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Reducing Students' Algebraic Misconceptions through Peer Tutoring Strategy in Secondary Schools, in Sokoto State, Nigeria

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ABSTRACT

This study examined the effectiveness of the Peer Tutoring instructional strategy in reducing students' misconceptions and improving performance in algebra among Senior Secondary School Two (SSII) students in Sokoto State, Nigeria. A quasi-experimental design involving a non-randomized control group with pretest and posttest measures was adopted. A total of 378 students were selected from four education zones (Sokoto North, Sokoto South, Bodinga, and Yabo) using proportionate stratified and simple random sampling techniques. The experimental group was taught using Peer Tutoring, while the control group received instruction through the Demonstration Method over a period of six weeks. Data were collected using the Students' Algebraic Performance Test (SAPT) and the 5-Tier Students' Algebraic Misconception Level Test (5T-SAMLT), which were validated and found reliable. Descriptive statistics and independent samples t-test at 0.05 level of significance were used for analysis. Findings revealed that students initially exhibited high levels of misconceptions in algebra. However, after the intervention, students exposed to Peer Tutoring showed a significant reduction in misconceptions and achieved higher performance scores than those taught using the Demonstration Method. The originality of this study lies in the application of a structured 5-tier diagnostic instrument alongside Peer Tutoring to address algebraic misconceptions within the Nigerian context. The study concludes that Peer Tutoring is an effective, student-centered strategy for enhancing conceptual understanding and performance in algebra. It therefore recommends its integration into classroom practice to improve mathematics learning outcomes.

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KEYWORDS:
Misconception, Performance, Peer Tutoring

1. Introduction

Algebra is a fundamental component of mathematics that involves the use of symbols to represent and manipulate relationships among quantities (Mangorsi & Solaiman, 2013; Ayhan & Nifuler, 2017). It plays a vital role in developing logical reasoning, problem-solving skills, and supports learning in Science, Technology, Engineering, and Mathematics (STEM) fields (Schanzer, 2015). Beyond mathematics, algebra enhances analytical abilities applicable to areas such as economics, accounting, and the sciences (Alajmi, 2016). It also serves as a universal language for expressing mathematical ideas and facilitating communication and collaboration which leds to general performance (Arcavi, Drijvers & Stacey, 2016).

Students' performance in algebra is a key indicator of their level of understanding, reasoning ability, and readiness for advanced mathematical learning. It reflects how well learners can apply concepts, solve problems, and transfer knowledge to new situations. However, reports from examinations such as WAEC consistently reveal that many secondary school students perform poorly in algebra-related tasks, particularly in areas requiring conceptual understanding and problem-solving. This poor performance is often linked to shallow understanding and persistent misconceptions, which limit students' ability to reason logically and apply algebraic principles effectively. At the senior secondary school level in Nigeria, algebra is essential for academic success and future career opportunities (Son & Fatimah, 2021). However, many students experience difficulties in learning algebra effectively, largely due to persistent misconceptions. These include misunderstanding algebraic symbols, misinterpreting the equal sign, confusing variables with constants, and incorrectly applying rules for solving equations (Julius, 2022). Such misconceptions hinder students' understanding and lead to poor performance in mathematics.

Addressing these challenges requires a shift from passive teaching methods to active, student-centered approaches. One effective strategy is Peer Tutoring, which is grounded in constructivist learning theory and promotes active student engagement (Sewanu, 2022). Peer tutoring involves students working in pairs or small groups, where a "tutor" explains concepts and guides problem-solving, while the "tutee" asks questions and practices similar tasks (Topping et al., 2017). This interaction benefits both learners, as tutors reinforce their understanding through explanation, while tutees gain clearer insights from peer support (Abdurrahman et al., 2019; 2021). In algebra, peer tutoring encourages students to express their reasoning, explore different solution methods, and receive immediate feedback, which helps in identifying and correcting misconceptions (Alegre et al., 2019). It also improves problem-solving skills, builds confidence, and promotes collaboration among learners (Avcı, 2025). This study is guided by Bandura's Social Learning Theory, which emphasizes learning through observation and interaction, and Kolb's Experiential Learning Theory, which focuses on learning through experience and reflection. Therefore, this study investigates the effectiveness of the Peer Tutoring instructional strategy in reducing students' algebraic misconceptions and improving their performance.

