

# EFFECTS OF SCAFFOLDING AND CONVENTIONAL INSTRUCTIONAL METHODS ON FEMALE STUDENTS' ACADEMIC ACHIEVEMENT AND MATHEMATICS ANXIETY IN GEOMETRY IN AGAIE LOCAL GOVERNMENT, NIGER STATE.

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## Abstract

This study aimed to assess the effect of scaffolding and conventional instructional methods on female student's academic achievement and mathematics anxiety in geometry. The study employed a quasi-experimental design of pre-test and post-test control design. The population of the study consisted of 443 SSII female students' distribution over 8 public schools in Agaie Local Government Area of Niger State, Nigeria. 130 SSII students selected from two schools using multistage sampling formed the sample of the study. Data were collected through four instruments: Scaffolding lesson model for the experimental group, Conventional lesson model for control group, Geometry Achievement Test (GAT) and Mathematics Anxiety Questionnaire (MAQ). The instruments were validated by three experts from IBBUL and FUT Minna. The reliability index of (GAT) and (MAQ) are 0.76 and 0.86 respectively. Research questions were answered through mean, standard deviation and mean difference, while t-test at 0.05 level of significance was used to analyse the null hypotheses. The findings revealed that female students exposed to scaffolding instruction method have higher mean score than those exposed to conventional instructional method. Based on the results, it is recommended among others, the teaching of mathematics especially geometry incorporate scaffolding instruction. Similarly, this method should be incorporated in the methodology and micro- teaching courses of pre-service teachers.

**Keywords:** Anxiety, Conventional, Geometry, Mathematics, Scaffolding,

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## Introduction

The mathematics knowledge and competency proved to be vital vehicle to train the minds of the students to think logically, objectively and reasonable in solving daily problems. Mathematics as a science subject taught at the post primary level in Nigeria is divided into seven segments, which includes: number and numeration, Algebra, Mensuration, Geometry, Trigonometry, Statistics and Probability (Zakariyya & Ahmad, 2021). Geometry is a concept of mathematics which deals with study of different shapes, either plane or solid shape. It is vital area that forms the building block of engineering and technical graphics. But many learners in secondary schools have not been demonstrating strong conceptual knowledge, and they were not adequately prepared for geometry concept (Ahmad, 2016). Several research evidences have showed that students complained that some topics in mathematics are too difficult to understand and consequently cause mathematics anxiety and poor performance in the final examinations among students (Juman et al, 2022 &, Odor et al, 2024). Such difficult topics as observed by mathematics educators include bearings, latitude and longitude, areas and volume of shapes, word problems and geometry constructions (Salma, 2018).

These are attributed to some factors, which include instructional method use by mathematics teachers in our schools, large class size, and inadequate learning materials for teaching the subject. Teachers of mathematics have been criticized for adopting conventional method in teaching of large classes, with intention of covering large contents. However, the method is deficient in meeting the needs of majority of students. It has also been described as teacher centre and didactics with students simply listening, copying notes, doing homework and allowed

easy handling of large classes without stress (Ahmad & Zakariyya, 2021). The conventional method most often is found to favour the educational advantaged learners at detriment of the educational disadvantaged ones. This method has not been successful in promoting learners' anxiety in learning mathematics, which would enhance their high achievement in geometry (Zakariyya & Ahmad, 2021).

Furthermore, the instructional method does not tend to foster creative and logical thinking, and collaborative problem solving. Therefore, it has become very necessary to search for method that ensure and enhance better academic achievement of the students in mathematics especially geometry concepts, example of scaffolding.

Scaffolding is an instructional strategy where by a teacher or more knowledgeable peer assists a learner, modifying the learning task so the learner can solve problems or accomplish tasks that would otherwise be out of reach. It can also be regarded as a powerful instructional tool to help learners extend their level of understanding and complete tasks successfully (Yong, 2021). Ogundele (2020) see it as an instructional method in which learners are offered constructive support until when they can apply new skill and strategies individually. Scaffolding instructional strategy was based on the conceptual framework of Vygotsky's (1978) construct of the Zone of Proximal Development (ZPD) (Vygotsky, 1978).

