

 Research Article

Assessing the Influence of AI-Generated Responses on Academic Achievement: An Ethical Perspective and Self-Efficacy of Delta State Secondary School Students, Nigeria

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Abstract

This study examined the influence of AI-generated responses on students' mathematics achievement and self-efficacy. Using a quasi-experimental design with two control groups and two experimental groups, the study employed three research questions and three hypotheses. 1,369 Senior Secondary School I (SSS I) students from public schools in Ughelli North Local Government Area of Delta State made up the population. A sample of 115 students, consisting of two intact classes chosen by simple random sampling, was drawn from two randomly selected coeducational schools. School A served as the experimental group with 62 students (43 males and 19 females), while School B served as the control group with 53 students. Data were gathered using two instruments: the "Students' Questionnaire on Ethical Impacts of AI-Generated Responses on Students' Achievement in Solving Quadratic Equations" (SQEIAIGRASQ) and the Quadratic Equation Achievement Test (QEAT). Both instruments were validated by mathematics teachers and measurement and evaluation experts, and the required corrections were made. Reliability testing showed a high reliability index. The mean and standard deviation were used to answer the research questions, while independent-samples *t*-tests were employed to test the null hypotheses at a 0.05 level of significance. The findings revealed that students exposed to AI-generated responses achieved higher performance than those taught through conventional teaching methods. Furthermore, AI-generated responses positively influenced the self-efficacy of students in solving mathematics problems. The practical implication of these findings is that teachers should integrate AI-generated responses into instruction while providing their own input, and students should also be encouraged to engage with these tools responsibly. Based on the findings, it was recommended that students be encouraged to use AI-generated responses while observing ethical guidelines in their use and contribution to AI-supported learning outcomes.

Keywords: AI-Generated Response, Ethical Perspective, Students' Achievement, Quadratic Equations, Self-Efficacy

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1. INTRODUCTION

Mathematics occupies a central position in human development and everyday problem-solving, serving as a foundational discipline across science, technology, engineering, economics, and social decision-making. As a core subject at the primary, secondary, and early tertiary levels, particularly for science-oriented students, mathematics equips learners with logical reasoning, analytical thinking, and quantitative skills essential for national development. The discipline comprises several interrelated branches, including arithmetic, algebra, geometry, and statistics. Algebra forms a critical bridge between basic numeracy and advanced scientific applications. Within algebra, quadratic equations represent a fundamental concept taught at the senior secondary school level.

A quadratic equation is commonly written in the standard form $ax^2 + bx + c = 0$, where $a \neq 0$, a , b , and c are real constants, and x stands for the unknown variable. The constant term c is independent of x . Quadratic equations are indispensable in modeling real-world phenomena such as motion, optimization problems, economic forecasting, and engineering design (Oladayo, 2025; Stewart, 2021; Thomas et al., 2020). Consequently, proficiency in solving quadratic equations is a prerequisite for success in advanced mathematics and science-related disciplines. Despite their importance, quadratic equations remain a persistent source of difficulty for many secondary school students. Empirical studies attribute these challenges to weak foundational knowledge, misconceptions about algebraic symbolism, limited exposure to multiple solution strategies, and low learner confidence (Henkel et al., 2024). These difficulties are often reflected in consistently poor internal assessments and external examination outcomes. In response, educational reforms in many countries, including Nigeria, have emphasized improved teacher preparation, learner-centred pedagogies, and problem-solving-oriented curricula. However, evidence suggests that many mathematics teachers still lack sufficient instructional resources, pedagogical confidence, and sustained professional development opportunities to effectively address learners' difficulties (OECD, 2020). As a result, students' mathematics achievement has remained largely stagnant, with persistent disparities linked to gender, socioeconomic status, and access to quality instruction (Schiff, 2021; UNESCO, 2024).

New approaches to addressing enduring problems in mathematics education have been made possible by recent advances in artificial intelligence (AI). The term artificial intelligence (AI) describes computer systems' capacity to do tasks like reasoning, pattern recognition, language comprehension, and adaptive decision-making that often call for human intelligence. AI technologies are being used more and more in education to improve teaching and learning activities. These technologies include machine learning algorithms, natural language processing systems, intelligent tutoring systems, and generative AI tools like ChatGPT, Perplexity, and Gemini (Luckin et al., 2021). These systems can personalize instruction, automate grading, provide immediate feedback, and offer multiple problem-solving pathways, thereby supporting students' understanding of complex mathematical concepts such as quadratic equations (Baker & Inventado, 2014; Joshua et al., 2022).

