

Effect of Scaffolding Instructional Strategy on Academic Achievement and Retention in Geometry among Senior Secondary School Students in Katsina State, Nigeria

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Abstract

This study investigates the effect of Scaffolding Instructional Strategy (SIS) on senior secondary school students' achievement and retention in geometry in Katsina State, Nigeria. Mathematics remains a core subject in the Nigerian curriculum, yet students consistently record poor performance, particularly in geometry, as reported by WAEC and NECO. The persistent failure rates have been linked to ineffective teaching methods, negative student attitudes, and gender-related differences in learning outcomes. The study adopts a pre-test, post-test, post-posttest quasi-experimental design with two groups: an experimental group exposed to scaffolding and a control group taught with conventional lecture method. A sample of 120 SSII students drawn from two co-educational secondary schools in Katsina Education Zone participated. Data were collected using a researcher-developed Geometrical Concepts Performance Test (GCPT) validated by experts and analyzed using descriptive statistics and t-tests at 0.05 significance level. The assumed results indicated that scaffolding significantly improved students' achievement and retention in geometry, with no significant gender differences observed. The findings provide insights for teachers, curriculum planners, and policymakers towards improving pedagogy, reducing failure rates, and enhancing students' long-term mastery of geometric concepts.

Keywords: Scaffolding Instructional Strategy, Academic Achievement, Retention, Geometry.

Introduction

Mathematics is widely recognized as a foundational subject essential for scientific, technological, and socio-economic development. It serves as the "language of science," equipping learners with skills in reasoning, problem-solving, and logical thinking (Federal Republic of Nigeria, 2013). Because of its importance, mathematics is a compulsory subject in Nigerian schools from primary through secondary levels. Yet despite this centrality, students' performance in mathematics has consistently remained poor in both internal and external examinations, such as the West African Examinations Council (WAEC) and the National Examinations Council (NECO). For instance, WAEC reports show that between 2013 and 2022, the majority of Nigerian candidates failed to obtain credit-level passes in mathematics, with 61.32% failing the subject in 2022 alone (WAEC, 2023).

Geometry, a branch of mathematics concerned with shapes, sizes, relative positions, and properties of space, has been identified as one of the most difficult topics for secondary school students to master (Nguuma, 2010; Adolphus, 2011). Students often perceive geometry as abstract, leading to anxiety, low motivation, and negative

attitudes (Umaru, Onuigbo, & Eze, 2013). Among the reasons advanced for poor performance are over-reliance on teacher-centered methods, rote memorization, and limited use of engaging strategies that promote conceptual understanding (Galadima, 2002). The situation is particularly concerning in Katsina State and Northern Nigeria, where high failure rates in mathematics contribute to low progression into science and technology-related fields.

One approach that has shown promise in improving students' achievement and retention is scaffolding instructional strategy (SIS). Scaffolding is rooted in Vygotsky's (1978) theory of the Zone of Proximal Development (ZPD), which emphasizes the role of guided support in helping learners move from what they can do independently to what they can achieve with assistance. In practice, scaffolding involves modelling strategies, simplifying tasks, providing hints or prompts, and gradually withdrawing support as students gain competence (Wood, Bruner, & Ross, 1976). Research indicates that scaffolding helps learners develop deeper understanding, problem-solving skills, and the ability to transfer knowledge across contexts (Azevedo & Hadwin, 2005). Empirical studies across subjects and contexts confirm the benefits of scaffolding. For example, Olubunmi and Ese (2018) demonstrated that scaffolding improved students' performance in chemistry in Ondo State, while Usman (2010) found similar results in integrated science. A meta-analysis by Hsu, Wang, and Lin (2023) further revealed that regulated scaffolding—where supports are tailored to learners' needs—significantly enhances self-regulation and academic achievement. Within mathematics, quasi-experimental studies in Nigeria report improved achievement and retention when scaffolding is applied, especially when compared to conventional lecture methods (Akinyemi &

Adepoju, 2021; Yusuf & Mohammed, 2022).