It is an instructional method designed to promote a deeper level of learning. It is the support given during the leaning process, which is tailored to the needs of the students with the intention of assisting the learners achieved their learning objectives (Ahmad, 2016). The instructional scaffolding provides for supportive learning environment in which students are free to ask questions, provide feedback, and support their peers. Septi el at. (2024) submitted that when you incorporate scaffolding in the classroom, you become more of a mentor and facilitator of knowledge rather the dominant content expert. This instructional method provides the incentives for learners to take more active roles in their learning. Learners share responsibility of teaching and learning through scaffolds that require them to move beyond their current skill and knowledge levels. Through these interaction students are enable to take ownership of the learning. According to Ukwueze el at. (2020) that scaffolding is a kind of support which learners receive in their interaction with parents, teachers, peers and mentors as they move to new tasks/skills, concepts or levels of understanding. It assists to portray the temporary, but essential nature of the teachers' assistance as the student advance in knowledge and understanding. The learners are well guided in the learning process, pushing them to think deeply, and model the kinds of questions that they need to be asking them; forming a cognitive apprenticeship. This method is not limited to the cognitive domain only but it also relates to affective and emotive factors. During the process the teacher might need to manage and control frustration, fear and loss of interest that could be experienced by the learners. It encourages learners to take a more active role in the learning process by fully participations and engaging in problem-solving activities (Ahmad el at, 2022). Also, Olubunmi and Ese (2018) conducted a study using scaffolding in Chemistry and reported that it improved students' achievement in Chemistry. To them, scaffolding instructional method assists learners to achieve significant success in tasks that would be too difficult to achieve by themselves and also build confident in learners. Furthermore, the method assists learners reach higher levels of comprehension and skill acquisition that they would not be able attain with assistance. Therefore, this study will into whether scaffolding instructional method can have improved students' achievement in Geometry in mathematics. Again students' poor achievement in Geometry has also been levied to gender.

Gender has been a controversial issue in many studies of mathematics education studies. Gender differences in mathematics performance and female underrepresentation in mathematics and STEM (Science, Technology, Engineering and Mathematics) disciplines has been documented. According to the National Science Foundation (2018), women outnumber men in earning Bachelor's degrees in biological and agricultural sciences, psychology, and the social sciences. However, in the more mathematics intensive areas of study, men outnumber women. Similarly,

Campbell (2020) in her study of gender differences at the highest levels of mathematics achievement showed that the percentage the gap between the percentage of male and female students scoring in the top quartile grew wider in higher score bands. In most studies male outperformed female in mathematics tests. For example, Oluyemo, et al., (2022) study revealed that male students excel in mathematics more than their female counterparts. However, Efa and Frimpong (2023) study showed that there was a significant gender difference in students' performance in mathematics in favour of females. Since there is no general acceptable result on gender differences in geometry and mathematics, there is need to investigate whether the use of scaffolding instructional in teaching geometry could bridge the gap.

Mathematics anxiety which can refer to the fear, tension, and apprehension individuals experience when facing mathematics problem (McCullagh et al., 2024) is one of the psychological variables that has been found to have negatively influence on performance and acquisition of mathematics skills. Studies of Barroso et al., (2021) and Caviola et al. (2022) have shown that mathematics anxiety is strongly related to mathematical performance. Mathematics anxiety affects student's confidence in the subject (Ahmad & Babawacikio, 2021). Many learners of mathematics especially geometry suffer from mathematics anxiety and have little confidence in their ability to master the subject and this in turn bring low performance in the subject (Jerry, et al., 2019). Psychologists viewed mathematics anxiety to be positive sometime, if it helps you deal with a tensed situation to study harder for exams handle a new task, or stay focused on an important task.

Several studies examining gender differences in mathematics anxiety have found that female report higher levels of mathematics anxiety than male (Hart & Ganley, 2020; Szczygieł, 2020; Delage, et al., 2022 & Anbar et al., 2022). However, several studies have also shown that instructional strategies that are student-centred and activity based are effective in reducing gender differences in mathematics performance and anxiety. Similarly, Nwoke, et al., (2018) recommended that teachers should use innovative strategies in teaching mathematics to get both male and female students involved in classroom activities. However, when mathematics anxiety becomes excessive, doesn't fit the situation, or last for a long time, it can get interfere on students' performance on the task (Ahmad & Auwal, 2021).

Innovative strategies such as computer-assisted assessment model Nasution et al. (2019), cooperative learning Zavareh et al. (2022) and problem-based learning method as Ajai, and Imoko (2015) has been explored. This study therefore explore the effects of scaffolding instructional method on female students' academic achievement and mathematics anxiety in geometry.

### **Objectives of the Study**

The objectives of this research study are to:

1. Find out the effect of scaffolding and conventional instructional on academic achievement of female students in geometry concepts of mathematics;
2. Examines the effect of scaffolding and conventional instructional methods on female students' mathematics-anxiety in geometry concepts of mathematics.

