

Effect of Simulation-Game Teaching Method on Secondary School Students' Achievement in Algebra: Evidence from Awka Education Zone, Anambra State, Nigeria


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ARTICLE INFO	ABSTRACT
<p>Keywords: <i>simulation-game method, algebra, academic achievement, secondary school</i></p> <p><i>Received: 12, Mar. 2026</i> <i>Revised: 11, April 2026</i> <i>Accepted: 12, April 2026</i></p> <p>©2026 Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International</p> 	<p><i>The effect of the Simulation-Game Teaching Method (SGM) on secondary school students' academic achievement in algebra in was investigated Awka Education Zone of Anambra State, Nigeria. Two research questions and two null hypotheses were used for the study. A quasi-experimental pre-test post-test non-randomized control group design was adopted. A sample of 164 Senior Secondary Two (SS2) students was drawn from two public secondary schools using a multi-stage sampling procedure. Algebra Achievement Test (AAT), a 50-item multiple-choice instrument with a KR-20 reliability coefficient of 0.86, was used for data collection. The instrument was face and content validated by three experts in the Faculty of Education, Nnamdi Azikiwe University, Awka. Mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at a 0.05 level of significance. The findings from results showed that students taught algebra using the SGM significantly achieved higher than those taught using the Conventional Lecture Method. Gender did not significantly influence students' achievement in algebra. The study concludes that the Simulation-Game Method is an effective method for improving achievement of SS2 students in algebra in secondary schools regardless of gender. It is recommended that mathematics teachers be trained in the use of simulation-game method by the state Ministry of Education for algebra instruction and the Mathematics teachers should adopt the use of SGM in teaching..</i></p>

INTRODUCTION

Mathematics occupies a central position in secondary school education, serving as a prerequisite for university admission in Nigeria and underpinning success in science, technology, engineering, and economics. Within mathematics, algebra is particularly significant as it forms the foundation for advanced mathematical reasoning. Despite its importance, algebra remains one of the most challenging areas for secondary school students, and persistent low performance in the area continues to be a concern for educators and policymakers in education across Nigeria (Osei & Agyei, 2024). Evidence from the West African Examinations Council (WAEC) Chief Examiners' Reports (WAEC 2019–2023) and data from the Awka Education Zone indicate that candidates' performance in mathematics examinations has remained consistently below 50%, with algebra identified as a major area of difficulty (Egara & Mosimege, 2024). Ralston, Li, and Taylor (2018) describe algebra as a gateway to higher mathematics, while Gronmo (2018) refers to it as the language of mathematics, yet many students find its abstract and symbolic nature cognitively demanding and disconnected from real-life experience according to Musi (2023).

A key contributing factor to this poor performance is the continued dominance of conventional, teacher-centered instructional methods in Nigerian classrooms. The lecture method, which prioritizes transmission of information from teacher to student, offers limited opportunities for active participation or hands-on exploration (Onwumere, Ogbonnaya, & Okoronkwo, 2024). Research consistently demonstrates, like that of Boris (2020), that passive learning environments

hinder deep conceptual understanding and reduce student motivation (Boris, 2020). The Simulation-Game Teaching Method (SGM) offers a promising alternative. It creates interactive, experience-based learning environments in which students actively engage with mathematical concepts, make decisions, experiment with variables, and receive immediate feedback (Yang, Zhang, & Lin, 2022). Several studies have reported positive performance of simulation-game approaches on achievement in mathematics (Dorji & Rigdel, 2024; Idama & Ajaja, 2024).

The Simulation-Game Teaching Method is a learner-centered instructional strategy that combines simulation and gaming to facilitate active, experiential learning. Loboda and Denysenko (2023) describe simulation games as educational tools that simplify complex real-world scenarios through structured, interactive tasks. Pratiwi and Istiyowati (2020) describe the method as one that promotes learning by doing — students manipulate variables, test ideas, and visualize outcomes, fostering deeper conceptual understanding than passive instruction. The theoretical foundation draws on Mayer's (2005) Cognitive Theory of Multimedia Learning, which explains how well-designed interactive environments support meaningful learning, and Bruner's (1990) Constructivist Theory, which emphasizes that knowledge is best constructed through active engagement and real-world experience.

Empirically, Dorji and Rigdel (2024) found that students taught using games and simulations in Bhutan performed significantly better than controls ($p < 0.05$), with a strong correlation between positive perceptions and achievement ($r = 0.96$). Idama and Ajaja (2024) reported that mathematical games outperformed both analogy-based and lecture methods. Talan's (2021) meta-analysis of 7,575 participants reported a mean effect size of $g = 0.759$ in favour of simulation-based instruction. Kibiwott and Njoroge (2024) and Letsa-Agbozo, Susuoroka, and Donnoe (2023) corroborated these findings in physics and mathematics contexts respectively.