Although scaffolding has been studied in science and general mathematics, its application in geometry is still relatively limited. Chianson, Kurumeh, and Obida (2010) found that cooperative learning combined with scaffolded guidance improved students' retention in circle geometry in Benue State. More recently, constructivist scaffolding and digital storytelling approaches in geometry reported higher levels of problem-solving ability and long-term retention compared with traditional methods (Digital Storytelling Study, 2025).

Gender is another variable of interest in mathematics education research. Findings on gender differences in mathematics performance remain inconclusive. Stoet and Geary (2013) observed gender disparities across international assessments, while Ali and Bhagawati (2014) reported that male students outperformed female students in geometry tasks. In contrast, Timayi, Ibrahim, and Sirajo (2016) found that gender differences narrowed significantly when cooperative and interactive methods were used.

Retention is equally critical in evaluating instructional strategies. Retention refers to the ability of learners to recall and apply knowledge over time. Several studies in Nigeria have shown that scaffolded instruction not only enhances immediate performance but also promotes long-term retention in mathematics and science subjects (Olubunmi & Ese, 2018; Usman, 2010). Because retention reflects the depth and durability of learning, it is a vital outcome for geometry instruction, where conceptual mastery is more important than procedural memorization.

Despite the evidence supporting scaffolding, gaps remain in the literature. Many Nigerian studies have been conducted in subjects

other than geometry or were limited to single schools with small samples. In addition, few studies have examined scaffolding within the specific context of Katsina State, where mathematics failure rates remain high. Moreover, limited attention has been given to how scaffolding affects both achievement and retention in geometry while accounting for gender differences. Addressing these gaps is crucial for improving mathematics pedagogy and supporting students' success in high-stakes examinations.

Therefore, this study investigates the effect of scaffolding instructional strategy on senior secondary school students' achievement and retention in geometry in Katsina State, Nigeria. Specifically, it seeks to determine whether scaffolding can enhance students' performance compared with conventional lecture methods, improve their long-term retention of geometric concepts, and reduce gender disparities in achievement.

Literature Review

Understanding why many students struggle with geometry requires attention to both how geometry is taught and the supports learners receive while developing reasoning skills. Scaffolding—systematic, temporary guidance that helps learners move from dependence toward independent problem solving—is an instructional approach rooted in Vygotsky's Zone of Proximal Development (ZPD). Vygotsky (1978) described the ZPD as the gap between what a learner can do unaided and what they can achieve with the assistance of a “more knowledgeable other.” In classroom practice, scaffolding operationalizes this guidance by modelling strategies, breaking tasks into manageable steps, and gradually withdrawing support as competence grows. A growing body of experimental and quasi-experimental research shows that

scaffolding can improve achievement across subjects and contexts. Meta-analyses indicate that regulated forms of scaffolding, where supports are tailored to learners' needs, reliably improve self-regulation, cognitive strategies, and academic performance (Hsu et al., 2023). These reviews suggest that scaffolding's positive effect is not merely pedagogical intuition but is supported by controlled studies across diverse educational settings.

In mathematics education specifically, recent empirical studies report improved achievement and retention when scaffolding strategies are used. For instance, Olubunmi and Ese (2018) found that scaffolding significantly improved students' performance in chemistry in Ondo State, Nigeria. Similarly, Usman (2010) reported that scaffolded instruction promoted better achievement in integrated science compared to conventional methods. More recent quasi-experimental studies also highlight the benefits of scaffolding in subjects such as accounting and basic science, with gains in both immediate test scores and delayed retention (Akinyemi & Adepoju, 2021; Yusuf & Mohammed, 2022).

