

**EFFECT OF PROCEDURAL SCAFFOLDING STRATEGY ON SENIOR SECONDARY TWO STUDENTS' SELF-EFFICACY IN ALGEBRA IN JOS-SOUTH LOCAL GOVERNMENT AREA, PLATEAU STATE, NIGERIA**

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**ABSTRACT**

The study was embarked upon to find out the effects of procedural scaffolding instructional strategy on SSII students' self-efficacy in Algebra in Jos-South Local Government Area (LGA), Plateau State, Nigeria. Quasi-experimental research design, particularly the non-equivalent pretest-posttest control group was adopted as the design of the study. The population of the study comprised of 1004 SSII students comprising of 546 males and 458 females from 11 co-educational public secondary schools in Jos-South LGA that met the requirements of inclusion in the study out of 20 schools. A total of 68 SSII students with 27 males and 41 females selected from two public senior secondary schools made up the sample of the study. An online randomizer called Dcode was used to select the two sampled schools. The students were placed into experimental and control groups with the experimental group having 31 students with 19 males and 12 females and the control group with 37 students, having 08 males and 29 females. A 20-item questionnaire named; Students' Algebra Self-Efficacy Questionnaire (SASEQ) was used for data collection. To obtain content validity, the instrument was given to experts in Mathematics Education and Research, Measurement and Evaluation in University of Jos. The reliability coefficient of SASEQ on the other hand was obtained using Cronbach's alpha as 0.95. Mean and standard deviation were used to answer the research questions and Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The findings of the study reveal that procedural scaffolding instructional strategy significantly enhances SSII students' self-efficacy in Algebra irrespective of their gender. Thus, it was recommended among others that teachers and stakeholders in education generally and Mathematics in particular should encourage and incorporate the use of procedural scaffolding instructional strategy in the classroom irrespective of the gender of students in order to enhance their self-efficacy

**INTRODUCTION**

Education plays very critical roles in the development of any nation. This is because nation's developmental blueprints rely so much on educational engagements, decisions and actions. In Nigeria, the national educational aims and objectives are; the inculcation of national consciousness and unity, the inculcation of the right types of values and attitudes for the survival of the individual and Nigeria society, training of the mind in the understanding of the world around, and acquisition of appropriate skills, abilities and competences both mental and physical as equipment for the individual to live in and contribute to the development of his society (Federal Republic of Nigeria (FRN), 2014). To achieve these goals, subjects have been designated across the educational levels, particularly, Primary and Secondary levels. One of such is Mathematics.

Mathematics is useful in almost every field like natural science, technology, engineering, arts and law (Kumar, 2017). Human life generally is characterized by one form of mathematical manipulation or the other. For example, the daily family budgeting involves addition, subtraction, multiplication, and division. Building construction, fashion designing and interior decorations also involve budgeting, measurement, estimation and use of geometrical shapes. Mathematics is useful in the society, at home, schools, offices, markets, industries, banks and highways. This then indicates that Mathematics is important in everyday life in that, solutions to everyday basic human problems involve the use of calculations, either directly or indirectly. This has necessitated the

enrichment of the Curriculum at all levels of education to ensure that knowledge acquired by students helps them to develop their problem-solving skills, spatial awareness, logical reasoning and critical thinking competence. Mathematics Curriculum, which spans six years: three years of Junior Secondary School and three years of Senior Secondary School is divided into different branches; Numbers and Numeration, Algebra, Geometry and Measurement, Trigonometry, Statistics, Calculus, Vectors, Mechanics and Algebra

Algebra is a branch of Mathematics in which signs and letters are used to represent quantities. It is taught in Nigeria Secondary education at Junior Secondary School and Senior Secondary School levels. Algebra is divided into different sub-branches such as abstract algebra, linear algebra, and commutative algebra. Algebra requires students to adopt logical thinking. This in turn, stimulates the students' senses that create awareness of self-efficacy and allows them to focus on arithmetic operations, focusing on the use of symbols to represent equations and establish relationships in mathematical operations (Ying, Osman, Kurniati, Masykuri, Kumar & Hanri, 2020). It is regarded as a key component of all the other branches of Mathematics owing to the fact that those other branches contain one form of algebraic operator, operation and expression or the other. The knowledge of Algebra even at basic stage is useful in everyday life of individuals in the society. This indicates that knowledge of Algebra enhances competence and achievements in all spheres of life. Students' achievement in Mathematics generally and Algebra could be impacted by many factors some of which are teacher's content knowledge level, teaching skills and motivation. Others are, instructional materials, teaching methods and students' self-efficacy.