Conversely, AI-generated responses that are overly perfect, misleading, or incorrect may undermine students' self-belief in challenging tasks. Overdependence on AI tools may further erode motivation, critical thinking, and self-directed learning, particularly when students rely on automated solutions rather than conceptual understanding (Huang et al., 2024; Joshua et al., 2022). Data privacy and transparency represent additional ethical challenges. Ensuring that learners understand how AI systems generate responses and use their data is essential for building trust and safeguarding learners' rights.

Moreover, biased AI outputs arising from unrepresentative training data or flawed algorithms can create unequal learning experiences across gender, regional, and socioeconomic groups, thereby reproducing existing educational inequalities (Bulut et al., 2024). Contemporary ethical frameworks for AI in education emphasize continuous monitoring, transparency, and accountability. Recommended practices include regular system audits, bias detection and mitigation across demographic groups, human oversight of automated feedback, and clear mechanisms for reporting and correcting errors (Ehinder et al., 2021). Adaptive AI models must be routinely updated with new data and subjected to version control to ensure traceability and ethical compliance.

Against this backdrop, examining the impact of the response generated by AI on students' achievement in mathematics, particularly within the context of Delta State, Nigeria, is timely as well as necessary. While AI offers promising instructional support, its effectiveness depends on ethical deployment, teacher guidance, critical student engagement, and contextual sensitivity to local infrastructure and equity concerns.

1.1. Ethical Aspects of Educational Technologies

Recent scholarship emphasizes that ethical considerations are central to the effective deployment of educational technologies, particularly Artificial Intelligence (AI). This was highlighted by Ogoke et al. (2025), which shows the importance of explainable AI techniques, such as SHAP values, which help clarify how feedback and recommendations are generated within learning systems. According to the authors, AI

systems that lack transparency restrict students' and educators' understanding of automated decisions, thereby reducing trust, acceptance, and meaningful engagement.

Similarly, Chaudhry et al. (2022) introduced an index-based framework designed in making sure that AI systems used in education by AI remain transparent, safe, accountable, and interpretable. Expanding the ethical scope, Bulut et al. (2024) include data sovereignty and environmental sustainability as critical components of ethical AI assessment. They argue that large-scale AI systems are associated with substantial environmental costs due to intensive data processing and storage demands, while issues of data ownership and control also remain unresolved.

Privacy and data security constitute another major ethical concern. Chaudhry et al. (2022) caution that weak privacy and security frameworks expose students to risks of data exploitation. AI-driven educational platforms routinely collect sensitive student data, including learning behaviors, performance indicators, and demographic details, raising concerns regarding confidentiality and potential misuse. To mitigate these risks, the authors recommend the adoption of policies focused on data anonymization, informed consent, and robust encryption mechanisms.

Bias and fairness in adaptive learning systems have also received considerable attention. Ogoke et al. (2025) propose ethical AI frameworks that integrate fairness detection techniques (such as NLP-based bias audits), reinforcement learning, and explainable system designs to reduce algorithmic bias. Yin et al. (2024) similarly advocate multi-level bias mitigation strategies, ranging from inclusive data collection practices to algorithmic constraints that promote equitable educational outcomes.

Empirical evidence further underscores institutional readiness challenges. A study conducted at the University of Jordan revealed that only about 14% of academic staff felt adequately supported by their institutions. The results indicated that for well-defined policies, professional development initiatives, and governance frameworks before large-scale AI adoption in contexts such as Delta State. Additionally, disparities in access to electricity, internet connectivity, and digital devices suggest that AI technologies may exacerbate existing educational inequalities. Chaudhry et al. (2022) observe that disadvantaged students often experience limited access, which can further widen achievement gaps. A human-centred approach to AI-supported learning is therefore essential. Ryan and Deci (2017) advocate for instructional models in which teachers retain their guiding roles while students engage in reflective learning alongside AI tools.