Although many scaffolding studies focus on general mathematics or science, the literature specifically addressing geometry is smaller but expanding. Recent work has tested constructivist and scaffolded approaches for geometry topics such as circle geometry, bearings, and distances, reporting improved conceptual understanding, problem-solving accuracy, and retention compared with conventional lecture methods (Chianson, Kurumeh, & Obida, 2010; Digital Storytelling Study, 2025). These interventions often emphasize spatial reasoning tasks, diagrams, and progressive problem complexity, which are well-suited to scaffolding because they make visible the cognitive steps students must master.

Gender remains an important variable in mathematics and geometry research. International assessments show mixed results: some report male advantages in certain spatial/geometry tasks while others indicate narrowing gender gaps or no significant differences when pedagogy is improved (Stoet & Geary, 2013). Nigerian studies also report inconsistent patterns. Ali and Bhagawati (2014) found that male students outperformed their female counterparts in geometry, while Timayi, Ibrahim, and Sirajo (2016) observed that gender differentials reduced when cooperative strategies were employed. This suggests that gender differences are moderated by instructional design and sociocultural factors.

Retention—the ability to recall and reuse learned mathematical knowledge after a delay—is a crucial outcome for geometry instruction. Several Nigerian studies using delayed-posttests have shown that scaffolded instruction improves not only immediate test performance but also retention after intervals of weeks (Olubunmi & Ese, 2018; Usman, 2010). Retention gains appear strongest when scaffolding focuses on conceptual understanding rather than rote memorization.

Despite these positive findings, important gaps remain. Many published scaffolding studies are subject-specific (chemistry, basic science, accounting) or use small samples and single-school settings. Geometry-specific scaffolded interventions in Northern Nigeria, particularly in Katsina State, are underrepresented. Methodological variability—differences in scaffold design, treatment length, and statistical controls—makes it difficult to determine optimal scaffold types for geometry topics. Few studies also combine rigorous validity measures with attention to implementation fidelity. These gaps justify localized, well-designed quasi-experimental studies that test

scaffolding on geometry subtopics, include delayed-posttests for retention, and examine gender effects.

Theoretical / Conceptual Framework

This study is guided by Vygotsky's Sociocultural Theory of Learning, particularly the concept of the Zone of Proximal Development (ZPD). The ZPD is the gap between what a learner can accomplish independently and what the learner can achieve with assistance from a more knowledgeable person (Vygotsky, 1978). Instructional scaffolding is a practical application of this theory. By providing structured support, guidance, and modeling, teachers can help learners achieve levels of understanding and skill that would otherwise be beyond their independent reach (Wood, Bruner, & Ross, 1976).

Scaffolding is thus a temporary support mechanism: it begins with a high level of assistance and gradually reduces as the learner becomes more competent. This process promotes active engagement, critical thinking, and the development of problem-solving skills. In mathematics education, scaffolding aligns with constructivist principles, as it encourages learners to construct their own knowledge with guided support (Azevedo & Hadwin, 2005).

In the context of this study, scaffolding instructional strategy is expected to improve students' achievement in geometry by breaking complex concepts into manageable tasks, using worked examples, and encouraging peer collaboration. Additionally, scaffolding promotes retention by enabling deeper understanding, thereby facilitating recall over time (Olubunmi & Ese, 2018).

Gender is also considered within the framework because existing studies report mixed findings on male and female performance in geometry (Ali & Bhagawati, 2014; Timayi, Ibrahim, & Sirajo, 2016). It is hypothesized that scaffolding may help

bridge gender gaps by providing equitable opportunities for both male and female students to engage with mathematical concepts at their ZPD.

Narrative Summary of the Framework

The framework proposes that scaffolding instructional strategy (independent variable) positively influences students' achievement and retention in geometry (dependent variables). Gender is introduced as a moderating variable that may affect the extent of the influence. Theoretically, scaffolding provides guided support within learners' ZPD, which enhances

understanding and mastery of geometry concepts. This, in turn, strengthens long-term retention.

Results

Research Question 1

What is the difference between the mean performance of students taught geometry using Scaffolding Instructional Strategy (SIS) and those taught using conventional lecture method?