Statement of the Problem

Algebra remains a challenging area for many students in Nigerian secondary schools, particularly in Sokoto State. Students often experience difficulties in tasks such as simplifying expressions, solving equations, and interpreting functions. Evidence from WAEC Chief Examiners' Reports (2014–2025) indicates persistent poor performance and widespread misconceptions in algebraic processes. These challenges are largely linked to deep-rooted misunderstandings of algebraic concepts developed at earlier levels of education. Students frequently misinterpret symbols, misuse

rules, and apply procedures incorrectly, reflecting a lack of conceptual understanding. Traditional teaching methods, especially the demonstration or lecture approach, are largely teacher-centered and emphasize memorization rather than meaningful learning. Consequently, they do not adequately promote critical thinking or help students identify and correct their misconceptions (Sadiq, 2019; Ginga & Zakariya, 2020). Therefore, this study investigates the effectiveness of the Peer Tutoring instructional strategy in reducing students' algebraic misconceptions and improving their performance.

Research Questions

To achieve the stated objectives, the following research questions were formulated to guide the research:

1. What are the misconceptions of students in solving algebraic problems before using the Peer tutoring instructional strategy and demonstration method among senior secondary school students in Sokoto State?
2. What are the misconceptions of students in solving algebraic problems after using the Peer tutoring instructional strategy and demonstration method among senior secondary school students in Sokoto State?
3. What are the differences in the mean performance score of students taught algebraic processes using Peer tutoring instructional strategy and those taught using demonstration method among senior secondary school in Sokoto State?

Research Hypothesis

1. There is no significant difference in the mean performance score of students taught algebraic processes using Peer tutoring instructional strategy and those taught using traditional demonstration method among senior secondary school in Sokoto State.

2. Methodology

The study adopted a non-randomized control group, pretest–posttest quasi-experimental design. The experimental group was taught using the Peer Tutoring strategy, while the control group received instruction through the Demonstration Method. The population comprised 22,173 Public Senior Secondary School Two (SSII) students from 92 schools across selected education zones in Sokoto State, excluding Goronyo and Gwadabawa zones due to security concerns.

One school was selected from each of the four education zones using simple random sampling to ensure adequate representation of the study area. The sample size was proportionately distributed across the selected schools, resulting in a total of 384 students. Following selection, the schools were randomly assigned to either the experimental or control group. One school (School A) was assigned to the experimental group, while the remaining three schools (Schools B, C, and D) were assigned to the control group. The use of one experimental school and three control schools was intentional to provide a broader baseline for comparison and to minimize contamination of treatment across groups. Since the intervention required controlled implementation of specific instructional strategies, assigning a single school to the experimental group ensured effective monitoring and fidelity of treatment, while the multiple control schools provided a more stable and representative comparison of conventional teaching practices across different zones.

Although the study adopted a quasi-experimental design, adequate sample coverage was ensured by including schools from all four education zones in Sokoto State. This wide coverage enhances the representativeness of the sample. Furthermore, research evidence suggests that larger

and more diverse samples improve the reliability and generalizability of study findings. Therefore, the use of 384 students across four zones strengthens the validity of the results and supports their applicability to similar educational contexts. The experimental group (School A) comprised 90 students drawn from two intact classes (51 and 39 students), while the control group (Schools B, C, and D) consisted of 294 students from five intact classes: School B (169 students from three classes 56, 58 and 55), School C (58 students from one class), and School D (67 students from one class), as presented in Table 1.

