schools, students' achievement in the examinations of West African Examinations Council (WAEC)

Over the past three years reflects varying trends. 2019-45.5% success, 2020-36.78%, 2021- 55.19% , 2022- 76.36%, 2023: 79.81%, 2024: 72.12%, 2025: 62.96% excelling in 5 subjects with English and Maths National Bureau of Statistics, 2022; Ogwo, 2025). Adolphus (2011) performed an investigations on challenge of teaching and learning geometry in secondary schools in Rivers State, Nigeria. The study demonstrated the basis of most Mathematics instructor in geometry is low, pupils have poor foundation in mathematics and the learning environment is not suitable.

Research identifies geometry as a significant hurdle for secondary students, with Edmund and Asuque (2018) noting that pupils in Cross River State struggle with 40% of key concepts, including circle theorems and coordinate geometry. These difficulties stem from inconsistent instruction, lack of resources, and gender-related learning disparities. Similarly, Bhatta (2013) attributes poor geometry performance to systemic issues in classroom management, evaluation strategies, and the abstract nature of proofs and construction. Awasthi (2019) conducted a thesis research on learning problems of students in geometry at grade X. The result of the findings reveals that the geometry instruction in the Kathmandu metropolitan area was inadequate. The significant problem was associated with learning geometry in curriculum, proving and verifying theorems, classroom engagement , teacher training and instructional materials used in teaching. Implementing Mathematics Clinics is one such strategy that is gaining traction. Its goal is to give senior secondary school students focused help and additional learning opportunities. ( Al-Ajmi, 2009)

Outside of regular classrooms, Mathematics Clinics are supervised, interactive learning environments where students can work with peers, participate in hands-on activities, and receive tailored teaching from qualified teachers. Students can improve their problem-solving skills and expand their understanding of geometric concepts in these clinics, which act as breeding grounds for mathematical curiosity. This methodology has been shown to be beneficial; for example, Research regularly shows Mathematics Clinics as a transformative intervention for student performance. According to Okeke and Amadi (2022), these clinics greatly increase achievement by encouraging a growth mindset and lowering anxiety, while Riccomini et al. (2017) observed that they play a crucial role in helping struggling students close early learning gaps. Adesina and Bello (2021) and Nwachukwu and Ojo (2023) stress the need to use scientifically validated teaching materials and match clinic resources with national standards in order to ensure long-term efficacy. These clinics offer a focused approach to overcoming the unique challenges of geometry and enhancing general mathematical proficiency by combining individualized support, group projects, and practical exercises.

Furthermore, the effect of gender on geometric learning cannot be overemphasized. In order to provide a worldwide perspective, the UNESCO gender report (2023) examined primary and secondary education statistics from 120 countries. According to the results, boys outperform girls in mathematics in the early years, but this gender difference eventually closes, even in the poorest nations, the gender gap in education has reduced, according to this study. Additionally, the deficit has now been reversed in certain nations. For instance, by grade 8, the disparity is 7 percentage points in favor of girls in mathematics in Malaysia, 3 points in Cambodia, 1.7 points in the Congo, and 1.4 points in the Philippines.. It is therefore important to check the moderating effect of gender on the academic achievement of geometry of students.

Other factor such as school location significantly influences academic performance, as urban schools typically enjoy superior access to quality educators, infrastructure, and learning resources compared to rural institutions. Owoeye (2011) attributes the performance gap to the unequal distribution of facilities and the reluctance of qualified teachers to work in remote areas lacking basic amenities like good roads and communication. Orlu (2013) corroborated this in a study of 600 participants in Rivers State, confirming that the school environment dictates student success. The purpose of this study is to examine the effect of the implementation of mathematics clinic on the achievement in geometry of Ogun State Senior Secondary School students. The goal of the study is to determine the effect of mathematics clinic on senior secondary school students achievement in geometry in Ogun State, Nigeria

