



Shifting Perspectives in Mathematics: The Effect of Graphmatics Teaching Strategy versus Conventional Methods on Students' Attitude towards Quadratic Graphs

By

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Abstract

Affective factors such as motivation and confidence are critical predictors of success in mathematics; however, senior secondary students in Nigeria frequently exhibit anxiety and negative attitudes towards graphical concepts due to entrenched, teacher-centred instructional methods. This study investigated the impact of the Graphmatics Teaching Strategy (GTS) on students' attitudes towards quadratic graphs, comparing its efficacy against the Conventional Teaching Method (CTM). A quasi-experimental pre-test, post-test, non-equivalent control group design was employed, utilizing a sample of 128 Senior Secondary School 2 (SSS2) students from two public schools in Lagos State. Data were collected using a validated 20-item Student Attitude Questionnaire (SAQ) and analyzed using Analysis of Covariance (ANCOVA). Results revealed that students taught using GTS achieved a substantially higher mean attitude gain (38.02) compared to the CTM group (16.70). Furthermore, ANCOVA indicated a statistically significant difference in post-test attitude scores in favour of the GTS group, $F(1,125)=216.74, p<.05$. The study concludes that GTS effectively dismantles affective barriers by transforming abstract algebraic concepts into interactive visual experiences. It is recommended that educational policymakers integrate dynamic mathematics software into public schools and provide targeted teacher training to foster experiential learning.

Keywords: Attitude towards Mathematics, Conventional Teaching Method, GeoGebra, Graphmatics Teaching Strategy, Mathematics Anxiety and Quadratic Graphs.

Introduction

Affective factors, such as motivation, confidence, and engagement, are critical predictors of success in mathematics. However, senior secondary students in Nigeria frequently exhibit negative attitudes, mathematics anxiety, and disengagement towards graphical concepts. This is largely attributed to an entrenched reliance on conventional, teacher-centred instructional methods that prioritise procedural fluency over representational reasoning (Yusuf & Afolabi, 2020). Consequently, students often perceive graph-related tasks as abstract, difficult, and irrelevant, contributing to the persistent poor performance in these areas noted by examination bodies (WAEC, 2023).

Attitude toward mathematics constitutes a multidimensional construct encompassing students' affective responses, cognitive beliefs, and behavioural tendencies. These attitudinal formations are particularly malleable during adolescence, making the secondary school years a critical window for pedagogical intervention. The Graphmatics

Teaching Strategy (GTS) enters this psychological landscape as a potentially transformative approach. By rendering abstract concepts visible and manipulable through tools like GeoGebra, GTS can demystify mathematical ideas, replacing confusion with moments of insight that foster enjoyment, perceived competence, and self-efficacy (Mwangi & Omondi, 2023).

Despite the growing advocacy for innovative pedagogical approaches, systematic investigations into learners' attitudinal shifts following exposure to such interventions remain conspicuously absent in the Nigerian context. While professional development initiatives increasingly advocate for learner-centred methods (Shahmohammadi, 2023), there is a significant lack of empirical evidence evaluating whether a structured approach like GTS can meaningfully shift students' affective dispositions compared to traditional methods. This study seeks to address this gap by empirically comparing the mean attitude scores of students taught via the Graphmatics Teaching Strategy against those taught using conventional

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methods, determining whether visual, interactive pedagogy can foster a more positive and sustained orientation towards mathematical inquiry.

Problem Statement

Affective factors, such as motivation, confidence, and engagement, are critical predictors of success in mathematics. However, senior secondary students in Nigeria frequently exhibit negative attitudes, anxiety, and disengagement towards graphical concepts. This is largely attributed to an entrenched reliance on conventional, teacher-centred instructional methods that prioritise procedural fluency over representational reasoning and conceptual understanding (Yusuf & Afolabi, 2020; Ojo & Akinbobola, 2021). Consequently, students often perceive graph-related tasks as abstract, difficult, and irrelevant, contributing to the persistent poor performance in these areas noted by the West African Examinations Council (WAEC, 2023).

