ASEAN Journal for Science Education

Journal homepage: https://ejournal.bumipublikasinusantara.id/index.php/ajsed

Integrating Artificial Intelligence (AI) in Mathematics Education: Enhancing Students' Interest and Achievement through Adaptive Learning Systems

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ABSTRACT

This study investigates the integration of Artificial Intelligence (AI) into mathematics education as a scientific approach to enhancing students' interest and achievement in Enugu State, Nigeria. A quasi-experimental design with pre-test and post-test control groups was employed, involving 200 secondary school students. AI-based tools, including adaptive learning systems and intelligent tutoring programs, were used to personalize instruction and provide real-time feedback. Results from paired and independent t-tests revealed significant improvements in students' interest and performance compared to traditional methods. The increase in engagement occurred because AI adjusted to individual learning paces, thereby reducing anxiety and promoting conceptual understanding. The study concludes that AI integration enhances mathematics learning through data-driven personalization and cognitive support, suggesting its potential as a transformative tool in science and mathematics education aligned with global educational technology standards.

ARTICLE INFO

Article History:
Submitted/Received 22 Jul 2025
First Revised 25 Aug 2025
Accepted 27 Oct 2025
First Available online 28 Oct 2025
Publication Date 01 Mar 2026

Keyword:
Artificial intelligence,
Educational technology,
Enugu state,
Mathematics education,
Student engagement.

1. INTRODUCTION

Mathematics is the cornerstone of science and technology education, forming the foundation for analytical reasoning, problem-solving, and innovation (Albrecht & Oppenheim, 2024; Glover & Xu, 2024). Despite its central role, many students continue to view mathematics as abstract and difficult, resulting in low interest and poor academic achievement (Hernandez & Perez, 2024). In Nigeria, particularly in Enugu State, this problem is persistent, as students often find it challenging to relate mathematical concepts to real-world applications (Khosravi & Shahbazi, 2023; Mensah & Asamoah, 2023). This situation threatens the development of a scientifically literate generation capable of contributing to the national STEM agenda and Sustainable Development Goal 4 (SDG 4) on quality education.

Traditional approaches to teaching mathematics (characterized by rote memorization and teacher-centered instruction) fail to accommodate diverse learning needs (Kadir & Munir, 2024; Liu & Li, 2024). Such limitations contribute to disengagement and hinder students' ability to develop conceptual understanding. Consequently, there is a growing demand for scientific innovations in education that can transform the teaching and learning of mathematics into a more interactive and personalized experience.

Artificial Intelligence (AI) has emerged as a transformative tool in this regard. AI-based educational systems such as adaptive learning platforms and intelligent tutoring systems provide personalized pathways that adjust to students' cognitive progress and individual learning paces (Andersson & Gustafsson, 2023; Boyd & Knight, 2023). These systems generate real-time feedback and gamified learning experiences that enhance motivation and self-regulated learning (Aydin, 2023; Nikolaidou, 2023). Globally, AI has been recognized as a catalyst for promoting deeper engagement and improved performance in mathematics education (Dimitriadis & Ioannou, 2024; Elakkiya & Subramani, 2024). However, empirical evidence from Nigerian contexts remains scarce, especially concerning secondary school learners.

Therefore, this study aims to investigate the effect of Artificial Intelligence in improving students' interest and achievement in mathematics in Enugu State, Nigeria. The novelty of this study lies in integrating AI-based systems into classroom instruction as a data-driven approach to enhance conceptual understanding and engagement in mathematics. The study contributes to the growing discourse on how technology-enhanced learning aligns with the broader goals of science education and sustainable development.

Research questions are in the following:

(i) To what extent does the use of Artificial Intelligence (AI) tools influence students' interest and engagement in mathematics in Enugu State?

(ii) How does AI-based learning compare to traditional teaching methods in improving students' attitudes and performance in mathematics in Enugu State?

Research hypotheses are in the following:

(i) H_{o1}: There will be no significant positive effect of Artificial Intelligence (AI)-based learning tools on students' interest in mathematics in Enugu State.

(ii) H_{o2}: Students exposed to AI-based learning methods will not show significantly higher engagement and improved academic performance in mathematics compared to those taught using traditional teaching methods in Enugu State.