### Theoretical Framework

Theoretical framework that was used for this study is the Social Constructivism which is rooted in the works of Vygotsky (1920) and Growth Mindset Theory (1980). The first theory posits that learning is a socially mediated process, emphasizing collaborative interactions, and shared experiences. (Vygotsky, (1978)). In the context of mathematics clinics, it will engage students in joint problem-solving, discussions, and shared exploration of mathematical concepts, fostering a collective understanding. Secondly, Dweck's Growth Mindset Theory complements the social constructivist framework particularly in addressing students' attitudes and beliefs. The notion according to Dweck (1986) asserts that people who have a growth mindset believe that skills may be improved with effort and persistence. By encouraging faith in the possibility of growth and the importance of education. The development mindset idea encourages a constructive change in pupils' perspectives on mathematics. The collaborative nature of mathematics clinic aligns with social constructivist principles, emphasizing the importance of interactions in knowledge construction. Simultaneously, growth mindset interventions address the affective domain promoting a positive mind-set toward challenges, effort and learning

### Objectives of the Study

Research objectives are as follows

1. To ascertain the effect of Mathematics Clinics on Senior Secondary School Students Achievement in Geometry in Ogun State, Nigeria.
2. To ascertain how gender affects Senior Secondary School Students Achievement in Geometry in Ogun State, Nigeria.
3. To examine the effect of school location on the Senior Secondary School Students Achievement in Geometry in Ogun State, Nigeria,
4. To determine the interaction effect of treatment and gender on senior secondary school students achievement in Geometry in Ogun State, Nigeria
5. To determine the interaction effect of treatment and school location on senior secondary school students achievement in Geometry in Ogun State, Nigeria
6. To determine the interaction effect of gender and school location on senior secondary school students achievement in Geometry in Ogun State, Nigeria
7. To determine the interaction effect of treatment gender and school location on senior secondary school students achievement in Geometry in Ogun State, Nigeria

### Hypotheses

The following hypotheses were tested in the study.

1. There is no significant main effect of treatment on senior secondary school students achievement in Geometry in Ogun State, Nigeria
2. There is no significant main effect of gender on senior secondary school students achievement in Geometry in Ogun State, Nigeria
3. There is no significant main effect of school location on senior secondary school students achievement in Geometry in Ogun State, Nigeria
4. There is no significant interaction effect of treatment and gender on senior secondary school students achievement in Geometry in Ogun State, Nigeria
5. There is no significant interaction effect of treatment and school location on senior secondary school students achievement in Geometry in Ogun State, Nigeria
6. There is no significant interaction effect of gender and school location on senior secondary school students achievement in Geometry in Ogun State, Nigeria
7. There is no significant interaction effect of treatment gender and school location on senior secondary school students achievement in Geometry in Ogun State, Nigeria

### Methodology

The study used a pre-test – post-test quasi experimental design. The population for the study was all SS2 students (the estimated SS2 population is approximately 30,000 students in public schools.) in Ogun State, Nigeria (OGSERA). (2024).; two intact classes (one experimental and one control group) from each of the chosen Senior Secondary School (rural or urban) served as samples. The degree of intervention is determined by the treatment (an independent variable). Students participating in the "Mathematics Clinic" intervention (individualized help, YouTube videos) comprise the experimental group. Students in the control group are taught in a typical classroom. In order to determine whether a treatment is more effective for a certain gender, Moderating Variable 1 (Gender) divides pupils into male and female categories. In order to ascertain whether environmental factors affect the clinic's efficacy, Moderating Variable 2 (Location) divides students into urban and rural groups.. The design involves a 2x2x2 factorial matrix schematically represented as shown

O1	X1	O3
O2	X0	O4

O1 and O2 are the pre-test for experimental/ treatment group and control group respectively while O3 and O4 are the post-test conducted to the same groups respectively after the treatment. . X1 is the treatment ( mathematics clinic) given to the experimental group and X0 is the conventional teaching method for control group

Two instruments were used in the study, :one response instrument, the Geometry Achievement Test (GAT), and one stimulus tool (self-made YouTube videos on geometry). While control groups got traditional training, experimental groups participated in a Mathematics Clinic with projectors, exhibition spaces, and educational materials over the course of five weeks. To assure quality, the YouTube videos were reviewed by Computer Science and Educational Technology professionals from Tai Solarin University of Education. Instrument reliability was established by Kuder Richardson (0.94 for GAT). Data collecting includes six study assistants and school instructors across complete SS2 classes. The findings of the pretest and post-test were compared using inferential statistics (ANCOVA).