Table 1: Sample of the Study

S/N	Zones	Name of School	No. of Students
1	Sokoto North	School A (EXG)	90
2	Sokoto South	School B (CONT)	169
3	Bodinga	School C (CONT)	58
4	Yabo	School D (CONT)	67
		Total	**384**

Two instruments were used for data collection: the Students' Algebraic Performance Test (SAPT) and the 5-Tier Students' Algebraic Misconception Level Test (5T-SAMLT). The SAPT measured students' performance in algebraic processes and consisted of 35 multiple-choice items drawn from past WAEC and NECO examinations and recommended textbooks. Each item had four options, with one correct answer scored one mark, giving a maximum score of 35. The 5T-SAMLT was a five-tier diagnostic instrument designed to assess students' misconceptions in algebra. It evaluated multiple dimensions, including correctness of responses, confidence level, and conceptual reasoning, providing a deeper understanding of students' learning difficulties beyond surface performance. Both instruments were validated by experts and pilot-tested with 40 students. The results showed acceptable indices after the validation and pilot test processes (SAPT: validity = 0.93, reliability = 0.71; 5T-SAMLT: validity = 0.97, reliability = 0.92), confirming their suitability for the study. The 5T-SAMLT scoring system combines responses across its tiers to determine students' levels of understanding, as detailed in Table 2.

Table: 2 Marking, Grading and Decision for 5T-SAMLT

S/N	Decision	Description	Marking	Grading
1.	AC **(Algebraic Conception)**	Students provide correct answers at the macroscopic level (the main algebraic question) and sub-microscopic levels (Tiers 1-5), are confident in their answers, and their drawings are aligned with algebraic concepts.	Full marks are awarded. This is the highest level of understanding, reflecting complete mastery of the algebraic concepts, confidence in their answers, and accurate representation through drawings.	**Connected**
2.	**AAC (Almost Algebraic Conception)**	Students give correct answers at both the macroscopic and sub-microscopic levels, with high confidence. However, their drawings are either not fully accurate or do not entirely match the algebraic concept or explanation	High marks are given but slightly reduced compared to AC due to the issue with the drawings. The student understands the concepts but lacks full alignment between explanation and representation.	**Unconnected**

3.	**LC (Lack of Confidence)**	Students provide correct answers at both levels (macroscopic and sub-microscopic), and their drawings are accurate, but they express uncertainty about their answers.	Marks are awarded for correct answers and proper drawings, but there is a deduction due to the lack of confidence. This suggests understanding but hesitancy in applying the concepts.	**Connected**
4.	**LK (Lack of Knowledge)**	Students provide answers that are partly correct at either the macroscopic or sub-microscopic levels, with varying confidence. Their drawings only partially align with algebraic concepts.	Partial marks are awarded. The answers show some knowledge, but the incomplete or inaccurate drawings and answers suggest gaps in understanding	**Unconnected**
5.	**MC (Misconception)**	Students may provide either correct or incorrect answers at both levels, but they lack full confidence, and their drawings are not in line with algebraic concepts.	Marks are deducted due to misconceptions and incorrect or inappropriate drawings. This reflects confusion or misunderstanding of the algebraic processes	**Connected**
6.	**HNC (Have No Conception)**	Students give incorrect answers at all levels, have no confidence in their responses, and their drawings are completely unrelated to algebraic concepts	Minimal or no marks are awarded. This decision reflects a lack of understanding and severe misconceptions	**Unconnected**

Source: (Widodo, Sopandi & Wu, 2020)

A pretest was administered to determine the homogeneity of the groups before the intervention. The treatment lasted for six weeks, after which a posttest was conducted using the same instruments to assess the effectiveness of the Peer Tutoring strategy. The collected data were analyzed using SPSS. Descriptive statistics (mean, standard deviation, percentages, and frequencies) were used to answer the research questions, while the independent samples t-test was employed to test the null hypothesis at the 0.05 level of significance.

3. Results

Research Question One

What are the misconceptions of students in solving algebraic problems before using the Peer tutoring instructional strategy and demonstration method among senior secondary school students in Sokoto State? The result of the analysis is presented in Table 3 and 4.