Self-efficacy is defined as the confidence students' have about their abilities to accomplish tasks assigned to them. According to Bandura (1997) who is one of the earliest proponents of self-efficacy, it refers to the persons' trust about whether they can efficaciously engage in and execute a specific behavior. Bandura further holds the view that self-efficacy has a powerful effect over peoples' behaviours. Self-efficacy is regarded as one of the important determinants of students' successes. This position is supported by Asika (2021) who asserts that an individual performs better in any field if he believes in his ability to perform a specific task. This implies that belief in one's ability to perform a task is the first step to achieving such a task. It is also believed that the sense of self-efficacy stimulates a student to persevere in achieving certain objectives, even in the presence of obstacles, and leads them to the strategic use of all abilities (Okafor-Agbala & Okigbo, 2021).

Lack of self-efficacy which is a psychological factor is believed to be partly responsible for students' low achievement in Mathematics, apart from cognitive factors as evident in some researches like that of Alpacion, Camanan, Gregorio, Panlaan and Tudy (2014). This indicates that self-efficacy is an important determinant of students' achievement. This position has been supported by Toland and Usher (2015) who asserted that the predictive power of self-efficacy is enhanced when self-efficacy and achievement measures closely. Furthermore, Eduwem, Umoinyang and Otu (2017) posited that a learner with a positive view of abilities to accomplish a task could maximally benefit and achieve good results in school learning experiences. On the other hand, a learner with a negative view of abilities to accomplish a task is most likely going to struggle through the academic process and achieve low.

Teaching method which is another determinant of students' achievement in Mathematics that is centred on the learners is key to actualizing positive self-efficacy in students. One of such strategies is the scaffolding instructional strategy. Scaffolding Instructional Strategy (SIS) is typical to the platforms or stands commonly used in buildings which help builders undertaking construction or renovation work on a building reach any part of the building no matter how high it may be. Olubunmi and Ese (2018) define scaffolding strategy as certain kinds of support which learners receive in their interaction with parents, teachers, and other 'mentors' as they move new skills, concepts or levels of understanding. It is a process through which a teacher adds supports for students in order to enhance learning and aid in the mastery of tasks. This implies that through scaffolding, learners are guided to master and accomplish tasks that they wouldn't have been able

to accomplish on their own. The scaffolds are usually temporary and adjustable and they are usually withdrawn or adjusted based on the level of mastery of tasks by the learners. Scaffolding Instructional Strategy is made up of a number of types, some of which are; conceptual scaffolding, content scaffolding, familiar or highly interesting content scaffolding, emotional scaffolding and procedural scaffolding.

Procedural Scaffolding Instructional Strategy, which is the focus of this study, provides students with the step-by-step strategies and methods they need in accomplishing a task (example, solving problem). In procedural scaffolding instructional strategy, the teacher breaks down complex mathematical procedures into manageable steps and then provides temporary support and guidance as students learn and use each step in solving mathematical problems. It involves breaking down complex tasks into smaller, more manageable steps, and maybe providing additional guidance such as vocabulary lists along the way. One way of using procedural scaffolding in the classroom is by providing a step-by-step process for brainstorming, outlining, and drafting. This approach helps students build their skills and confidence, and gradually become more independent learners. The strategy also helps learners to know the nature of a course and also how to interact with the teacher, fellow students and content materials. In implementing the strategy, the teacher first develops the steps in solving a problem and after that the students are exposed to the first step of its implementation, which is the "I DO". At this stage, the teacher is expected to use the steps (model, algorithm) developed to solve problem while the students follow through.

After that, the next step, which is "WE DO" is enforced. This step involves the learners and teacher working together with the students allowed space to do most of the work while the teacher provides them with whatever kind of support to do so. At this stage also, the teacher gradually pulls out such support as the learners grow into the learning. Lastly, is the stage called "YOU DO", where learners are completely responsible to themselves. They are required at this level to accomplish the task independently without any form of support from the teacher or More Knowledgeable Order (MKO). Literature has not presented a study, wherein, the effect of procedural scaffolding instructional strategy on students' self-efficacy in Mathematics, particularly Algebra in Nigeria generally and Plateau state in particular has been determined. The effects on students' self-efficacy have also not been determined. This is indicative of the fact that a gap exists in the body of knowledge. The study therefore, intends to fill this gap.