While professional development initiatives increasingly advocate for learner-centred and visual instructional methods (Shahmohammadi, 2023), there is a significant lack of empirical evidence evaluating whether a structured, named approach like the Graphmatics Teaching Strategy can meaningfully shift students' affective dispositions. Existing studies in sub-Saharan Africa have focused predominantly on cognitive outcomes, leaving the attitudinal impact of visual-graphical interventions largely unexamined (Oluwafemi et al., 2021). This study seeks to address this gap by empirically comparing the mean attitude scores of students taught via the Graphmatics Teaching Strategy against those taught using conventional methods, determining whether visual, interactive pedagogy can foster a more positive and sustained orientation towards mathematical inquiry.

Purpose of the Study

The purpose of this study is to investigate the impact of the Graphmatics Teaching Strategy on the affective domain of Senior Secondary School Students in Mathematics. Specifically, the study aims to compare the differences in mean attitude scores of students taught Quadratic Graph using the Graphmatics Teaching Strategy compared to those taught using the Conventional Teaching Method.

Research Question

Is there a difference in the mean attitude scores of students taught Quadratic Graph using Graphmatics Teaching Strategy versus those taught using Conventional Teaching Method?

Null Hypothesis

There is no significant difference in the mean attitude scores of students taught Quadratic Graph using Graphmatics Teaching Strategy and Conventional Teaching Method.

Conceptual Review

The Graphmatics Teaching Strategy is a student-centred method that uses visual tools like GeoGebra to teach mathematics. Instead of relying on the old method of talking and memorising, it uses interactive graphs to make learning easier. This is crucial in Nigeria, where students often struggle to read or draw graphs, as noted in the Chief Examiner Report

(2023). By using these tools, students can explore math visually. Oluwafemi et al. (2021) explain that interactive teaching greatly boosts student interest and understanding in Nigerian secondary schools.

A key feature of this strategy is personalised learning. Teachers can adjust lessons to fit each student's speed and learning style. This is very helpful in crowded Nigerian classrooms to fix common mistakes, like misunderstanding graph scales (Oladipo & Adeyemi, 2020). Students can use software to change graph lines and see the results instantly, building their confidence. This is much better than the old one-size-fits-all method, which often leaves students behind (Adewale & Kolawole, 2020). Adetimirin (2020) adds that using technology to meet individual needs greatly improves student motivation and learning results.

The strategy also encourages teamwork. Students work in groups to solve problems and share ideas, which builds critical thinking. To make this work well, teachers need proper training, as many currently lack the skills to use digital teaching tools (Olasupo et al., 2021). The strategy includes training to help teachers create effective visual lessons. Gideon (2017) stresses that training teachers is essential for using visual methods successfully in Nigerian schools. Additionally, Adetimirin (2020) notes that collaborative learning in African schools improves the sharing of ideas and overall teaching quality.

Finally, the Graphmatics Teaching Strategy promotes fairness in education. Many Nigerian schools lack good teaching materials, which creates an unfair gap between rich and poor students (Adewale & Kolawole, 2020). This strategy uses free, low-cost tools like GeoGebra and open educational resources to fix this problem. It ensures that students in poorly funded schools can access the same high-quality visual materials as those in better schools. By making math interactive, engaging, and fair, the Graphmatics Teaching Strategy offers a powerful way to improve graph skills and overall academic success for senior secondary students in Nigeria.

Methodology

Design: A quasi-experimental pre-test, post-test, non-equivalent control group design was employed to evaluate the affective impact of the Graphmatics Teaching Strategy compared to the Conventional Teaching Method.

Population and Sample: The study targeted 128 (one hundred and twenty-eight) SSS2 mathematics students in Lagos State Education District V. Two intact classes from two public schools were selected via multistage sampling and assigned to the experimental (Graphmatics) and control (Conventional) groups.

Instrumentation: The Student Attitude Questionnaire (SAQ) was used. It is a 20-item Likert-scale instrument (4-point scale) measuring motivation, confidence, and engagement. It achieved a Cronbach's alpha of 0.84, indicating high internal consistency.

Data Collection Procedure: The 8-week procedure included baseline SAQ administration in Week 2. Weeks 3–6 implemented the interventions (interactive GeoGebra tasks for the experimental group; chalkboard/textbook methods for the control). Week 7 administered the post-intervention SAQ.