Table 3: Students Levels of Misconception before using Peer Tutoring Instructional Strategy

S/N	Decision	Frequency	Percentages
1	AC	4	4%
2	AAC	7	8%
3	LC	8	9%
4	LK	15	17%
5	MC	25	28%
6	HNC	31	34%
Total		**90**	**100%**

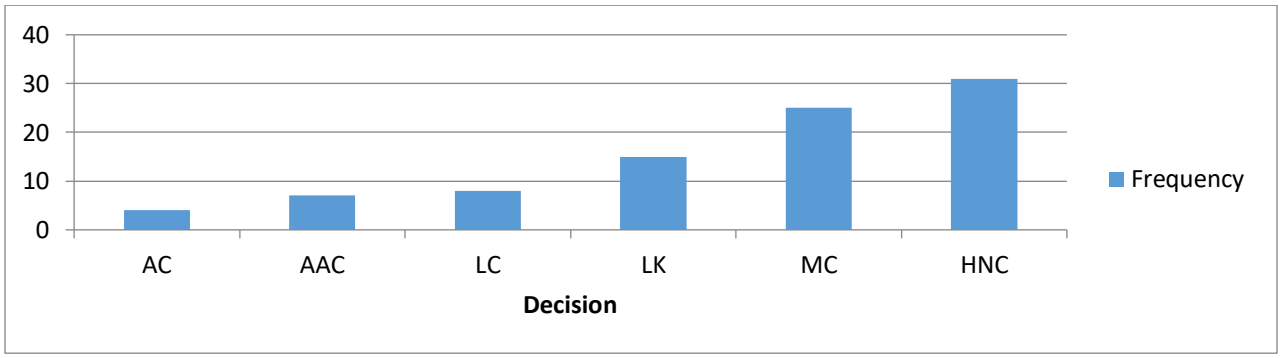

Figure 1: Students Levels of Misconception before using Peer Tutoring

Table 3 and Figure 1 present students' levels of misconceptions before the application of Peer Tutoring. The results indicate that only a small proportion of students demonstrated adequate understanding of algebraic concepts. Specifically, 4 students (4%) showed full Algebraic Conceptual (AC) understanding, while 7 students (8%) were classified under Almost Algebraic Conceptual (AAC). However, the majority of students exhibited varying levels of misconceptions and difficulties. About 8 students (9%) showed lack of confidence (LC), and 15 students (17%) demonstrated lack of knowledge (LK). A larger proportion, 25 students (28%), displayed clear misconceptions (MC), while the highest number, 31 students (34%), fell under the Have No Conception (HNC) category, indicating a complete lack of understanding of algebraic concepts.

Table 4: Students Levels of Misconception before using Demonstration Method

S/N	Decision	Frequency	Percentages
1	AC	11	4%
2	AAC	21	7%
3	LC	26	8%
4	LK	49	17%
5	MC	84	29%
6	HNC	103	35%
Total		**294**	**100%**