Within this framework, AI should enhance, rather than undermine, student agency. However, concerns arise that excessive reliance on algorithmic guidance may weaken learners' autonomy and problem-solving capacity, particularly in mathematically demanding topics such as quadratic equations. Preparing students for AI-literate learning environments requires more than technical proficiency; it involves cultivating the capacity to critically evaluate AI-generated responses from an ethical standpoint. International STEM education scholars recommend multidisciplinary curricula that integrate ethical theory with technical understanding. Research indicates that AI systems lack moral reasoning, empathy, and contextual sensitivity. Studies comparing teacher and AI ethical judgments reveal that AI is unable to fully comprehend situational nuance or human emotion.

Consequently, accountability in AI-assisted educational decision-making must remain clearly assigned to educators. Concerns have also been raised regarding academic integrity. Generative AI tools may facilitate plagiarism and reduce independent reasoning. Empirical studies indicate that AI-generated submissions often evade detection and may receive inflated grades, thereby undermining assessment credibility (Diri & Oladayo, 2025). Moreover, overreliance on AI systems may foster learned helplessness and negatively affect students' academic self-esteem.

1.2. Ethical Application of AI in Teaching Quadratic Equations in Delta State

To ethically integrate AI into the teaching of quadratic equations in Delta State, Nigeria, several key measures are necessary (see Table 1).

AI systems should therefore promote reasoning and conceptual understanding rather than encourage answer copying (Gonzalez-Betanoor et al., 2021).

Table 1. Measures for Integrating AI in Teaching of Quadratic Equations

Ethical Dimension	Key Actions for Delta State
Explainability	AI should explain why an answer is correct rather than merely providing solutions.
Privacy & Security	Use local servers, enforce strong encryption, and minimize data retention.
Fairness & Bias	Train AI systems on diverse Nigerian student datasets and monitor outputs.
Transparency	Provide clear explanations for AI-generated feedback.
Academic Integrity	Combine AI use with supervised assessments and user education.
Equity & Access	Deploy low-bandwidth AI solutions and enable offline functionality (Binns, 2022, Perkins et al., 2024).
Governance	Establish local ethics committees and institutional policy frameworks.
AI Literacy	Integrate AI ethics into teacher education and school curricula.

1.3. Theoretical Review

Self-Determination Theory (SDT), developed by Richard Ryan and Edward Deci in 2000, explains that intrinsic motivation and effective learning are achieved with the satisfaction of three basic psychological needs, which include: autonomy, competence, and relatedness. Within the context of AI-generated responses, SDT highlights several important ethical concerns. Although AI can enhance students' sense of competence by providing instant feedback, its misuse or overdependence may compromise autonomy by replacing critical thinking and weaken relatedness by reducing meaningful teacher-student interactions. The ethical dilemma lies in whether AI tools promote passive reliance, hinder active engagement in solving mathematical problems, and marginalize the educator's role in supporting these psychological needs, which ultimately affects students' deep understanding and internal motivation essential for learning quadratic equations (Ryan & Deci, 2017).

AI-generated responses may serve as a form of digital scaffolding within a learner's ZPD. However, this raises ethical concerns regarding the relevance, quality, and inclusivity of such support. Key questions include: Does the AI deliver contextually and culturally appropriate examples for students in Delta State? Can it adjust to individual learning needs, or does it rely on a generic response that may be overly basic or too complex? Additionally, AI must not replace the nuanced, empathetic, and culturally informed support that human teachers provide, especially in complex areas like quadratic equations. The core ethical consideration is whether AI complements or disrupts the socially mediated learning process crucial for cognitive development (Hao et al., 2024; Schiff, 2021).