### **AIM AND OBJECTIVES OF THE STUDY**

The aim of the study is to determine the effects of scaffolding instructional strategy on Senior Secondary Two students' self-efficacy in Algebra in Jos-South Local Government Area, Plateau State, Nigeria. The specific objectives of the study are to:

1. Determine the pre-test and post-test self-efficacy mean scores of SS II students in Algebra in the experimental and control groups.
2. Find out the post-test self-efficacy mean scores of the SS II students in Algebra in the experimental group based on gender.
3. Determine the interaction effects of treatment and gender on the SS II students' self-efficacy in Algebra in the experimental group.

### **RESEARCH QUESTIONS**

In order to achieve the objectives of the study, the following research questions were raised:

1. What are the pre-test and post-test self-efficacy mean scores of the SS II students in Algebra in the experimental and control groups?
2. What are the post-test self-efficacy mean scores of the SS II students in Algebra in the experimental group based on gender?
3. What are the interaction effects of treatment and gender on the SS II students' self-efficacy in Algebra in the experimental group?

## HYPOTHESES

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

- Ho<sub>1</sub>:** There is no significant difference between the pre-test and post-test self-efficacy mean scores of the SS II students in Algebra in the experimental and control groups.
- Ho<sub>3</sub>:** There is no significant difference between the post-test self-efficacy mean scores of the SS II students in Algebra in the experimental group based on gender.
- Ho<sub>5</sub>:** There are no significant interaction effects of treatment and gender on SS II students' self-efficacy in Algebra in the experimental group.

## METHODS AND PROCEDURE

The study adopted quasi-experimental research design, specifically the non-equivalent pretest-posttest control group design. A quasi-experimental design is an experimental design where random assignment of subjects to the experimental and control groups is not possible. One of the justifications for using intact classes is because the school arrangements are not to be distorted during the study as the schools may allow for that. The study comprised of two groups; Experimental Group (EG) and Control Group (CG). The EG was taught using the procedural scaffolding instructional strategy, the CG on the other hand was taught using the traditional method of talk and chalk. A pre-test was administered to the two groups. The treatment was administered to only the EG while the CG on the other hand, was taught using the traditional method of talk and chalk after which a post-test was given to the two groups.

The population of the study comprised of all the 1004 Senior Secondary Two students in Jos-South LGA, out of which 546 are males and 458 are females. The population is from 11 co-educational public secondary schools for the 2023/2024 academic session in the area, who met the condition for inclusion in the study. The 11 schools are out of a total of 20 schools. The remaining 9 schools were excluded, because, one of them is a boys' school (single-sex) and the other eight have Mathematics teachers who either have NCE, HND or other qualifications other than a minimum of B.Sc./B.Sc. (Ed.) required by the present study. The sample of the study comprised of 68 SS II students made up of 27 males and 41 females selected from two public senior secondary schools. An online randomizer called Dcode was used to select the two sampled schools, while all the students in their intact schools were used as participants. One of the schools used as the experimental group had 31 students having 19 males and 12 females and the other as control group had 37 students, having 08 males and 29 females.

A 20-item instrument (questionnaire) named; Students' Algebra Self-Efficacy Questionnaire (SASEQ) adapted from a General Self-Efficacy scale (GSE) by Schwarzer and Jerusalem (1995) and a General Self-Efficacy Scale (GSE) by Chen, Gully and Eden (2001) was used for data collection. To obtain content validity, the instrument was given to experts in Mathematics Education and Research, Measurement and Evaluation in University of Jos. Also, Factor Analysis Method, particularly Exploratory Factor Analysis (EFA) was used to obtain the construct validity of the instrument. Based on the analyses, five factor loadings for the 20 items were established. These factors represented distinct aspects of students' self-efficacy in Algebra; problem-solving confidence, handling algebraic fractions, quadratic equation solving abilities and coping with algebraic difficulties. The reliability coefficient of SASEQ on the other hand was obtained using Cronbach's alpha as 0.95. Mean and standard deviation were used to answer the research questions and Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

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## RESULTS

### Research Question One

What are the pre-test and post-test algebra self-efficacy scores of the SS II students in the experimental and control groups?