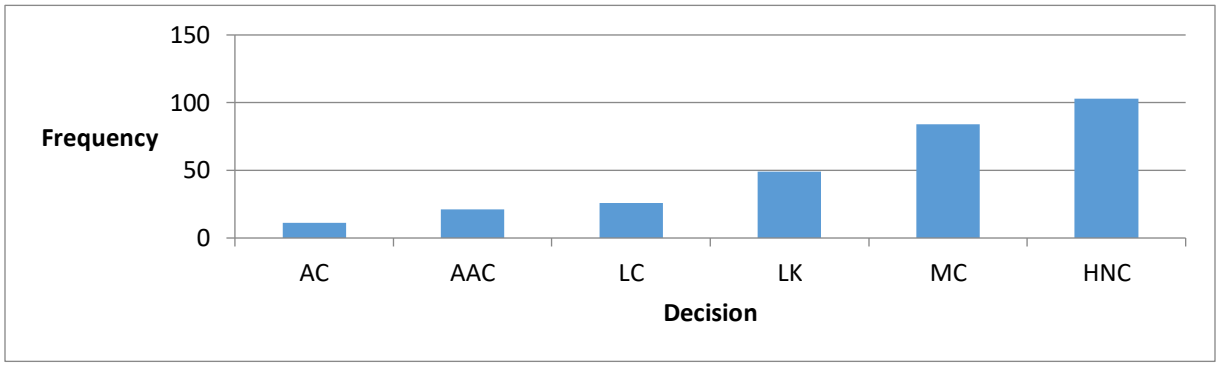

Figure 2: Students Levels of Misconception before using demonstration method

Table 4 and Figure 2 present the levels of misconceptions among students in the Demonstration Method group before the treatment. The results show that only a small proportion of students demonstrated adequate understanding of algebraic concepts. Specifically, 11 students (4%) exhibited full Algebraic Conceptual (AC) understanding, while 21 students (7%) were classified under Almost Algebraic Conceptual (AAC). However, the majority of students displayed various levels of misconceptions and difficulties. About 26 students (8%) showed lack of confidence (LC), and 49 students (17%) demonstrated lack of knowledge (LK). A larger proportion, 84 students (29%), exhibited misconceptions (MC), while the highest number, 103 students (35%), fell under the Have No Conception (HNC) category, indicating serious difficulty in understanding algebraic concepts.

Research Question Two

What are the misconceptions of students in solving algebraic problems after using the Peer tutoring instructional strategy and demonstration method among senior secondary school students in Sokoto State? The result of the analysis is presented in Table 5 and 6.

Table 5: Students Levels of Misconception after using Peer Tutoring Instructional Strategy

S/N	Decision	Frequency	Percentages
1	AC	45	50%
2	AAC	27	30%
3	LC	6	7%
4	LK	5	6%
5	MC	4	4%
6	HNC	3	3%
Total		**90**	**100%**

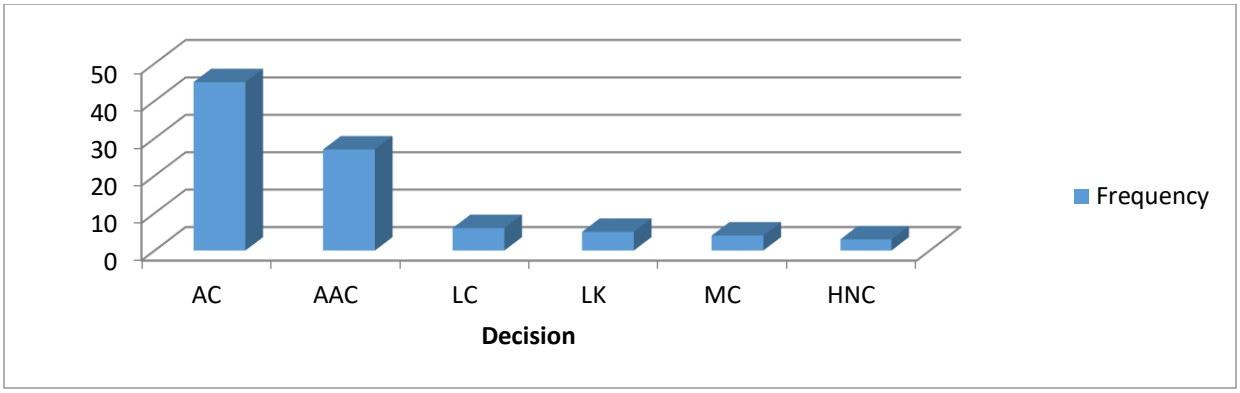

Figure 3: Misconception Levels among Students Taught with Peer Tutoring

Table 5 and Figure 3 present the levels of misconceptions among students after the application of the Peer Tutoring strategy. The results indicate a substantial improvement in students' understanding of algebraic concepts. Out of 90 students, 45 (50%) demonstrated full Algebraic Conceptual (AC) understanding, while 27 (30%) were classified as Almost Algebraic Conceptual (AAC), showing near-complete understanding with minor errors. Only 6 students (7%) lacked confidence (LC), 5 students (6%) showed lack of knowledge (LK), 4 students (4%) exhibited misconceptions (MC), and 3 students (3%) fell under Have No Conception (HNC). These findings suggest that Peer Tutoring significantly reduced students' misconceptions and improved their conceptual understanding of algebra, enabling the majority to achieve high levels of algebraic comprehension.