Data Analysis: ANCOVA was utilized to test the hypothesis. The post-test SAQ scores were the dependent variable, teaching method was the independent variable, and pre-test SAQ scores were the covariate.

Pilot Study Justification: The pilot study revealed a substantial +18.2 mean gain in the experimental group's SAQ

scores compared to +8.2 for the control group. Qualitative feedback indicated that the "hands-on nature" of Graphmatics made learning "fun," providing strong empirical justification to dedicate a full article to measuring these attitudinal shifts.

Presentation of Results

Research Question

Is there a difference in the mean attitude scores of students taught Quadratic Graph using Graphmatics Teaching Strategy versus those taught using Conventional Teaching Method?

Table 1: Mean, Standard Deviation, and Mean Gain of Pretest and Posttest Attitude Scores of Students Taught Using Graphmatics Teaching Strategy and Conventional Teaching Method

Group	N	Pretest M	Pretest SD	Posttest M	Posttest SD	Mean Gain
Graphmatics Teaching Strategy	65	24.03	3.63	62.05	8.47	38.02
Conventional Teaching Method	63	22.84	5.25	39.54	10.65	16.70
Total	128	23.45	4.52	50.97	14.80	27.52

Note. M = Mean; SD = Standard Deviation; Mean Gain = Posttest Mean – Pretest Mean.

Table 1 presents the mean, standard deviation, and mean gain of students' attitude scores toward quadratic graphs. Students taught using the Graphmatics Teaching Strategy had a pretest mean attitude score of 24.03 and a posttest mean score of 62.05, resulting in a mean gain of 38.02. Conversely, students taught using the Conventional Teaching Method recorded a pretest mean score of 22.84 and a posttest mean score of 39.54, yielding a mean gain of 16.70. The higher mean gain

observed among students exposed to the Graphmatics Teaching Strategy indicates that the strategy was more effective in improving students' attitudes toward quadratic graphs than the Conventional Teaching Method.

Null Hypothesis

There is no significant difference in the mean attitude scores of students taught Quadratic Graph using Graphmatics Teaching Strategy and Conventional Teaching Method.

Table 2: Tests of Between-Subjects Effects for Posttest Attitude Scores of Students Taught Quadratic Graphs Using Graphmatics and Conventional Methods (Controlling for Pretest Attitude)

Source	Type III Sum of Squares	df	Mean Square	F	P
Corrected Model	19753.43	2	9876.72	152.90	.00
Intercept	2405.47	1	2405.47	37.24	.00
Pretest Attitude	3548.07	1	3548.07	54.93	.00
Group	14000.36	1	14000.36	216.74	.00
Error	8074.45	125	64.60		
Total	360348.00	128			
Corrected Total	27827.88	127			

The ANCOVA results in Table 2 examining the effect of teaching method on students' posttest attitude scores in quadratic graphs, while controlling for pretest attitude, indicate that the overall model was statistically significant, $F(2, 125) = 152.90, p < .05$. The effect of Group (Graphmatics Teaching Strategy and Conventional Method) was statistically significant, $F(1, 125) = 216.74, p < .05$. This shows that there is a significant difference in the mean attitude scores of students taught quadratic graphs using the Graphmatics Teaching Strategy and those taught using the conventional method after adjusting for pretest attitude. The covariate pretest attitude was also statistically significant, $F(1, 125) = 54.93, p < .05$, indicating that students' initial attitude toward

mathematics significantly influenced their posttest attitude scores. Since the p-value for Group is less than .05 ($p < .05$), the null hypothesis is rejected, this implies that there is a statistically significant difference in the attitude mean scores of students taught quadratic graphs using the Graphmatics Teaching Strategy and those taught using the Conventional Teaching Method, in favour of the Graphmatics Teaching Strategy.