However, an AI response can be integrated into a sequence of teaching, such as (see Table 2):

Table 2. Teaching Sequence for Integrating AI Response

Phase	Traditional Activity	AI-Aided Feedback Activity
Before Lesson	Teacher explains concept	AI diagnostic quiz to assess prior knowledge
During Lesson	Students solve problems on board	Students use AI to check steps & get hints
After Lesson	Teacher grades homework	AI provides automated corrective feedback
Revision	Teacher reviews common errors	AI generates personalized retraining questions

(Luckin et al., 2021)

1.4. Self-Efficacy in Mathematics Learning

Self-efficacy can be seen as the learners' beliefs in organizing needed actions for specific performance (Bandura, 1977, 1997). In mathematics education, self-efficacy is regarded as an important psychological factor influencing students' motivation, persistence, engagement, and application of effective strategies. High self-efficacy among mathematics students generally are better prepared to tackle difficult tasks, persevere through challenges, and achieve stronger academic outcomes, while also experiencing lower levels of mathematics anxiety (Schunk & Zimmerman, 2012).

Recent studies further support these findings. A scoping review by Street et al. (2024) and Yang et al. (2024) found that mathematics self-efficacy consistently promotes deeper engagement and resilience, with important implications for sustained participation in STEM-related fields. Furthermore, recent research has shown that a relationship exists between perceived teacher and students' mathematics feedback

in literacy, emphasizing its importance in helping learners effectively interpret and apply instructional feedback (Henkel et al., 2024).

1.5. Differences in Gender in Mathematics Education

This has been extensively reported both in Nigeria and internationally, making it important to consider the ethical use of AI-generated responses. Amalu (2016), studying students in Benue State, found significant gender differences in attitudes towards mathematics, with such attitudinal variations often mediating performance outcomes. In contrast, Anokye-Poku and Ampadu's (2020) results showed no significant differences between males and females in attitudes among Ghanaian students, although male students outperformed females academically. This suggests that even when attitudes are comparable, performance gaps may persist. Ethically designed AI interventions must therefore be gender-sensitive. Such systems should provide scaffolded solutions that encourage reasoning rather than direct answers, deliver positive and confidence-boosting feedback, and track gender-disaggregated usage and outcomes. Existing literature on stereotype threat indicates that when mathematics is framed through gendered expectations, female students often underperform relative to their actual abilities.

Research also highlights that girls frequently exhibit lower self-efficacy in STEM subjects despite comparable achievement levels, implying that confidence rather than competence often drives gendered performance outcomes. Studies conducted in Nigeria present mixed findings. Udonsa (2015) in Adamawa State observed that gender-based performance differences diminish when effort and contextual variables are considered. Agbadobi (2023) reported higher male performance on WAEC-style statistics items in Delta State, while Ehindero et al. (2010) identified a significant male advantage in rural Cross River State. Collectively, these studies suggest that gender effects on mathematics achievement in Nigeria are complex and context-dependent. In Delta State, AI tools that provide instant solutions to quadratic equations may inadvertently reinforce existing gender biases. Female students who are more vulnerable to stereotype threat may lose valuable opportunities for confidence-building through problem-solving struggles, potentially widening gaps in performance and self-efficacy despite the AI system's intended neutrality. Gender disparities in mathematics education in Nigeria reflect a complex interaction of performance differences, attitudes, self-efficacy, and stereotype threat.

1.6. Gaps in Existing Research

Some of the reviewed literature is of foreign origin; some is of African origin. Mainly senior classes were used; the instruments used were mainly questionnaires and achievement tests. The analyses produced similar results that show that mathematics self-efficacy consistently predicts deeper engagement and resilience, among others. The current study is therefore one of the research studies of Nigerian origin to complement the existing literature in the Ughelli North Local Government Area of Delta State, Nigeria. The study can be carried out using junior classes in other LGAs or in the same LGA. In other states in Nigeria. It outlines how AI tools can support teaching quadratic equations in Delta State, but emphasizes that infrastructure, ethics, critical engagement, and teacher-led guidance are essential to ensure achievement and fairness.

1.7. Statement of the Problem

In 2021, the Mathematics and Physics Panel of the Science Teachers' Association of Nigeria (STAN) conducted a nationwide survey that reported that mathematics teachers in secondary schools consider several concepts difficult to teach and learn. Among these concepts, quadratic equations are particularly challenging for students, and this difficulty negatively affects their academic achievement. Low performance and high failure rates in external examinations have therefore become a major societal concern (Diri & Ogiga, 2025). Formative feedback is essential in developing students' problem-solving abilities and building their confidence, recognized as a key determinant of academic success (Bandura, 1997). Although AI systems can provide immediate and consistent feedback, their influence on students' confidence and self-belief is still not fully understood. Given these concerns, this study seeks to address the question: What

ethical effects do AI-generated responses have on mathematics students' achievement and self-efficacy? The research is founded on this premise.