**Table 1**

**The Pre-test and Post-test Algebra Self-Efficacy Mean Scores of Students in the Experimental and Control Groups**

Group	N	Before		After		Mean Gain	$\bar{x}$ -Gain Difference
		Mean	SD	Mean	SD		
Experimental	31	45.32	6.61	85.52	6.60	40.20	20.31
Control	37	45.19	6.18	65.08	17.41	19.89	

Table 1 shows the Algebra self-efficacy mean scores of the SSII students in experimental and control groups. The experimental group obtained a pre-test mean score of 45.53 with a standard deviation of 6.61 and a post-test mean score of 85.52 with a standard deviation of 6.60, yielding a mean gain of 40.20 after exposure to procedural scaffolding instructional strategy. The control group had a pre-test mean score of 45.19 with a standard deviation of 6.18 and post-test mean score of 65.08 with a standard deviation of 17.41, yielding a mean gain of 19.89. The result indicated that students in the experimental group had a higher mean gain score after exposure to the procedural scaffolding instructional strategy than those in the control group who were not given treatment. The mean gain difference was 20.31 in favour of the experimental group. This means that procedural scaffolding instructional strategy did increase the students' self-efficacy in Algebra.

### Hypothesis One

There is no significant difference in the pre-test-post-test self-efficacy mean scores of SSII students in the experimental and control groups.

**Table 2**

**ANCOVA Result on Pretest and Posttest Self-efficacy Mean Scores of SS II Students in Algebra in the Experimental and Control Groups**

Source	Type II Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	7336.825 <sup>a</sup>	2	3668.413	19.998	.000	.381
Intercept	4686.460	1	4686.460	25.548	.000	.282
Self-Efficacy	293.045	1	293.045	1.598	.211	.024
Group	7012.659	1	7012.659	38.229	.000	.370
Error	11923.454	65	183.438			
Total	395635.000	68				
Corrected Total	19260.279	67				

a. R Squared = .381 (Adjusted R Squared = .362)

The table 3 shows that  $F(1, 65) = 38.229$ ,  $P < 0.05$ . Since the p-value of .000 is less than the 0.05 level of significance, the null hypothesis was rejected. This indicates that, there was a significant effect of procedural scaffolding instructional strategy on students' self-efficacy in Algebra in the experimental group. The result further reveals an adjusted R squared value of .362 which means that 36.2 percent of the variation in the dependent variable which is students' self-efficacy is explained by variation in the treatment of procedural scaffolding instructional strategy while the remaining is due to other factors not included in this study. Hence, procedural scaffolding instructional strategy does improve students' self-efficacy in Algebra.

**Research Question Two**

What are the post-test self-efficacy mean scores of SS II students in the experimental group based on gender?

**Table 3**  
**The Post-test Algebra Self-Efficacy Mean Scores of Male and Female Students in the Experimental Group**

Group	N	Post-test		$\bar{x}$ - Gain Difference
		Mean	SD	
Male	19	85.95	5.48	1.12
Female	12	84.83	8.29	

Table 3 reveals the Algebra mean and standard deviation of post-test of SSII male and female students' self-efficacy in Algebra in the experimental group. The result for experimental group shows that the posttest interest mean score for male ( $\bar{x} = 85.95$ ,  $SD = 5.48$ ) while that of female students ( $\bar{x} = 84.83$ ,  $SD = 8.28$ ) with a mean gain difference of 1.12, indicating that male and female self-efficacy mean scores are almost the same in Algebra after exposure to procedural scaffolding instructional strategy.

**Hypothesis Two**

There is no significant difference in the post-test self-efficacy mean scores of SS II students in the experimental group based on gender.