Discussion of Findings

Research Question

The empirical evidence delineated in Table 1 elucidates the profound impact of the Graphmatics Teaching Strategy on students' affective dispositions towards quadratic graphs. The

findings reveal a striking divergence in attitude enhancement, with the Graphmatics cohort demonstrating a substantial mean gain of 38.02, compared to a marginal gain of 16.70 for those subjected to the Conventional Teaching Method. This pronounced positive shift in attitude is of paramount pedagogical significance, particularly within the context of Nigerian secondary education, where mathematics is frequently perceived with apprehension and anxiety (Oladipo & Adeyemi, 2020; Addae & Agyei, 2018). The conventional teaching method approach, characterised by abstract, teacher-centred transmission, often exacerbates mathematics anxiety, thereby cementing negative attitudes towards complex topics like graphing. Conversely, the Graphmatics Teaching Strategy effectively dismantles these affective barriers by transforming quadratic graphs from intimidating algebraic abstractions into accessible, interactive visual experiences, thereby fostering a significantly more positive psychological disposition towards the subject.

The superior efficacy of the Graphmatics Teaching Strategy in cultivating a positive attitude can be theoretically anchored in the principles of multimedia learning and experiential education. According to Mayer's (2009) cognitive theory of multimedia learning, the dual-channel processing of visual and verbal information reduces extraneous cognitive load, making the learning process less frustrating and inherently more enjoyable. Furthermore, the gamified, edutainment nature of Graphmatics aligns seamlessly with Kolb's (1984) experiential learning theory, which posits that active, reflective engagement enhances both comprehension and affinity for the subject matter. This empirical outcome strongly corroborates the findings of Alabi and Banjoko (2021) and Alabi et al. (2021), who established that edutainment and game-based instructional strategies serve as potent catalysts for improving students' interest and attitudes in secondary school science and mathematics. By providing immediate visual feedback and a sense of autonomous exploration, Graphmatics Teaching Strategy transforms the classroom dynamic from a passive, anxiety-inducing environment into an engaging, intrinsically motivating space, a feat that the conventional teaching method fundamentally fails to achieve (Yusuf & Afolabi, 2020).

Ultimately, the dramatic improvement in attitude scores recorded by the Graphmatics group resonates with broader empirical validations of technology-enhanced and interactive instructional strategies across diverse academic disciplines. For instance, Usman et al. (2024) similarly observed that web-based instructional applications significantly enhanced secondary school students' attitudes towards commerce in Lagos State, underscoring the universal affective benefits of modernising pedagogical delivery. Moreover, the critical nexus between positive attitudes and academic success is well-documented; as Hwang and Son (2021) and Wen and Dubé (2022) assert, a favourable disposition towards mathematics is a robust predictor of sustained academic achievement and graphical literacy. By significantly mitigating mathematics anxiety and cultivating a profound appreciation for quadratic graphs, the Graphmatics Teaching

Strategy not only addresses the affective deficits inherent in conventional teaching but also lays the crucial psychological foundation for long-term mathematical proficiency. Consequently, integrating such interactive, technology-driven strategies is imperative for reversing the chronic negative attitudes towards mathematics consistently highlighted in the Chief Examiner's Reports of the WAEC (2023) and NECO (2022).

Hypothesis

The Analysis of Covariance (ANCOVA) results presented in Table 2 unequivocally reject the null hypothesis, demonstrating a statistically significant difference in the posttest attitude scores of students taught quadratic graphs, with a profound positive shift observed in favour of the Graphmatics Teaching Strategy. This finding underscores the critical limitations of the Conventional Teaching Method in fostering a positive psychological disposition towards mathematics, a subject frequently plagued by anxiety and apprehension among secondary school students. The persistent negative attitudes towards mathematics, as consistently documented in the Chief Examiners' Reports of the West African Examinations Council (WAEC, 2023) and the National Examinations Council (NECO, 2022), are largely exacerbated by abstract, teacher-centred pedagogies that alienate learners. By contrast, the Graphmatics Teaching Strategy effectively dismantles these affective barriers, corroborating the assertions of Addae and Agyei (2018) and Wen and Dubé (2022) that interactive, student-centred instructional practices are paramount in mitigating mathematics anxiety and cultivating a resilient, positive attitude towards the subject.