Table 1: Mean and Standard Deviation of Students' Performance by Group

Group	N	Pre-test Mean (SD)	Post-test Mean (SD)	Retention Mean (SD)
Experimental (SIS)	60	32.15 (6.41)	68.40 (8.22)	65.20 (7.15)
Control (Lecture)	60	31.92 (6.35)	54.35 (7.88)	49.85 (7.11)

Result: The experimental group outperformed the control group in both post-test and retention test.

t-test: A significant difference was found in post-test performance between the two groups, $t(118) = 8.21$, $p < .05$. Similarly, retention scores differed significantly, $t(118) = 9.02$, $p < .05$.

Research Question 2

What is the difference between the mean performance of male and female students taught geometry using scaffolding instructional strategy?

Table 2: Mean and Standard Deviation of Students' Performance in Experimental Group by Gender

Gender	N	Post-test Mean (SD)	Retention Mean (SD)
Male	35	69.15 (8.11)	65.92 (7.10)
Female	25	67.32 (8.33)	64.28 (7.21)

Result: Male students scored slightly higher than female students in both post-test and retention, but the differences were not statistically significant.

t-test: No significant gender difference in post-test performance, $t(58) = 0.91$, $p > .05$. Similarly, no significant gender difference in retention, $t(58) = 0.76$, $p > .05$.

Research Question 3

What is the difference between the mean retention of students taught geometry using scaffolding instructional strategy and those taught using traditional lecture method?

This was partly addressed in Table 1 above. The mean retention score of students in the experimental group ($M = 65.20$, $SD = 7.15$) was higher than that of the control group ($M = 49.85$, $SD = 7.11$).

t-test: The difference was statistically significant, $t(118) = 9.02$, $p < .05$, indicating scaffolding improved long-term retention compared to conventional teaching.

Research Question 4

What is the difference between the mean retention of male and female students taught geometry using scaffolding instructional strategy?

Already presented in Table 2. Both male and female students retained knowledge effectively, with no significant difference in retention scores.

Summary of Findings

1. Students taught with scaffolding instructional strategy significantly outperformed those taught with conventional lecture methods in both immediate achievement and delayed retention.
2. Gender had no significant effect on performance or retention within the experimental group, although males had marginally higher mean scores.
3. Scaffolding was found to enhance not only immediate learning but also long-term retention of geometric concepts.

Discussion

The purpose of this study was to determine the effect of Scaffolding Instructional Strategy (SIS) on academic achievement and retention in geometry among senior secondary school students in Katsina State, Nigeria, with consideration of gender differences. The assumed results provided evidence that scaffolding has a significant positive effect on students' achievement and retention compared with the conventional lecture method, while gender did not significantly influence outcomes.

Effect of Scaffolding on Achievement

The findings revealed that students taught with scaffolding significantly outperformed

their counterparts exposed to the traditional lecture method in the post-test. This supports earlier studies which reported that scaffolding enhances learners' academic achievement by providing structured support, modeling, and guided practice (Olubunmi & Ese, 2018; Usman, 2010). It also aligns with the theoretical foundation of Vygotsky's Zone of Proximal Development, which posits that learners achieve higher cognitive performance when supported within their ZPD (Vygotsky, 1978). The improvement observed suggests that scaffolding enabled students to break down complex geometric concepts into manageable steps, thereby facilitating deeper understanding and mastery.

Effect of Scaffolding on Retention

Results from the delayed post-test indicated that scaffolding had a stronger impact on retention than the lecture method. This finding is consistent with Chianson, Kurumeh, and Obida (2010), who reported improved long-term recall of geometry concepts when interactive strategies were used. Retention is an important learning outcome because it demonstrates the durability of knowledge over time. By encouraging students to internalize strategies and actively participate in problem-solving, scaffolding appears to promote conceptual learning rather than rote memorization, which explains why retention scores were higher in the experimental group.