**Table 4**  
**ANCOVA Result on Effect of Gender on Self-efficacy of SSII Students in the Experimental Group**

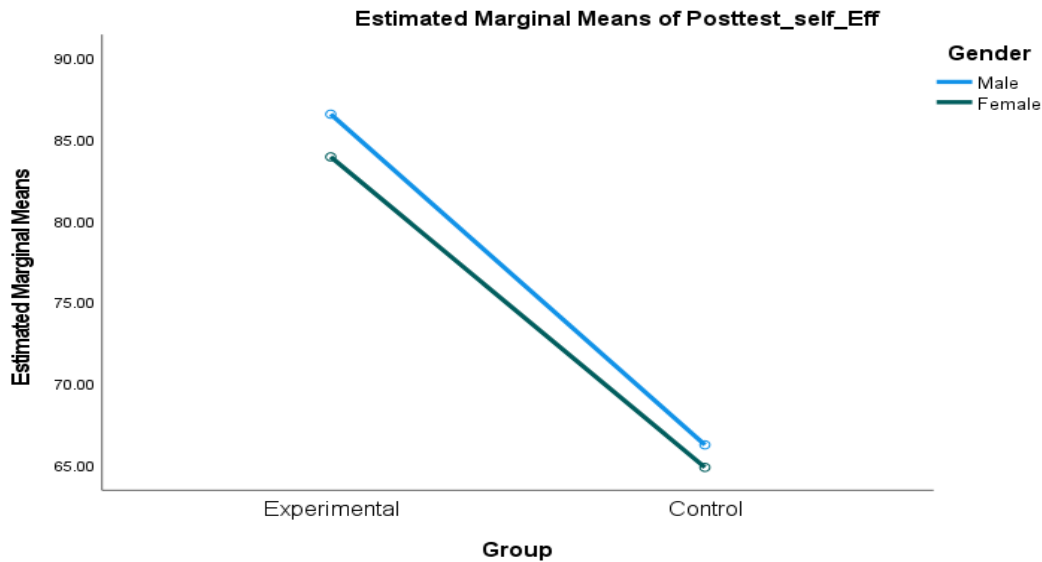
<b>Source</b>	<b>Type II Sum of Squares</b>	<b>Df</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig.</b>	<b>Partial Eta Squared</b>
Corrected Model	138.453 <sup>a</sup>	2	69.226	1.661	.208	.106
Intercept	5577.072	1	5577.072	133.778	.000	.827
Self-Efficacy	129.325	1	129.325	3.102	.089	.100
Gender	.548	1	.548	.013	.910	.000
Error	1167.289	28	41.689			
Total	228009.000	31				
Corrected Total	1305.742	30				

a. R Squared = .106 (Adjusted R Squared = .042)

Analysis of covariance (ANCOVA) was conducted to determine if there is a significant effect of gender on self-efficacy of SS II students taught Algebra using the procedural scaffolding instructional strategy. Table 4 shows the main effect of gender yielded  $F(1, 28) = .013$ ,  $P > 0.05$ . Since the p-value of .910 is greater than the 0.05 level of significance, the null hypothesis was retained, indicating that, there was no significant effect of gender on self-efficacy of students taught Algebra using procedural scaffolding instructional strategy. Hence, gender has no effect on the self-efficacy of students in Algebra.

### Research Question Three

What are the interaction effects of treatment and gender on SSII students' self-efficacy in Algebra?



Covariates appearing in the model are evaluated at the following values: pretest\_Self\_Eff = 45.2500

**Chart 1: The Interaction Effect of Treatment and Gender on Students' Self-efficacy in Algebra**

Chart 1 presents the profile plot showing the interaction effect of treatment and gender of students' self-efficacy in Algebra. The interactive pattern shows that the plots for male and female students did not intercept with that of treatment and non-treatment groups. Since the two lines are not crossed there is no likelihood of an interaction effect between treatment and gender on the students' self-efficacy in Algebra. It also shows that the plot is extrapolated, therefore the interaction and gender is not attainable.

**Hypothesis Three**

There is no significant difference in the interaction effect of treatment and gender on SS II students' self-efficacy in Algebra.