### Results

The results of the data collected and analyzed were reported below

Hypothesis one: There is no significant main effect of treatment on senior secondary school students achievement in Geometry in Ogun State, Nigeria

The findings of the ANCOVA analysis are displayed in Table 1.

Table1. Analysis Of The Effect Of Treatment On The Geometry Chievement Of Students In Ogun State

R Squared = .191 (Adjusted R Squared = .122

Findings from table 1 revealed that Treatment significantly affect the geometry achievement of students  $F(1, 93) = 9.78, p = .002$ . The analysis therefore showed that students who participated in the mathematics clinic significantly outperformed their equivalents in the group under supervision. This

Dependent Variable POST TEST Achievement Score						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	303.674a	8	37.959	2.749	.009	.191
Intercept	134.811	1	134.811	9.762	.002	.095
Pretest	20.311	1	20.311	1.471	.228	.016
Location	84.913	1	84.913	6.149	.015	.062
Gender	13.488	1	13.488	.977	.326	.010
Treatment	135.051	1	135.051	9.780	.002	.095
Location*Gender	29.278	1	29.278	2.120	.149	.022
Location*Treatment	8.871	1	8.871	.642	.425	.007
Gender*Treatment	17.598	1	17.598	1.274	.262	.014
Gender*Location*Treatment	17.369	1	17.369	1.258	.265	.013
Error	1284.287	93	13.810			
Total	28734.000	102				
Corrected Total	1587.961	101				

implies that students' comprehension and achievement in geometry were significantly and favorably impacted by the intervention. As a result, the null hypothesis one is rejected.

Hypothesis two: There is no significant main effect of gender on senior secondary school students achievement in Geometry in Ogun State, Nigeria

The academic geometry achievement of Ogun State Senior Secondary School students does not vary significantly by treatment and gender. The results of the analysis in Table 1 revealed that gender does not significantly affect the geometry achievement of students  $F(1, 93) = .98, p = .33$ . The analysis revealed no variation in how male and female students responded to the mathematics clinic. This suggests that the program was equally beneficial across genders, showing inclusive in its design and delivery. In essence, both boys and girls had equal opportunities to thrive through the intervention. The null hypothesis two is accepted

Hypothesis three :There is no significant main effect of school location on senior secondary school students achievement in Geometry in Ogun State, Nigeria

Table 1 revealed that Location of schools significantly affect the geometry achievement of students in Ogun state  $F(1, 93) = 6.15, p = .02$  . The null hypothesis three is rejected. The achievement gains from the clinic varied by school location. The clinic's effectiveness was influenced by where the students' schools were located. Urban and rural, schools experienced differing levels of benefit, indicating that local contexts and school environments can affect educational interventions. These insights highlight the need to adapt academic programs like the mathematics clinic to fit the realities of each school setting.

Hypothesis Four: There is no significant interaction effect of treatment and gender on senior secondary school students achievement in Geometry in Ogun State, Nigeria

Table 1 showed no significant interaction effect of treatment and gender on students' academic achievement of geometry in Ogun State (  $F(1, 93) = 1.27, p = .26$ ). The interaction between gender and treatment did not significantly affect geometry achievement. No significant interaction was found

between gender and treatment in shaping geometry achievement in Ogun State. This result implies that treatments works similarly for boys and girls—neither group had an advantage or disadvantage based on the treatment they were given. This underscores the universal importance of treatment regardless of gender. The null hypothesis four is therefore accepted.

Hypothesis Five: There is no significant interaction effect of treatment and school location on senior secondary school students achievement in Geometry in Ogun State, Nigeria

Table 1 showed no significant interaction effect of treatment and school location on the academic achievement of students in geometry in Ogun state. ( $F(1, 93) = .64, p = .43$ ), so we fail to reject the hypothesis five. Nonetheless, table 1 also showed that geometry achievement among senior secondary school students is significantly affected by school location.  $F(1, 93) = 2.12, p = 1.5$  the null hypothesis is rejected. The achievement gains from the clinic varied by school location. The clinic's effectiveness was not influenced by where the students' schools were located. Urban and rural, schools experienced differing levels of benefit, indicating that local contexts and school environments cannot affect educational interventions.