The superior efficacy of the Graphmatics Teaching Strategy in enhancing students' attitudes can be robustly explained through the theoretical lenses of Mayer's (2009) cognitive theory of multimedia learning and Kolb's (1984) experiential learning theory. Quadratic graphs, when taught conventionally, are often perceived as daunting and abstract, leading to cognitive overload and subsequent disengagement. Graphmatics addresses these affective bottlenecks by providing dynamic, interactive visualisations where students can manipulate algebraic coefficients and instantaneously observe the corresponding graphical transformations. This dual-channel processing reduces extraneous cognitive load, making the learning process inherently less frustrating and more enjoyable (Mayer, 2009). Furthermore, the gamified, edutainment nature of the software aligns seamlessly with experiential learning principles, transforming the classroom dynamic from a passive, anxiety-inducing environment into an engaging, intrinsically motivating space. This empirical outcome strongly resonates with the findings of Alabi and Banjoko (2021) and Usman et al. (2024), who established that edutainment and technology-mediated instructional strategies serve as potent catalysts for improving students' interest and attitudes in secondary education.

Ultimately, the dramatic improvement in attitude scores recorded by the Graphmatics group aligns with a robust body

of contemporary empirical literature investigating the affective impacts of dynamic mathematics software. Studies by Mthembu and Molefe (2021), Nwabueze and Okoro (2024), and Ibrahim and Zakaria (2022) have consistently demonstrated that interactive digital tools significantly enhance learners' confidence, reduce subject-related fear, and foster a positive disposition towards complex mathematical concepts. The critical nexus between positive attitudes and academic success is well-documented; as Hwang and Son (2021) assert, a favourable disposition towards mathematics is a robust predictor of sustained academic achievement and graphical literacy. By significantly mitigating mathematics anxiety and cultivating a profound appreciation for quadratic graphs, the Graphmatics Teaching Strategy not only addresses the affective deficits inherent in conventional teaching but also lays the crucial psychological foundation for long-term mathematical proficiency. Consequently, integrating such interactive, technology-driven strategies is imperative for reversing the chronic negative attitudes towards mathematics and promoting lifelong mathematical engagement in senior secondary schools.

Conclusion

Based on the findings of this study, it is conclusively established that the Graphmatics Teaching Strategy is a highly efficacious, transformative pedagogical tool for teaching quadratic graphs in senior secondary schools. The strategy successfully bridges the chasm between abstract algebraic equations and visual, spatial representations, thereby demystifying complex mathematical concepts that have historically plagued students and contributed to poor performance in external examinations.

Furthermore, the study concludes that while the Graphmatics Teaching Strategy is profoundly effective in neutralising gender disparities in students' attitudes towards mathematics, subtle cognitive and foundational gaps specifically related to prior graphical literacy and gendered interactions with digital tools still influence achievement outcomes. Therefore, the mere introduction of dynamic mathematics software is not a panacea; it must be accompanied by deliberate, targeted pedagogical scaffolding. Ultimately, the integration of the Graphmatics Teaching Strategy represents a critical paradigm shift from passive, teacher-centred instruction to active, student-centred experiential learning, offering a robust solution to the chronic challenges of mathematics education in Lagos State and Nigeria at large.

Recommendations

Considering the findings and conclusions, the following recommendations are proffered:

1. The Ministry should actively procure, subsidise, and integrate dynamic mathematics software, such as Geogebra, into the official instructional resources for public secondary schools. This should be coupled with the provision of functional computer laboratories to ensure equitable access to technology-enhanced learning.

2. Teachers should transition from conventional, chalk-and-talk methodologies to interactive, visual-based pedagogies. Specifically, when introducing quadratic graphs, educators should utilise graphing calculators such as Geogebra to allow students to manipulate variables dynamically. Furthermore, teachers must provide explicit, pre-emptive scaffolding for students with low graphical literacy to mitigate cognitive overload during software interaction.
3. Organisations such as the Educational Media and Technology Association of Nigeria (EMTAN) should organise continuous professional development (CPD) workshops and capacity-building seminars focused on the Technological Pedagogical Content Knowledge (TPACK) required to effectively integrate dynamic graphing tools into secondary school mathematics.

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