Table 6: Students Levels of Misconception after using Demonstration Method

S/N	Decision	Frequency	Percentages
1	AC	12	4%
2	AAC	17	6%
3	LC	38	13%
4	LK	53	18%
5	MC	61	21%
6	HNC	113	38%
Total		**294**	**100%**

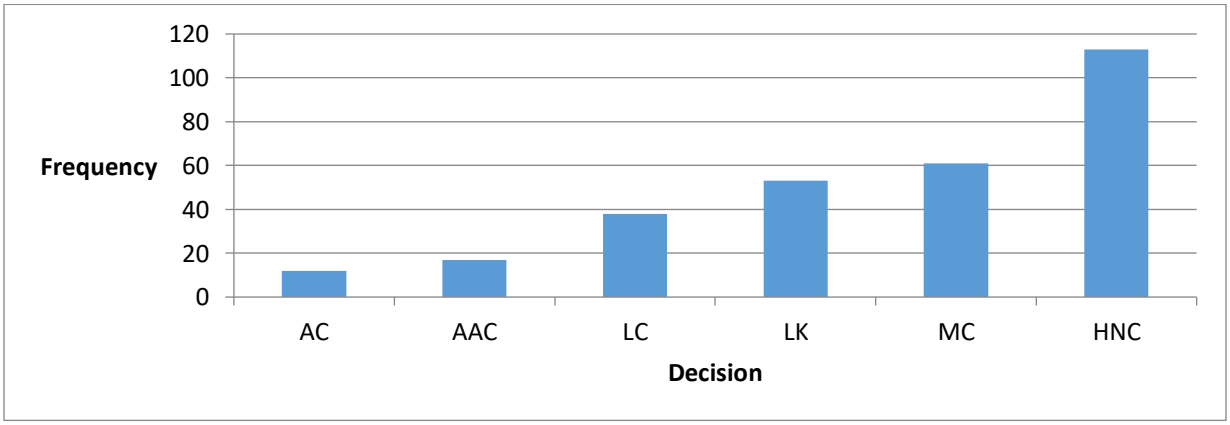

Figure 4: Students Misconception Levels after using Demonstration Method

Table 6 and Figure 4, presents the levels of misconceptions among students in the Demonstration Method group after the treatment. Out of 294 students, only 12 students (4%) demonstrated full understanding of algebraic concepts (AC), and 17 students (6%) were classified under Almost Algebraic Conception (AAC), showing near-complete but not perfect understanding, 38 students (13%) were categorized as having Lack of Confidence (LC), while 53 students (18%) showed Lack of Knowledge (LK) indicating weak foundational understanding of algebra. Notably, 61 students (21%) displayed misconceptions (MC), and 113 students (38%) were found to have No Conceptual Understanding (HNC), meaning they had serious difficulties grasping the core ideas of algebra.

Research Question Three

Is there any differences in the mean performance score of students taught algebraic processes using Peer tutoring instructional strategy and those taught using demonstration method among senior secondary school in Sokoto State? The result of the analysis is presented in Table 7.

Table 7: Means and Standard Deviation of Performance Scores of Students taught using Peer tutoring and Demonstration Method

					95% Confidence Interval of the Difference	
Group	**N**	**Mean**	**Std.**	**MD**	**Lower**	**Upper**
1. Peer Tutoring	90	23.96	6.385		-14.619	-12.042
2. Demonstration	294	10.63	5.093	13.33		
Total	**384**					

Table 7 presents the mean and Standard Deviation of performance Scores of Students taught using Peer tutoring and Demonstration Method. The mean performance score for peer tutoring is ($\bar{x} = 23.96, \sigma = 6.385$) and that of demonstration method is ($\bar{x} = 10.63, \sigma = 5.093$). The 95% confidence interval of the difference between the means is -14.619 to -12.042.

Null Hypothesis One

There is no significant difference in the mean performance score of students taught algebraic processes using Peer tutoring instructional strategy and those taught using demonstration method among senior secondary school in Sokoto State. The result of the analysis is presented in Table 8.