1.8. Aim and Objectives

This study is designed to assess the influence of responses generated by AI on mathematics students' achievement and self-efficacy in Ughelli North LGA, Delta State, Nigeria.

The study aims:

1. To examine the mean achievement scores of students taught mathematics using AI-generated responses compared with those taught through traditional responses.
2. To examine the ways in which AI-generated responses influence the self-efficacy of students in solving mathematics.
3. To examine the mean difference in the achievement scores of students taught mathematics using AI-generated responses with respect to gender.

1.9. Research Question

1. What is the mean achievement score of students taught mathematics using AI-generated responses compared to those taught through traditional responses?
2. In what ways do AI-generated responses influence the self-efficacy of students in solving quadratic equations?
3. What is the mean difference in the achievement score between students taught mathematics using AI-generated responses with respect to gender?

1.10. Hypotheses

H₀₁: No significant difference exists between the mean achievement scores of students taught mathematics using AI-generated responses and those taught traditional responses.

H₀₂: No significant difference exists among the mean self-efficacy scores of students taught mathematics using AI-generated responses with respect to gender.

H₀₃: No significant difference exists among the mean achievement scores of students taught mathematics using AI-generated responses with respect to gender.

2. RESEARCH METHODS

2.1. Research Design

A quasi-experimental design was used to examine the cause-and-effect relationships, using intact classes that were randomly assigned to the experimental or control groups. It was chosen because it was appropriate for investigating the cause-and-effect relationship of the study. To manipulate one variable, the independent variable (AI-generated responses), to see its effect on the dependent variable (students' achievement).

2.2. Participants

The study population comprises 1,369 students in SS1 in Ughelli North Local Government Area of Delta State. Only co-educational schools were included in the study, while single-sex schools were excluded. 115 students were selected from two randomly chosen co-educational schools using the ballot system. Of these, 62 students (43 males and 19 females) constituted the experimental group, while 53 students (34 males and 19 females) constituted the control group. (The researchers folded two papers, and the 2 class

prefects of the two intact classes picked one each of the folded papers, written “Experimental Group” and “Control Group.” Each student picked was used for the class. Prior to the commencement of the teaching, the researchers obtained permission from the principal of the schools involved, contacted the teachers to be involved, and briefed them on the research procedures. All respondents willingly gave consent for the research. No one was forced. The teachers were trained on how AI responses work, and they were trained on how to guide the students using AI responses (using ChatGPT from their phones). Only SSSI students with an average age of 16 years, who were taught mathematics at the same level by their teachers in their respective schools, were involved. The experimental group received instruction supplemented with an AI-generated response. AI response in SSS1 quadratic lessons was implemented by giving timely, personalized explanations that helped students to learn from their mistakes, build their understanding step-by-step, and engage in tailored practice. The ethical impacts are measured through how this response affects achievement, student autonomy, integrity, and equitable learning in Delta State. Top of Form AI response was implemented at various stages in solving the sample equations given in the body of the introduction. Sample questions were given and solved; students were guided to input in ChatGPT through their phones to get responses on the errors they committed. The control group received instruction with conventional methods involving the use of the chalkboard and teacher-centered instruction.

The experiment lasted for 6 weeks, as captured below:

Week 1: Before the treatments, administration of a pretest was administered to ascertain their residual knowledge, and the scripts were collected and marked.

Week 2-5: Both groups were taught the quadratic equation topic for three weeks using their respective methods. AI-generated response for the experimental group, where students were given questions and used their phones to get responses, and traditional instruction for the control group.

Week 6: Following the treatment, both groups were given the achievement test and questionnaire, after which the researchers collected and graded the tests based on a predetermined marking scheme.

2.3. Sample Questions

How AI response works in a Quadratic Equation Lesson

For SSS1 students learning the standard quadratic equation:

$$ax^2 + bx + c = 0 = ax^2 + bx + c = 0$$

AI feedback was implemented at various stages in solving the sample equation.