### **Research Questions**

The following research questions were asked to guide the study:

1. What is the significant difference in the academic achievement of female students exposed to scaffolding instructional method and conventional instructional method in geometry concepts in mathematics?
2. What is the significant difference in the mathematics anxiety of female students exposed to scaffolding instructional method and conventional instructional method in geometry concepts in mathematics?

## Null Hypotheses

The following null hypotheses were formulated and tested at alpha 0.05 level of significance.

H<sub>01</sub>: There is no significant difference in the academic achievement of female students exposed to scaffolding instructional method and conventional instructional method in geometry concepts of mathematics.

H<sub>02</sub>: There is no significant difference in the mathematics anxiety of female students exposed to scaffolding instructional method and conventional instructional method in geometry concepts of mathematics.

## Research Methods

The study adopted quasi-experimental design with two groups: experimental group and control group. The experimental group was exposed to scaffolding instructional method, and a lesson model was designed for the treatment. The steps involve in the use of scaffolding instructional method are:

Step I: Introduction: to assess their previous knowledge or mathematics skills of the learners through discussion or questioning. Step II: Task Discussion: the teacher then introduces the newly topic to arouse students' interest and also presentation of task through conventional instructional method. Step III: Collaborative learning: The teacher carefully groups the students and they are presented with a task to achieve a common goal. Step IV: Apprenticeship: Students are given a task individually to assess whether they have mastered the task at hand. Step V: Evaluation: The teachers evaluate the task by giving home assignment and to submit in the next lesson. The students in the control group are exposed to conventional instructional method with different lesson model designed based on conventional method.

The target population for the study consisted all the 433 SSII female students in 8 public senior secondary schools of Agaie Local Government Area. The sample of size comprised a total of one hundred and thirty (130) SSII students from two secondary schools with 60 students in experimental group and 70 students in the control group. The sample size of 130 was determined based on the central limit theory, which recommends an appropriate sample size of 30 students for research studies (Sambo, 2018). Systemic random sampling technique was employed in selecting sample size. Geometry Achievement Test (GAT) was generated through careful study of mathematics text books used in SSII classes in the selected schools. The items covered geometry topics and consist of twenty multiple questions with four options. Mathematics Anxiety Questionnaire (MAQ) consists of ten statements about geometry in mathematics. After each statement, the number (1, 2, 3, 4 and 5) are used to rate how true each of the following is of you, extremely or always true, not at all or never true. The statements in the inventory are not right or wrong answers. The two instructional were used for data collection and validated by three experts with rank of senior lecturers, two from IBBU Lapai and one from FUT Minna respectively. Reliability coefficient of the instruments was achieved through Pearson product moment correlation of the text retest of GAT and MAQ with reliability index of 0.76 and 0.86 respectively. Data collected were analysis using mean, standard deviation, mean difference and t-test statistics at  $\alpha = 0.05$  level of significance.

## Results

**Research Question One:** What is significance difference on the academic achievement of female students exposed to scaffolding Instructional method and conventional instructional method in geometry concepts of mathematics?

**Table 2: Means and Standard Deviations of Experimental and Control Groups in GAT**

Groups	N	Mean	S.D	Mean Difference
Experimental	60	30.87	15.74	12.16
Control	70	18.71	13.02	

Result in Table 2 showed that mean scores and standard deviations of academic achievement of female students in experimental and control groups. From the scores recorded female students taught using scaffolding instructional method has a mean score 30.87 and those taught using conventional instructional method has a mean score 18.71. the large mean difference 12.16 was recorded in the favour of experimental group.

**Ho1:** There is no significant difference in the academic achievement of female students exposed to scaffolding instructional method and conventional instructional method in the geometry concepts of mathematics. To test this hypothesis an independent sample t-test statistic was employed and the result is provided in Table 3.

**Table 3: t-test Analysis of Experimental and Control Groups in GAT**

Groups	N	Mean	S.D	DF	T-cal	P-value	Remark
Experimental	60	30.87	15.74	128	2.01	0.000	Sig
Control	70	18.71	13.02				

To evaluate the effectiveness of the treatment, GAT was administered to both groups. The result in Table 3 showed that 0.05 is greater than p-valve 0.000, therefore the stated null hypothesis was rejected. By this result, it is being concluded that there was significant difference in the achievement scores of the two groups taught geometry concepts of mathematics.

**Research Question Two:** What is the significant difference in the mathematics anxiety of female students exposed to scaffolding instructional method and conventional instructional method in geometry concepts of mathematics? The Table 4 Shows a summary of Mathematics Anxiety Questionnaire (MAQ) mean scores, standard deviations and mean difference.