Studies on gender and mathematics achievement present mixed findings. Febana, Makeleni, and Masha (2022) found no significant interaction between gender and instructional strategy on achievement in South Africa. Clifford, Sunday, and Joseph (2019) similarly reported no significant gender influence when simulation-game strategies were used. In contrast, Muhawenimana and Mutarutinya (2023) found that girls outperformed boys in Rwanda. Ojelade, Ekpo, and Aregbesola (2021) reported no gender difference in chemistry achievement when 3D simulation was used, suggesting that innovative student-centered strategies can provide equitable learning for all students. However, empirical evidence within the Nigerian context, particularly in Awka Education Zone, remains limited. This study therefore investigated the effect of the SGM on Senior secondary school students' achievement in algebra with specific attention to gender differences in the students' achievement. The study achieves the following two purposes:

1. To determine the effect of the Simulation-Game Teaching Method (SGM) on Senior Secondary Two (SS2) students' achievement in algebra in Awka Education Zone, Anambra State.
2. To examine the influence of gender on the achievement of students taught algebra using the SGM and the Conventional Lecture Method (CLM) in Awka Education Zone, Anambra State

Research Questions

The study was guided by two research questions:

1. What is the difference between the mean achievement scores of students taught algebra using the Simulation-Game Method (SGM) and those taught using the Conventional Lecture Method (CLM)?
2. What are the differences in the mean achievement scores of male and female students taught algebra using SGM and those taught using CLM?

Hypotheses

Two null hypotheses will be tested at .05 alpha level in this study:

1. There is no significant difference between the mean achievement scores of students taught algebra using SGM and those taught using CLM.
2. There is no significant difference in the mean achievement scores of male and female students taught algebra using SGM and those taught using CLM.

2. METHODOLOGY

The study adopted a quasi-experimental pre-test post-test non-randomized control group design. The population comprised 6,353 Senior Secondary Two (SS2) students of mathematics in Awka Education Zone of Anambra State, Nigeria. A sample of 164 students (79 males and 85 females) was selected using a multi-stage procedure: two Local Government Areas were randomly selected, one coeducational secondary school was purposively chosen from each LGA, and one intact class of SS2 from each school was the experimental group ($n = 86$, SGM) and control group ($n = 78$, CLM).

The Algebra Achievement Test (AAT) consisted of 50 multiple-choice items covering quadratic equations, each with four options (A–E). Each correct response carried two marks (total: 100 marks). The instrument was validated by three experts who were university lecturers and a reliable interval consistency test using KR-20 yielded a reliability coefficient of 0.86.

The experimental group was taught using the Treasure Path simulation game over four weeks. The control group received conventional lecture instruction. Both groups were taught by their regular mathematics teachers, who were trained by the researchers, Pre- and post-tests were administered to both groups before and after the treatments. Mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at $\alpha = 0.05$, with pre-test scores as the covariate measures.

3. RESULTS AND DISCUSSION

The results are presented in Tables according to research questions and hypotheses.

Table 1: The Difference between the Mean achievement scores of students taught algebra using Simulation-Game Method (SGM) and Conventional Lecture Method (CLM)

Group		Pre-test Mean (\bar{x})	SD	Post-test Mean (\bar{x})	SD	Mean Gain
Simulation-Game Method	86	41.58	8.27	70.46	7.91	28.88
Conventional Lecture Method	78	40.94	9.12	56.02	12.35	15.08
Mean Difference		0.64		14.44		13.80

Table 1 shows that the SGM group recorded a pre-test mean of 41.58 ($SD = 8.27$) and a post-test mean of 70.46 ($SD = 7.91$), yielding a mean gain of 28.88. The CLM group recorded a pre-test mean of 40.94 ($SD = 9.12$) and a post-test mean of 56.02 ($SD = 12.35$), yielding a mean gain of 15.08. The SGM group outperformed the CLM group with difference in the mean gain of 13.80.

Table 2: Difference in the mean achievement scores of male and female students taught algebra using SGM and those taught using CLM

Group	Gender	N	Pre-test Mean (\bar{x})	SD	Post-test Mean (\bar{x})	SD	Mean Gain
SGM	Male	42	41.72	8.35	70.18	8.04	28.46
SGM	Female	44	41.44	8.21	70.73	7.79	29.29
Mean Diff			0.28		0.55		0.83
CLM	Male	37	41.10	9.05	55.62	12.58	14.52
CLM	Female	41	40.82	9.18	56.38	12.11	15.56
Mean Diff.			0.28		0.76		1.04

Table 2 shows that both male (gain = 28.46) and female (gain = 29.29) students in the SGM group outperformed their CLM counterparts (male: 14.52; female: 15.56). The difference in mean gain between males and females within the SGM group was minimal (0.83), indicating that the method benefited both genders almost equally. The mean differences in each case are also shown.