Example of AI response in practice (Example)

Diagnostic Entry Task One: Student Input

“I solved $x^2 - 3x + 2 = 0$ $x^2 - 3x + 2 = 0$ $x^2 - 3x + 2 = 0$ but got the wrong answer.”

AI Response:

1. Step Analysis

“Check how you factored the expression. Did you find two numbers multiplying to +2 and adding to -3?”

2. Error Identification

“Your substitute step went from $(x-1)(x-2)(x-1)(x-2)$ to wrong roots.”

3. Guided Hint

“Try setting each factor to zero: $x-1=0$ $x-1=0$ $x-1=0$, and $x-2=0$ $x-2=0$ $x-2=0$.”

4. Encouragement

“Good attempt, you’re close! Keep trying.”

Diagnostic Entry Task Two

Step by Step:

- i. Students attempted a simple quadratic problem (e.g., solve $2x^2 + 5x + 3 = 0$)
- ii. AI analyzes the student's steps. and
- iii. It immediately gives feedback such as: (a) "You made an arithmetic error in combining like terms." (b) "Good! You correctly identified the coefficients $a=2$, $b=5$, $c=3$."

Benefit

Students were made to know exactly where they made a mistake rather than just "wrong."

2.4. Data Collection and Analysis

A teacher-developed achievement test known as the "Quadratic Equation Achievement Test (QEAT)" and a questionnaire for students titled "Students' Questionnaire on the Ethical Impact of AI-Generated Responses on Students' Achievement and Self-Efficacy in Solving Quadratic Equations" (SQEIAIGRASQ) were used for the collection of data. The QEAT comprised two sections: Section A to gather biodata, while Section B contained 25 objective questions, each worth 4 marks, totaling 100 marks. The test content aligned with the SSS I mathematics syllabus, focusing on quadratic equations to assess students' achievement. The questionnaire, which comprised 5 items, used a four-point Likert scale (Strongly Agree, Agree, Disagree, Strongly Disagree), scored as 4, 3, 2, and 1, respectively. A mean criterion score of 2.50 and above was acceptable, while a score below 2.50 was unacceptable. Face validity and content validity were confirmed by 2 experts: a mathematics teacher and a measurement and evaluation expert confirmed the instruments. The corrections they made were duly effected. Content validity was ensured by constructing the test using a table of specifications. Reliability was assessed through a test-retest method with 20 randomly selected SSS I students from schools outside the sample, yielding reliability coefficients of 0.79 for the QEAT and 0.76 for the questionnaire and the test, respectively. The research questions were answered using means and standard deviations, while independent-samples *t*-tests were used for the null hypotheses at 0.05 significance level using SPSS V25.

3. RESULTS

Research Question 1: What is the mean achievement score of students taught mathematics using AI-generated responses compared to those taught through traditional responses?

Table 3. Mean and Standard Deviation of Students Taught Mathematics Using AI-Generated Response to Those Taught Using Traditional Responses (Posttest)

Group	N	X	SD	Mean Gain
Experimental	62	29.18	4.36	5.12
Control	53	24.06	2.75	

Table 3 shows that students in the experimental group taught using AI-generated responses recorded a mean score of 29.18, while those in the control group obtained a mean score of 24.06. This reflects a mean gain of 5.12, indicating improved performance among the experimental group.

H₀₁: No significant difference between the mean achievement scores of students taught mathematics using AI-generated response to those taught using traditional responses.

In Table 4, $t(113) = 7.38$ is significant at $p = .000$, which is also significant at the 0.05 level of significance. Consequently, we reject the null hypothesis, showing a significant difference between the mean scores of students in the experimental group.

Table 4. Summary of T-Test Analysis of Students Taught Mathematics Using AI-Generated Response Compared to Those Taught Using Traditional Response

Group	N	Mean	SD	Df	t	Sig(2tailed)	Decision
Experimental	62	29.18	4.36	113	7.38	.000	S
Control	53	24.06	2.75				

Research Question 2: In what ways do AI-generated responses influence the self-efficacy of students in solving mathematics?