**Table 4: Mean and Standard Deviation of Experiment and Control Groups in MAQ**

Groups	N	Mean	S.D	DF	Mean Differences
Experimental	60	52.17	21.33	128	21.36
Control	70	30.81	10.31		

The result in Table 4 revealed that the mean score of experimental group was 52.17, while control group has 30.81. The large mean difference between the two groups was 21.36 in favor of experimental group.

**Ho2:** There is no significant difference on the mathematics anxiety of female students exposed to scaffolding instructional method and conventional instructional in geometry concepts of mathematics. The null hypothesis is tested by an independent sample t-test statistic and the result was recorded in Table 5.

**Table 5: t-test Analysis of Experiment and Control groups in MAQ**

Groups	N	Mean	S.D	DF	T-cal	P-value	Remark
Experimental	60	52.17	21.33				
				128	4.02	0.001	Sign
Control	70	30.81	10.31				

The result provided in Table 5 has proved that scaffolding instructional method was significant in reducing mathematics anxiety since alpha 0.05 level of significant is greater than P-value 0.001, therefore the null hypothesis was rejected.

### Discussion of the Findings

The result in Table 3 showed that 0.05 is greater than p-value 0.000, therefore the stated null hypothesis was rejected. By the result, it was concluded that there was significant difference in the achievement scores of the two groups taught geometry concepts in mathematics. This shows that there was significant difference between the experimental and control groups in the Geometry Achievement Test (GAT). This implied that Scaffolding instructional method significantly enhanced students' achievement in geometry compared with conventional method. Ukwueze et al. (2020) observed that the use of innovative method has positive effect on students' academic performance in mathematics, especially instructional scaffolding. The finding is in concurrence with that of Ahmad and Idrisu (2018) and Ukwueze et al. (2020) that students learn a task and performed heavily due to collaborative problem-solving as fundamental core of scaffolding, which allows them to active participate than conventional method. Scaffolding instructional method provides students opportunities to learn mathematics especially geometry through social interaction; they perform heavily and retain more knowledge acquired. Olubunmi and Ese (2018) stressed that scaffolding instructional method assists learners to achieve significant success in tasks that would be too difficult for them to achieve by themselves and also build confident in them. They further commented that the method assists learners reach higher levels of comprehension and skill acquisition that they would not be able attain with assistance.

The result provided in Table 5 has proved that scaffolding instructional method was significant in reducing mathematics anxiety since alpha 0.05 level of significant is greater than P-value 0.001, therefore the null hypothesis was rejected. By the implication there was significant difference between the experimental and control groups in terms of their mathematics anxiety towards geometry concepts of mathematics. This also confirmed the study of Ahmad (2016) and Ahmad and Auwal (2021) that students involving in scaffolding instructional method demonstrated successful performance and avoid unnecessary frustration due to social interaction between teacher- students and students-students. A low level of mathematics anxiety towards mathematics can result to higher performance in the subject as stressed Jerry, et al (2019) and Ahmad & Babawaciko (2021). Annika (2015) also reported that scaffolding can assist in reducing mathematics – anxiety by creating a positive and supportive learning environment that encourages motivation, engagement, and confidence. In addition, scaffolding addresses individual's needs, preferences, and goals; provide multiple paths to learn and demonstrate mathematics knowledge and skill; encourage exploration, experimentation, and assist develop metacognitive and self – regulation skills, and provide timely assessment and recognition (Septi, et al., 2024).

### Conclusion

The first null hypothesis was rejected. Therefore, there was significant difference on the academic achievement instructional method and conventional instructional method in the geometry concepts of mathematics. The second null hypothesis was also rejected. Therefore,

there was significant difference on the mathematics anxiety of female students exposed to scaffolding instructional method and conventional instructional method in the geometry concepts of mathematics.

Based on the findings it can be concluded that scaffolding instructional method is an effective instructional that can promote academic achievement and also reduce mathematics-anxiety towards geometry concepts in mathematics.

### **Recommendations**

Based on the research findings, the following recommendations were made.

1. Mathematics teachers should be encouraging to teach geometry concepts using scaffolding instructional method, as it has proven to be effective in improving academic achievement and mathematics anxiety.
2. It is good to provide adequate learning aids to support the adoption of the scaffolding method as well as aids that can enhance the teaching and learning process, like geometry.
3. Mathematics teachers should be exposed to scaffolding instructional method through conferences, seminars symposium and in service training.
4. Students should be enlightening on vital vehicle in social interaction play in classroom situation and also working in peer assists in understanding the content, reducing mathematics-anxiety because confident is built through collaboration.

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