**Table 5  
Interaction Effect of Treatment and Gender on Self-efficacy of Students in Algebra**

Source	Type II Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	7397.599 <sup>a</sup>	4	1849.400	9.822	.000	.384
Intercept	4184.101	1	4184.101	22.221	.000	.261
Self-Efficacy	324.141	1	324.141	1.721	.194	.027
Treatment	5251.293	1	5251.293	27.888	.000	.307
Gender	53.729	1	53.729	.285	.595	.005
Treatment * Gender	5.008	1	5.008	.027	.871	.000
Error	11862.680	63	188.297			

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Total	395635.000	68
Corrected Total	19260.279	67

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a. R Squared = .384 (Adjusted R Squared = .345)

Table 5 shows that the main effect of treatment yielded  $F(1,63) = 27.888$   $P < 0.05$ , since the P value of 0.000 is less than 0.05 level of significance, the null hypothesis was rejected, indicating that there is a significant effect of treatment on the self-efficacy of students in Algebra.

## DISCUSSION OF FINDINGS

The first research question examined the pre-test and post-test algebra self-efficacy scores of SS II students in the experimental and control groups. The results as contained in Table 1 shows that students in the experimental group had a higher mean gain score in self-efficacy after exposure to the procedural scaffolding instructional strategy than those in the control group. To determine the significance of the mean gain, further analysis was conducted based on Hypothesis One. The result of the analysis contained in Table 2 led to the rejection of the hypothesis, indicating a significant difference in the pretest-posttest self-efficacy mean scores of SS II students in the experimental and control groups. This finding is consistent with those of Almekhlafi and Almeqdadi (2017) and Oyedeji (2017), who found that procedural scaffolding instructional strategy enhanced students' self-efficacy in Mathematics. However, Adigun and Oyediran (2023) found that scaffolding instructional strategy had no significant effect on students' self-efficacy in Mathematics, contradicting the finding of the present study.

The second research question examined the post-test self-efficacy mean scores of SS II students in the experimental group in Algebra based on gender. The results based on Table 3 shows similar self-efficacy mean scores for male and female students in the experimental group. This finding supports Hypothesis one whose result is contained in Table 4, leading to the retention of the hypothesis. The finding indicates that there is no significant difference in the posttest self-efficacy mean scores of SS II students in the experimental group based on gender. This result is consistent with those of Wang and Lee (2020) and Uche and Nzewi (2022), who found that scaffolding instructional strategy had a similar effect on both male and female students' self-efficacy in Mathematics. However, Akomolafe and Ogunniyi (2020) found that scaffolding instructional strategy had a significant effect on female students' self-efficacy in Mathematics, but not on male students, contradicting the finding of the present study.

Similarly, the third research question examined the interaction effect of treatment and gender on SS II students' self-efficacy in Algebra. The results as contained in Chart 1 did not show any likelihood of interaction effects between treatment and gender on the students' self-efficacy in Algebra. This finding supports Hypothesis Three whose result is presented in Table 5, leading to the acceptance of the hypothesis. The finding therefore indicates that there is no significant difference in the interaction effects of treatment and gender on SS II students' self-efficacy in Algebra. This result is consistent with that of Chen and Hwang (2020), who found that scaffolding instructional strategy had a similar effect on both male and female students' self-efficacy in Mathematics, regardless of the interaction effect of treatment and gender. However, Akomolafe and Ogunniyi (2020) found that scaffolding instructional strategy had a significant interaction effect with gender on students' self-efficacy in Mathematics, contradicting the finding of the present study.

## CONCLUSION

Based on the findings of this study, it can be concluded that procedural scaffolding instructional strategy is effective in improving SS II students' self-efficacy in Algebra irrespective of their gender.

## RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

1. Teachers should use procedural scaffolding instructional strategy in teaching Algebra to improve students' self-efficacy and by extension achievement since available literature shows a nexus between them.
2. Teachers should provide equal opportunities for both male and female students to benefit from procedural scaffolding instructional strategy.
3. Authors of mathematics textbooks at secondary school level should integrate the scaffolding instruction as an instructional technique when developing Mathematics textbooks.
4. Educational administrators should provide teachers with training and support on the use of procedural scaffolding instructional strategy.
5. Curriculum planners/developers can incorporate scaffolding instructional strategy into Mathematics curricula to enhance students' learning outcomes.
6. Government in collaboration with other critical stakeholders in the field of Mathematics, such as Mathematics Association of Nigeria (MAN), Science Teachers Association of Nigeria (STAN) and the Curriculum Organization of Nigeria (CON) should from time to time organize seminars and workshops that could provide platforms where Mathematics teachers could be exposed to the use of procedural scaffolding instructional strategy in the classroom.

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