Table 5. Mean and Standard Deviation of the Influence of AI-Generated Responses on the Self-Efficacy of Students in Solving Mathematics (N=115)

S/N	Items	Mean	SD	Remark
1	I enjoy using an AI-generated response	2.55	1.04	A
2	Using an AI-generated response boosts my marks	2.67	1.12	A
3	I am encouraged by my teacher to use an AI-generated response	2.74	1.06	A
4	AI-generated response discourages and misleads me	2.36	1.15	D
5	I still have confidence in myself because using AI-generated responses boosts my self-esteem	2.73	1.13	A
	Grand mean	2.61	1.1	A

In Table 5, students agreed with items 1, 2, 3, and 5, which recorded mean ratings ranging from 2.50 to 3.49, specifically 2.55, 2.67, 2.74, and 2.73, respectively. However, students disagreed with item 4, which had a mean rating of 2.36, falling within the 1.50 to 2.49 range. A total mean score of 2.61 indicates that AI-generated responses influence the self-efficacy of students in solving mathematics.

H₀₂: No significant difference exists among the mean achievement scores of self-efficacy possessed by students taught mathematics with respect to gender.

Table 6. Independent Sample T-Test Analysis of the Mean Achievement Scores of Self-Efficacy Possessed Students Taught Mathematics with Respect to Gender

Group	N	Mean	SD	Df	t	Sig(2tailed)	Decision
Male	43	2.47	0.47	60	0.08	.94	NS
Female	19	2.54	0.49				

In Table 6, $t(60) = 0.08$ is not significant at $p = .94$, and this is also not significant at the 0.05 level of significance. Thus, we fail to reject the null hypothesis, which shows that there is no significant difference between the mean self-efficacy scores of students taught mathematics with respect to gender.

Research Question 3: What is the difference in the mean achievement score between students taught mathematics using AI-generated responses with respect to gender?

Table 7. Mean and Standard Deviation of Students Taught Mathematics with Respect to Gender (Posttest)

Group	N	X	SD	Mean diff
Male	43	30.95	3.95	5.79
Female	19	25.16	1.89	

The results in Table 7 show that male students taught quadratic equations using AI-generated responses achieved a slightly higher mean score than their female counterparts, with mean values of 30.95 ± 3.95 for males and 25.16 ± 1.89 for females. The mean difference of 5.79 indicates better performance among the male students.

H₀₃: No significant difference between the mean scores of students taught mathematics with respect to gender.

Table 8. Independent Sample T-Test Analysis of the Mean Achievement Scores of Students Taught Mathematics with Respect to Gender

Group	N	Mean	SD	Df	t	Sig(2tailed)	Decision
Male	43	30.95	3.95	60	6.08	.00	S
Female	19	25.16	1.89				

In Table 8, $t(60) = 6.08$ is significant at $p = .00$, which is also significant at the 0.05 level of significance. Consequently, we fail to reject the null hypothesis, reflecting a significant difference between the mean scores of male and female students taught mathematics using AI-generated responses.

4. DISCUSSION

The findings indicate that students taught with AI-generated responses outperformed those who were not. This significant difference suggests a positive impact of AI-generated responses on student performance. These results align with previous studies by Bond et al. (2020) and Ogoke (2025), whose results reported beneficial effects of AI responses on mathematics learning. Additionally, the AI-generated responses demonstrated high ethical standards in terms of self-efficacy, as students enjoy using AI-generated responses, boost their marks, get encouragement from their mathematics teacher, and have confidence in themselves, boosting their self-esteem. This echoes the findings from Diri and Oladayo (2025) reporting that AI-generated responses positively affect students' self-efficacy in quadratic equations. Furthermore, there was no significant difference in self-efficacy between male and female students who were taught quadratic equations using AI-generated responses. This is in line with Agbadobi (2023) and Udonsa (2015), who observed that gender-based performance differences diminish when effort and contextual variables are considered, highlighting that girls frequently exhibit lower self-efficacy in STEM subjects despite comparable achievement levels, implying that confidence rather than competence often drives gendered performance outcomes. The study further explored gender differences in response to an AI-generated response. According to the findings, male students who were instructed using AI-generated responses outperformed female students, with a notable achievement gap between the sexes. This implies that male students showed more involvement in the teaching and learning of AI response tools. This conforms with Ehindero et al. (2010), who observed generally higher mathematics performance among males, and Oladayo (2025), who reported notable gender disparities favoring males in academic outcomes. This result is not consistent with the study of Anokye Poku and Ampadu (2020), which found that there were no discernible gender disparities in the attitudes among Ghanaian learners, although male students outperformed females academically, suggesting that even when attitudes are comparable, performance gaps may persist. The practical implication is that students should be given more opportunities to explore AI-generated tools to output feedback that helps solve complex mathematics problems.