Table 3: ANCOVA test of significant difference between the mean achievement scores of students in SGM and CLM groups

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	11264.418 ^a	2	5632.209	352.416	.000
Intercept	498.732	1	498.732	31.221	.000
Pre-test (Covariate)	10985.304	1	10985.304	686.105	.000
Teaching Method	278.114	1	278.114	17.374	.000
Error	2564.782	161	15.929		
Total	318420.000	164			
Corrected Total	13829.200	163			

The teaching method effect was statistically significant ($F(1, 161) = 17.374, p = .000 < .05$), thus the null hypothesis one is rejected, showing that there is a significant difference in favour of SGM group.

Gender did not significantly affect achievement ($F(1, 160) = 0.930, p = .336 > .05$), so H_{02} is not rejected. Teaching method, however, remained a significant predictor ($F = 17.941, p = .000$). The SGM improved algebra achievement irrespective of students' gender.

The first finding of this study revealed that students taught algebra using the Simulation-Game Teaching Method (SGM) achieved significantly higher post-test mean scores ($\bar{x} = 70.46$) than those taught using the Conventional Lecture Method (CLM) ($\bar{x} = 56.02$), with a mean gain difference of 13.80 points and a significant F-value of $F(1, 161) = 17.374, p < .05$. This indicates that the SGM was more effective than the CLM in improving students' algebra achievement in Awka Education Zone.

Table 4: ANCOVA test of significant difference between the mean achievement scores of male and female students

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	11872.506 ^a	3	3957.502	248.916	.000
Intercept	512.184	1	512.184	32.234	.000
Pre-test (Covariate)	11102.396	1	11102.396	699.185	.000
Gender	14.782	1	14.782	0.930	.336
Teaching Method	284.915	1	284.915	17.941	.000
Error	2576.694	160	16.104		
Total	318420.000	164			
Corrected Total	14449.200	163			

This finding aligns with Dorji and Rigdel (2024), Idama and Ajaja (2024), Kibiwott and Njoroge (2024), and Letsa-Agbozo *et al.* (2023), all of whom reported superior outcomes for game-based or simulation-based instruction over conventional methods. The improvement is theoretically grounded in Mayer's (2005) Cognitive Theory of Multimedia Learning (CTML), which holds that simulation games engage both visual and verbal cognitive channels, reducing cognitive overload while deepening understanding, and in Bruner's (1990) constructivism, which emphasizes active knowledge construction. The Treasure Path game specifically made abstract quadratic equation solving concrete, collaborative, and self-correcting, which are key drivers of improved conceptual understanding.

The second finding of this study showed that gender did not significantly influence students' achievement in algebra ($F(1, 160) = 0.930, p = .336 > .05$), with male students in the SGM group recording a mean gain of 28.46 and female students recording a mean gain of 29.29 — a negligible difference of 0.83. This suggests that the SGM benefited both male and female students almost equally, creating an equitable learning environment regardless of gender. This finding agrees with Febana, Makeleni, and Masha (2022) and Clifford, Sunday, and Joseph (2019), who reported gender-neutral outcomes under innovative instructional strategies. It diverges from Muhawenimana and Mutarutinya (2023), who found that girls outperformed boys in Rwanda — a difference that may reflect contextual and socio-cultural factors specific to that setting. The present findings suggest that the SGM creates an equitable learning environment that supports both male and female students equally in Awka Education Zone.

CONCLUSION

The Simulation-Game Teaching Method significantly improved secondary school students' algebra achievement compared to the Conventional Lecture Method, with the benefit extending equally to both genders. Based on the findings of this study, the following recommendations are made:

1. Mathematics teachers should adopt the Simulation-Game Teaching Method (SGM) in teaching algebra in secondary schools, as it has been shown to significantly improve students' achievement compared to the Conventional Lecture Method (CLM).
2. The State Ministry of Education should organize workshops and seminars to train mathematics teachers in the use of simulation-game strategies for algebra instruction at the secondary school level.

3. Curriculum planners and educational policymakers should integrate game-based and simulation strategies into the secondary school mathematics curriculum, particularly in the algebra strand.
4. Teacher training institutions should equip pre-service and in-service mathematics teachers with the skills needed for designing and implementing simulation games as instructional tools in mathematics classrooms.
5. Since the SGM was found to benefit both male and female students equally, school administrators should encourage its use as an inclusive instructional strategy that promotes gender equity in mathematics achievement.

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