2. METHODS

This study employed a quasi-experimental design involving pre-test and post-test control groups to determine the effect of Artificial Intelligence (AI) on students' interest and

achievement in mathematics. This design was appropriate because random assignment was not feasible in the school setting, yet comparison between experimental and control groups allowed for reliable causal inference (Arthur & Quinn, 2023). The intervention involved integrating AI-powered learning tools into mathematics instruction for the experimental group, while the control group continued with traditional teacher-led instruction.

The population consisted of secondary school students in Enugu State, Nigeria. Using a stratified random sampling technique, 200 students were selected from four secondary schools, ensuring equal representation from public and private institutions. Participants were divided into two groups: the experimental group (n = 100), which used AI-based tools, and the control group (n = 100), which received conventional instruction. This stratification ensured demographic diversity and minimized sampling bias (Hernandez & Perez, 2024).

Two validated instruments were used for data collection:

(i) Mathematics Interest Questionnaire (MIQ): designed to measure students' interest, motivation, and attitudes toward mathematics using a five-point Likert scale.
(ii) Mathematics Achievement Test (MAT): a standardized test assessing students' performance across key curriculum topics.

Both instruments underwent expert validation for content and construct alignment (Kaur & Singh, 2023). A pilot test conducted on 20 students yielded Cronbach's alpha coefficients of 0.70 (MIQ) and 0.76 (MAT), indicating satisfactory reliability and internal consistency (Costa & Silva, 2023).

Data collection was carried out over six weeks. In the first week, both groups completed the pre-test (MIQ and MAT) to establish baseline data. The experimental group was then introduced to AI-driven platforms, including adaptive learning systems and intelligent tutoring software, which provided personalized tasks and real-time feedback. Students interacted with these tools for 90-minute sessions each week under teacher supervision. The control group continued learning mathematics through face-to-face lectures and textbook-based exercises. At the end of the sixth week, both groups completed the post-test.

Collected data were analyzed using SPSS version 23. Descriptive statistics (mean, standard deviation) summarized students' interest and achievement levels, while inferential statistics tested the research hypotheses.

(i) A paired-sample t-test compared pre-test and post-test results within groups to evaluate changes in students' interest and performance.
(ii) An independent-sample t-test compared post-test results between experimental and control groups.

The significance level was set at $p < 0.05$, ensuring statistical validity and reliability. Findings were presented in tables and interpreted with respect to existing literature in mathematics and science education.

3. RESULTS AND DISCUSSION

Results were drawn from complementary quantitative and qualitative evidence gathered from students and teachers in Enugu State, examining the impact of Artificial Intelligence (AI) on students' interest in mathematics. Two hundred students from four secondary schools participated. Using a pre-test/post-test design, we measured changes in mathematics interest before and after exposure to AI-based learning tools. In addition, interviews with students and teachers provided qualitative insights into classroom implementation and perceived effects of AI integration.

3.1. Research Question 1: To what extent does the Use of Artificial Intelligence (AI) Tools Influence Students' Interest and Engagement in Mathematics in Enugu State?

To address this research question, a paired-sample t-test was performed to compare students' levels of interest in mathematics before and after the implementation of AI-based learning tools. The statistical results are summarized in **Table 1**. The results show a statistically significant improvement in students' interest in mathematics following the introduction of AI-based tools ($t = -15.23$, $p < 0.001$). The mean score increased from 2.45 in the pre-test to 4.10 in the post-test, indicating a marked enhancement in engagement and motivation toward mathematics. This finding supports the research hypothesis that the integration of AI tools can effectively increase students' interest in mathematics by creating more interactive and personalized learning experiences.

Table 1. Paired sample t-test results for students' interest in mathematics.

Measurement	Mean (Pre-test)	Mean (Post-test)	Standard Deviation	t-value	p-value
Student Interest	2.45	4.10	0.86	-15.23	0.000

3.2. Research Question 2: How does AI-based Learning Compare to Traditional Teaching Methods in Terms of Improving Students' Attitudes and Performance in Mathematics in Enugu State?

To further investigate this relationship, an independent-sample t-test was conducted to compare the academic performance of students who used AI-based learning tools with those who did not. The results are presented in **Table 2**. The analysis reveals a statistically significant difference in academic performance between students who used AI-based tools and those who received traditional instruction ($t = 5.72$, $p < 0.001$). The AI group achieved a higher mean score (78.4) than the control group (65.2), demonstrating that AI-supported instruction not only enhances students' interest but also contributes to improved learning outcomes. This finding corroborates previous research emphasizing the effectiveness of AI-assisted learning environments in fostering deeper conceptual understanding and sustained academic achievement in mathematics (Chinwe & Onuoha, 2024; Goh & Seah, 2023).