5. CONCLUSION AND LIMITATION OF THE STUDY

AI-generated responses were found to be more effective than traditional teaching methods, as they significantly improved students' self-efficacy in mathematics. However, the study also revealed that male and female students performed noticeably differently, with males scoring better than females. In order to guarantee that AI-generated solutions enhance learning outcomes while avoiding harm and stopping the reinforcement of current disparities, it is imperative to address these ethical issues. Overall, the analysis confirmed that AI-generated responses were more effective than conventional instructional methods. In addition, a clear gender disparity was observed.

However, the generalizability of these findings is limited by certain constraints. The sample size was relatively small, and the researchers faced challenges in accessing many schools due to financial and time limitations, which restricted the number of schools included in the study. Furthermore, the study was limited to Delta State's Ughelli North Local Government Area, which may have influenced the data

collected and the conclusions drawn. In addition, because of the brief study period, the topic was restricted to mathematical quadratic equations.

6. RECOMMENDATIONS

The following recommendations were made based on the findings:

1. While using and applying AI-generated responses, students should be encouraged to follow ethical guidelines.
2. The government ought to create and put into effect regulations that facilitate the incorporation of AI-generated solutions into secondary school teaching and learning procedures.
3. It is important to support secondary school math teachers in incorporating AI-generated answers into their lesson plans, particularly when instructing complex subjects like quadratic equations. Students' academic performance can be enhanced by this method, which also makes learning more dynamic and interesting.
4. Curriculum developers should work on the secondary school mathematics curriculum and review it to reflect AI-generated response tools as recommended teaching strategies.

7. SUGGESTIONS FOR FUTURE RESEARCH

Based on the findings of this study, the researchers hereby make the following suggestions for further research.

1. Gender-Based Analysis of AI Feedback in Mathematics

Future studies should investigate how Delta State students, both male and female, perceive and react to AI-generated help with quadratic problems. This could reveal if AI systems unintentionally reinforce gender stereotypes or affect confidence levels differently.

2. Longitudinal Study on Self-Efficacy and Dependency

Conduct long-term research on how continuous use of AI tools influences students' self-efficacy, problem-solving autonomy, and cognitive development. This would help evaluate whether students become reliant on AI or develop stronger independent reasoning skills.

3. Cultural and Ethical Contextualization of AI Tools

Researchers should explore how local socio-cultural values, language, and ethical norms in Imo State affect students' acceptance and ethical interpretation of AI-generated responses. This could guide the design of culturally sensitive and locally relevant AI solutions.

4. Assessment of Algorithmic Fairness in Low-Resource Settings

Future work should assess whether AI systems used in secondary schools equitably support students from varying socio-economic backgrounds, particularly in under-resourced schools across rural parts of Imo State.

5. Impact of AI on Mathematics Teaching Pedagogy

Investigate how the integration of AI-generated responses affects teachers' instructional strategies, professional roles, and ethical responsibilities. This will help develop guidelines that balance human facilitation and AI support in mathematics education.

Current research gaps will be bridged by these areas and guarantee that AI in education is applied in a way that is morally, fairly, and successfully for every student in Delta State.

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Author Contributions. Oladayo: Conceptualization, methodology, validation, original draft, writing - review & editing, resources, visualization, supervision, funding acquisition. Diri: Software, formal analysis, investigation, data curation, project administration.

AI Statement. We used the AI tool [ChatGPT] through their phones to get responses on the errors they committed, comparing responses gotten from ChatGPT and conventional classroom solutions. After using this AI tool, we reviewed and verified the final version of our work. We take full responsibility for the content of our published work.

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