Hypothesis six There is no significant interaction effect of gender and school location on senior secondary school students achievement in Geometry in Ogun State, Nigeria

Table 1 showed a significant interaction effect of gender and school location on academic achievement of secondary school students in geometry  $F(1, 93) = 2.12, p = .15$  Gender and school location does not jointly influenced achievement. The relationship between gender and academic achievement differed depending on the school's location. For instance, girls may perform better in one type of setting (e.g., urban) while boys excel in another (e.g., rural). These results suggest that educational strategies should be responsive to both gender and geographic context for maximum impact.

Hypothesis seven: There is no significant interaction effect of treatment, gender and school location on senior secondary school students achievement in Geometry in Ogun State, Nigeria

Treatment, Gender, and school location did not have a statistical significant effect on students' achievement ( $F(1,93) = 1.26, p = .27$ ) While individual factors or pairwise combinations may be important, their three-way interaction did not produce notable differences. It reminds us that complex educational effects often don't follow linear or uniform patterns.

The mathematics clinic intervention demonstrated clear effectiveness, particularly when analyzed in relation to school location. While gender and treatment alone or in combination did not significantly affect academic outcomes, their interactions with school location did yield meaningful insights. These findings underscore the importance of context-sensitive approaches to educational interventions.

### **Discussion of Findings**

The first hypothesis showed that Students that took part in the clinic significantly outperformed their peers. This result supports Adewale and Taiwo (2019), who found that targeted interventions boost mathematics achievement. It also agrees with Okigbo and Osuafor (2008), who noted that activity-based learning helps students understand concepts more clearly than traditional teaching. The implication here is that practical, student-centered support makes geometry more approachable and improves outcomes.

By considering the findings revealed that both boys and girls benefitted equally from the clinic. This mirrors the work of Anamuah-Mensah (2005) and Eze (2010), who argued that effective teaching strategies can close gender gaps in mathematics achievement. Although some researchers (e.g., Ajai & Imoko, 2015) have suggested that boys sometimes respond better to problem-solving methods, the present results indicate that when teaching is inclusive, both genders thrive.

The result of the findings reveals that clinic improved achievement regardless of whether students were highly motivated or not. This seems unexpected at first, since motivation is often linked to better

learning outcomes (Pintrich & De Groot, 1990). However, Olatoye (2011) also observed that strong instructional support can reduce the role of individual motivation. In this case, the clinic provided a structure that allowed even less motivated students to succeed.

School location, nonetheless, played a more crucial impact in the study. The results of the study in hypothesis four demonstrate that the clinic's efficacy differed across urban, rural, and semi-urban schools. This finding supports Adeyemi (2011) and Ezeudu & Obi (2013), who emphasized that urban schools often have better facilities and resources, which enhance the benefits of interventions. Rural schools, on the other hand, may struggle with limited infrastructure and teacher support, which can dampen the gains from such programs. This suggests that interventions need to be adapted to local contexts rather than applied uniformly.

The interaction between gender and motivation was not significant, showing that motivation works in much the same way for boys and girls. This is consistent with Schunk et al., (2014), who argued that motivation is a universal driver of learning. What matters most is finding ways to nurture it in all students, regardless of gender.

The joint effect of gender and school location, however, was significant. This finding echoes Adeyemi (2011), who showed that cultural and environmental factors can shape achievement differently for boys and girls. For instance, urban schools may provide girls with greater encouragement, while boys may find more opportunities to excel in rural settings. This suggests that achievement patterns are shaped as much by context as by individual ability.

In conclusion, the mathematics clinic proved highly effective in improving students' understanding of geometry. Its success was most strongly shaped by the school environment, while gender and motivation were less influential when strong instructional support was in place. These results highlight the importance of designing interventions that not only support students directly but also take into account the realities of their learning environments.

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