Table 2. Independent sample t-test results for academic performance in mathematics.

Group	Mean (AI Group)	Mean (Control Group)	Standard Deviation	t-value	p-value
Academic Performance	78.4	65.2	10.45	5.72	0.000

3.3. Hypothesis One (H_{01})

There will be no significant positive effect of Artificial Intelligence (AI)-based learning tools on students' interest in mathematics in Enugu State.

The results from the paired-sample t-test for Research Question 1 ($t = -15.23$, $p < 0.001$) indicate that Hypothesis 1 is rejected. The data reveal a significant increase in students' interest in mathematics following exposure to AI-based learning tools. This demonstrates that AI applications significantly enhance students' engagement, motivation, and attitudes toward mathematics.

3.4. Hypothesis Two (H_{o2})

Students exposed to AI-based learning methods will not show significantly higher levels of engagement and improved academic performance in mathematics compared to those taught using traditional teaching methods in Enugu State.

The independent-sample t-test for Research Question 2 ($t = 5.72$, $p < 0.001$) shows that Hypothesis 2 is rejected. The findings reveal that students who learned with AI-based tools achieved significantly better academic performance than those who did not. This provides empirical evidence that AI integration enhances both engagement and academic achievement in mathematics learning.

3.5. Discussion

The results of this study highlight the positive impact of AI on improving students' interest, engagement, and performance in mathematics within Enugu State. Students exposed to AI-based learning tools demonstrated greater motivation, enthusiasm, and a deeper understanding of mathematical concepts compared to their counterparts in traditional classrooms. These findings align with previous research (Jones, 2023; Kaur and Singh, 2023; Wilson, 2023; Zhao and Yao, 2024), which collectively emphasize the transformative role of AI in enhancing students' attitudes toward learning.

AI's adaptive and personalized learning capabilities appear to play a key role in reducing students' perceived difficulty with mathematics, making lessons more accessible and interactive. By providing real-time feedback and individualized learning paths, AI tools help bridge cognitive gaps and sustain student interest (Naseer & Khawaja, 2025; Halkiopoulos & Gkintoni, 2024; Strielkowski et al., 2025). These results corroborate earlier findings (Chinwe and Onuoha, 2024), who reported that AI integration fosters deeper engagement and improved academic outcomes through personalized pedagogical interventions.

However, despite these promising results, the study acknowledges several contextual challenges that could affect the large-scale implementation of AI in Nigerian schools. Constraints such as limited technological resources, inadequate digital infrastructure, and insufficient teacher training pose significant barriers to equitable adoption. While the experimental group benefited from AI-based tools, the sustainability and scalability of such interventions require systemic support.

Future research should therefore explore strategies to overcome these challenges, focusing on capacity building for teachers, infrastructure development, and policy integration to ensure equitable access to AI-driven learning environments. Addressing these issues will be critical to realizing the full potential of AI in promoting quality, inclusive, and technology-driven education, in line with Sustainable Development Goal 4 (SDG 4).

4. CONCLUSION

This study demonstrated that the integration of Artificial Intelligence (AI) tools significantly enhances students' interest and academic performance in mathematics. The results from both the paired-sample and independent-sample t-tests confirmed that AI-based learning environments promote deeper engagement, motivation, and understanding of mathematical concepts among secondary school students in Enugu State. These findings affirm that AI can serve as an effective pedagogical innovation in science and mathematics education, particularly when used to personalize learning and provide adaptive feedback. However, sustainable implementation will require adequate infrastructure, teacher training, and

institutional support to ensure equitable access to AI-driven education. Based on the findings, the following recommendations are proposed:

(i) Integration into Curriculum: The Federal Ministry of Education should incorporate AI-based learning platforms into the mathematics curriculum to enhance interest and achievement.
(ii) Teacher Capacity Building: Regular professional development programs should be provided to equip teachers with the skills needed to implement AI-assisted instruction effectively.
(iii) Infrastructure Development: Schools should be supported with the necessary technological infrastructure (such as reliable internet connectivity, digital devices, and power supply) to sustain AI-based learning.
(iv) Policy and Collaboration: Policymakers should promote collaboration between educational institutions and technology developers to design context-appropriate AI learning tools.
(v) Future Research: Further studies should examine the long-term impact of AI on learning motivation and conceptual understanding across other STEM subjects, as well as strategies to reduce equity gaps in AI adoption.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

6. REFERENCES

Albrecht, T., and Oppenheim, J. (2024). Mathematics as a foundation for scientific reasoning and technological innovation. *Journal of Science and Education Research, 18*(2), 45–58.