Table 8: Independent Sample t-test on Algebraic Mean Performance Scores of Students taught using Peer tutoring and Demonstration Method

Group	**N**	**Mean**	**Std.**	**T**	**df**	**Sig. (2-tailed)**
1. Peer Tutoring	90	23.96	6.385			
2. Demonstration	294	10.63	5.093	-20.343	376	.000
Total	**384**					

Table 8 Independent Sample t-test on Algebraic Mean Performance Scores of Students taught using Peer tutoring and Demonstration Method. The result of the analysis revealed that $t(376) = -20.343, p = 0.001$; the null hypothesis which stated there is no significant difference is rejected. Therefore, there was a significant difference in the mean performance score of students taught algebraic processes using Peer tutoring instructional strategy and those taught using demonstration method among senior secondary school in Sokoto State. This difference could be attributed to the efficacy of the peer tutoring strategy over the demonstration method.

4. Discussions of Findings

The findings from Research Question One showed that Students in both groups (Peer Tutoring and Demonstration Method) showed adequate misconceptions in solving algebraic problems before the intervention. The finding revealed that students in both the Peer Tutoring and Demonstration Method groups exhibited considerable misconceptions in solving algebraic problems before the intervention. This result aligns with previous studies such as Shrestha, (2018) and Forte, (2025), which reported that many students struggle with deep-seated misconceptions in algebra due to overreliance on rote learning, poor conceptual foundations, and teacher-centered instructional approaches. Similar trends have also been noted in Nigeria by Sa'ad, Adamu, and Sadiq (2014) and in WAEC Chief Examiners' reports (2014-2024) which consistently highlight students' difficulties in manipulating algebraic symbols and applying appropriate procedures. However, studies such as Awofala and Agbolade (2023) and Gurmu, Tuge, and Hunde (2024) reported contrasting results, where students under structured peer tutoring programs demonstrated fewer initial misconceptions. This difference may be attributed to variations in prior exposure, tutor training, and school learning environments. Therefore, the present finding underscores the persistence of algebraic misconceptions among secondary school students and the need for more engaging, concept-oriented instructional approaches to address them effectively.

The findings from Research Question Two showed that, Students taught using the Peer Tutoring instructional strategy demonstrated the fewest algebraic misconceptions after the intervention. The findings from Research Question Two showed that students taught using the Peer Tutoring strategy had the fewest algebraic misconceptions after the intervention. This agrees with studies by Aleid and Abdulaziz, (2015) and Abdurrahman, Abdullah and Osman, (2020), which found that peer tutoring improves understanding by promoting active participation and peer explanation. However, the result contradicts studies like Wolfe, (2018) who found no significant effect of peer tutoring, possibly due to poor tutor preparation or weak group interaction.

The finding from Research Question Three showed that, Students taught using Peer Tutoring instructional strategy recorded the highest mean achievement scores in algebra. The finding aligns with studies by Nardacchione and Peconio, (2022) which found that peer tutoring improves achievement through active interaction and shared understanding among learners. Conversely, Moliner and Alegre, (2020) reported no significant effect of peer tutoring, likely due to poor student pairing or inadequate supervision. Through peer collaboration and social interaction. Therefore, this study supports the growing body of evidence that innovative and student-centered teaching methods, especially the Peer tutoring instructional strategy, are more effective in reducing misconceptions and enhancing algebra learning than traditional methods. However, successful implementation depends on teacher preparedness, classroom conditions, and student involvement.

5. Conclusion

This study concludes that the Peer tutoring instructional strategy is the most effective strategy for reducing misconceptions among senior secondary school students in Sokoto State. Compared to Demonstration method, the Peer tutoring led to deeper conceptual understanding, highlighting the benefits of learner-centered, constructivist approaches over traditional teacher-centered methods.

6. Recommendations

1. Teachers should be trained and encouraged to use the Peer tutoring instructional strategy regularly in teaching algebra, as it led to the student performance and deeper understanding.

2. Schools should reduce reliance on the traditional demonstration method and adopt more student-centered strategies like Peer tutoring.

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