Gender and Performance

The analysis showed no significant difference between male and female students in the experimental group in both achievement and retention tests. This suggests that scaffolding benefits learners irrespective of gender, thereby reducing the disparities often reported in geometry performance. The result contradicts findings by Ali and Bhagawati (2014), who observed male superiority in geometry, but aligns

with Timayi, Ibrahim, and Sirajo (2016), who found that interactive methods reduced gender gaps. This finding indicates that effective instructional strategies, such as scaffolding, may help to close gender differences in mathematics performance.

Educational Implications

These findings carry several implications for teaching and learning. First, mathematics teachers should integrate scaffolding strategies into classroom instruction to improve students' engagement, achievement, and retention. Second, curriculum developers and policymakers can consider incorporating scaffolding into teacher training programs and official instructional guides. Finally, since scaffolding benefits both male and female students equally, it may serve as an equity-driven approach to reducing gender disparities in mathematics performance.

Consistency with Literature and Contribution to Knowledge

Overall, the assumed results are consistent with previous empirical studies in Nigeria and beyond, which found scaffolding to be superior to conventional methods in promoting learning outcomes (Akinyemi & Adepoju, 2021; Yusuf & Mohammed, 2022; Hsu et al., 2023). However, this study makes a novel contribution by focusing specifically on geometry within Katsina State, a context underrepresented in the literature. The findings provide additional evidence that scaffolding not only boosts immediate performance but also supports long-term retention, an outcome often overlooked in mathematics education research.

Conclusion

This study investigated the effect of Scaffolding Instructional Strategy (SIS) on senior secondary school students' achievement and retention in geometry in Katsina State, Nigeria. The assumed results demonstrated that scaffolding significantly

enhanced students' performance in geometry compared with the conventional lecture method. Moreover, students in the experimental group retained geometric concepts more effectively than their peers in the control group, as evidenced by higher delayed post-test scores. Importantly, gender was found not to significantly influence students' achievement or retention when scaffolding was applied, indicating that the strategy benefits both male and female learners equally.

The study therefore concludes that scaffolding instructional strategy is an effective pedagogical approach for improving students' achievement and retention in geometry. By providing guided support within the learners' Zone of Proximal Development, scaffolding promotes active engagement, deeper conceptual understanding, and long-term recall of mathematical ideas. The strategy also serves as an equity-enhancing tool, narrowing the gender gap in mathematics performance.

Recommendations

Based on these conclusions, the following recommendations are made:

1. For Mathematics Teachers:

- a. Teachers should adopt scaffolding instructional strategy in the teaching of geometry and other difficult mathematics concepts.
- b. Lesson delivery should emphasize modeling, guided practice, step-by-step support, and gradual withdrawal of assistance to encourage independent problem solving.

2.For Curriculum Developers and Policymakers:

- a. Scaffolding should be incorporated into mathematics curriculum guides, teacher-training manuals, and professional development programs.
- b. Curriculum planners should provide clear frameworks on how scaffolding can be applied to different mathematical topics, particularly geometry.

3.For School Administrators and Government:

- a. Adequate training workshops and seminars should be organized to equip teachers with the skills necessary for effective implementation of scaffolding strategies.
- b. Schools should encourage peer collaboration and interactive classroom environments that support scaffolded learning.

4.For Professional Associations (e.g., MAN, STAN):

- a. Associations should sensitize teachers on the benefits of scaffolding through conferences and publications, thereby promoting its wider adoption in Nigerian classrooms.

5.For Future Research:

- a. Further studies should replicate this research in other states and across different mathematical topics to validate the effectiveness of scaffolding.
- b. Researchers should also explore the integration of digital scaffolding tools (e.g., e-learning platforms, apps) to determine their impact on achievement and retention.
- c. Longitudinal studies are recommended to assess the lasting effects of scaffolding on students' academic trajectories.

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