Andersson, K., and Gustafsson, P. (2023). Adaptive learning systems and artificial intelligence in mathematics education. *Computers & Education, 195*, 104683.

Arthur, L., and Quinn, D. (2023). Experimental and quasi-experimental approaches in educational technology research. *Educational Research Methods, 42*(1), 72–90.

Aydin, M. (2023). Gamified artificial intelligence in mathematics classrooms: Enhancing student motivation and engagement. *International Journal of STEM Education, 10*(1), 1–14.

Boyd, T., and Knight, S. (2023). Data-driven personalization in mathematics learning environments. *Journal of Learning Analytics, 10*(3), 25–41.

Chinwe, A., and Onuoha, P. (2024). Artificial intelligence integration in secondary school mathematics: A Nigerian perspective. *African Journal of Educational Technology, 8*(1), 55–68.

Costa, E., and Silva, F. (2023). Reliability and validity in educational measurement tools: Best practices and challenges. *Measurement in Education Journal, 31*(4), 201–216.

Dimitriadis, G., and Ioannou, A. (2024). Artificial intelligence as a catalyst for mathematics learning transformation. *International Journal of Educational Technology in Higher Education, 21*(2), 112–130.

Elakkiya, R., and Subramani, P. (2024). Artificial intelligence and adaptive feedback systems in STEM education: A systematic review. *Education and Information Technologies, 29*(5), 2341–2359.

Glover, J., and Xu, L. (2024). Scientific literacy and mathematics reasoning in secondary education. *International Journal of Science Education, 46*(1), 80–95.

Halkiopoulos, C., and Gkintoni, E. (2024). Leveraging AI in e-learning: Personalized learning and adaptive assessment through cognitive neuropsychology—A systematic analysis. *Electronics*, *13*(18), 3762.

Hernandez, L., and Perez, M. (2024). Barriers to student engagement in mathematics learning in Sub-Saharan Africa. *Journal of Educational Research in Developing Countries, 9*(2), 117–132.

Ismail, M., and Ranjan, K. (2024). AI-based mathematics education in Nigerian secondary schools: Opportunities and challenges. *Journal of Digital Education Studies, 7*(1), 1–12.

Jones, H. (2023). Exploring student motivation and engagement in AI-supported mathematics learning environments. *Journal of Educational Psychology, 115*(3), 405–420.

Kadir, R., and Munir, M. (2024). Challenges of traditional mathematics teaching and transition to digital pedagogy. *Journal of Mathematics Education and Practice, 14*(2), 90–105.

Kaur, P., and Singh, R. (2023). Integrating AI tools for enhancing student motivation in STEM education. *Journal of Science and Technology Education, 28*(4), 412–429.

Khosravi, S., and Shahbazi, F. (2023). Students' perceptions of mathematics difficulty and the role of learning technologies. *Eurasia Journal of Mathematics, Science and Technology Education, 19*(6), 101–115.

Liu, J., and Li, H. (2024). Differentiated instruction through artificial intelligence in mathematics classrooms. *Computers in Human Behavior, 150*, 107156.

Mensah, P., and Asamoah, S. (2023). Improving mathematics interest through technology-enhanced instruction in West Africa. *African Journal of Pedagogical Research, 11*(3), 223–239.

Naseer, F., and Khawaja, S. (2025). Mitigating conceptual learning gaps in mixed-ability classrooms: A learning analytics-based evaluation of ai-driven adaptive feedback for struggling learners. *Applied Sciences*, *15*(8), 4473.

Nikolaidou, M. (2023). AI-driven tutoring and formative feedback in science and mathematics learning. *Journal of Interactive Learning Research, 34*(2), 175–192.

Strielkowski, W., Grebennikova, V., Lisovskiy, A., Rakhimova, G., and Vasileva, T. (2025). AI-driven adaptive learning for sustainable educational transformation. *Sustainable Development*, *33*(2), 1921-1947.

Wilson, D. (2023). Artificial intelligence as an educational innovation: Opportunities for mathematics teaching. *International Journal of Emerging Technologies in Learning, 18*(5), 150–167.

Zhao, X., and Yao, J. (2024). Personalized learning and cognitive engagement through AI in mathematics education. *Journal of Educational Computing Research, 62*(1), 34–49.