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EFFECTS OF AI-ASSISTED LEARNING PLATFORMS ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN MATHEMATICS AND PHYSICS IN NIGERIA.

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Abstract

The integration of Artificial Intelligence (AI) into educational practice has created new opportunities for improving teaching and learning outcomes, particularly in Science, Technology, Engineering, and Mathematics (STEM) education. This study investigated the effects of AI-assisted learning platforms on secondary school students' achievement in Mathematics and Physics in Nigeria. The study adopted a quasi-experimental pretest-posttest control group design involving 300 Senior Secondary School II students selected from public secondary schools across Ogun, Oyo, and Lagos States. Participants were assigned to experimental (n = 150) and control (n = 150) groups. The experimental group received instruction through AI-assisted learning platforms incorporating adaptive learning algorithms, intelligent tutoring systems, automated assessments, and personalized feedback, while the control group was taught using conventional instructional methods. Data were collected using the Mathematics Achievement Test (MAT) and Physics Achievement Test (PAT), with reliability coefficients of 0.87 and 0.84 respectively. Data were analyzed using mean, standard deviation, independent-samples t-test, multiple regression analysis, and Cohen's effect size statistics at the 0.05 level of significance. Findings revealed that students exposed to AI-assisted learning achieved significantly higher scores in Mathematics (M = 78.40, SD = 8.50) and Physics (M = 76.20, SD = 7.90) than their counterparts in the control group (Mathematics: M = 65.10, SD = 9.20; Physics: M = 63.40, SD = 8.70). Independent-samples t-test results indicated significant differences in Mathematics achievement ($t = 12.14$, $p < .05$) and Physics achievement ($t = 11.27$, $p < .05$) in favour of the experimental group. Multiple regression analysis further revealed that AI usage significantly predicted academic achievement ($\beta = 0.57$, $p < .05$), accounting for approximately 32% of the variance in students' performance. Large effect sizes were observed for Mathematics (d = 1.50) and Physics (d = 1.42), indicating substantial educational impact. The study concluded that AI-assisted learning platforms significantly enhance students' achievement in Mathematics and Physics and represent an effective strategy for improving STEM education in Nigerian secondary schools. The study recommends increased investment in AI-enabled educational technologies, teacher capacity development, and digital infrastructure to support effective implementation.

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Keywords: *Artificial Intelligence, AI-assisted learning, Mathematics achievement, Physics achievement, adaptive learning, STEM education.*

Introduction

The rapid advancement of Artificial Intelligence (AI) has significantly transformed educational practices across the globe. AI refers to computer systems capable of performing tasks that typically require human intelligence, including learning, reasoning, problem-solving, decision-making, and language processing. In the educational sector, AI has emerged as a powerful technological innovation with the potential to improve teaching effectiveness, personalize learning experiences, and enhance students' academic outcomes. Educational institutions increasingly utilize AI-assisted learning platforms to support instructional delivery, monitor student progress, provide immediate feedback, and facilitate adaptive learning pathways tailored to individual learners' needs (UNESCO, 2023).

Mathematics and Physics are among the most important subjects in secondary school education because they provide foundational knowledge for science, technology, engineering, and mathematics (STEM) disciplines. These subjects contribute significantly to national technological advancement, economic development, and innovation capacity. In Nigeria, achievement in Mathematics and Physics remains a major concern among educators, policymakers, and stakeholders. Reports from national examinations such as the West African Senior School Certificate Examination (WASSCE) and the National Examination Council (NECO) indicate that many students continue to perform below expectations in these subjects. The persistent underachievement has been attributed to factors such as inadequate instructional resources, teacher-centered pedagogical approaches, poor student motivation, insufficient practical exposure, and limited opportunities for individualized learning (Adebayo & Yusuf, 2023).

The challenges associated with Mathematics and Physics education are particularly significant because these subjects are often perceived as difficult by students. Many learners struggle with abstract concepts, complex calculations, and problem-solving tasks. Traditional instructional methods frequently emphasize memorization and procedural learning rather than conceptual understanding. Consequently, students may develop anxiety, low self-efficacy, and negative attitudes toward these subjects. Such challenges necessitate the exploration of innovative instructional strategies capable of improving student engagement and academic achievement.

AI-assisted learning platforms offer promising solutions to many of these challenges. Through adaptive learning technologies, students can receive personalized instructional experiences that accommodate their learning pace, preferences, and abilities. Intelligent tutoring systems provide real-time feedback, identify misconceptions, and guide learners through structured problem-solving processes. These capabilities support active learning and enable students to develop deeper conceptual understanding. Furthermore, AI-powered educational systems can generate learning analytics that assist teachers in monitoring student performance and implementing targeted interventions (Chen et al., 2020).

This study addresses this gap by examining the effects of AI-assisted learning platforms on secondary school students' achievement in Mathematics and Physics in Nigeria. By generating empirical evidence on the effectiveness of AI-supported instruction, the study contributes to the growing body of literature on educational technology integration and STEM education improvement. The findings are expected to provide valuable insights for policymakers, curriculum

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developers, school administrators, teachers, and educational technology developers seeking to enhance educational outcomes through innovative instructional app.

Statement of the Problem

Persistent underachievement in Mathematics and Physics continues to affect secondary school students across many regions of Nigeria. Conventional teaching approaches frequently struggle to accommodate diverse learning needs, resulting in uneven academic outcomes. Although AI-assisted learning has demonstrated promise internationally, empirical evidence within the Nigerian secondary school context remains limited. This study addresses that gap.

Objectives of the Study

1. Determine the effect of AI-assisted learning on Mathematics achievement.
2. Examine the effect of AI-assisted learning on Physics achievement.
3. Compare achievement outcomes between experimental and control groups.
4. Assess the predictive contribution of AI usage to academic performance.

Research Hypotheses

H_{01}: No significant difference exists in Mathematics achievement between experimental and control groups.

H_{02}: No significant difference exists in Physics achievement between experimental and control groups.

H_{03}: AI-assisted learning platform does not significantly predict students' academic achievement in Mathematics and Physics.

Literature Review

Concept of Artificial Intelligence in Education

Artificial Intelligence has become one of the most influential technological innovations shaping modern education. AI in education refers to the application of intelligent computer systems capable of performing educational functions such as assessment, tutoring, feedback generation, adaptive content delivery, and learning analytics. According to UNESCO (2023), AI technologies can facilitate more inclusive, equitable, and personalized learning experiences while supporting teachers in instructional decision-making.

Educational AI systems encompass a wide range of technologies, including intelligent tutoring systems, adaptive learning platforms, chatbots, virtual assistants, automated assessment tools, and predictive analytics systems. These technologies utilize data-driven algorithms to optimize learning experiences and improve educational outcomes. AI-assisted learning environments differ from traditional educational technologies because they continuously learn from user interactions and adapt instructional content accordingly (Alenezi, 2023).

AI-Assisted Learning Platforms and Student Achievement

AI-assisted learning platforms are designed to provide individualized instruction by adapting learning activities to students' needs, abilities, and performance levels. Research indicates that adaptive learning systems can significantly improve academic achievement by offering customized support and immediate feedback. Students receive instructional materials that

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correspond to their current level of understanding, thereby reducing frustration and promoting meaningful learning experiences (Johnson et al., 2024).

Several studies have reported positive relationships between AI-assisted learning and academic achievement. Chen et al. (2020) found that AI-supported instructional systems enhanced learner engagement, knowledge retention, and problem-solving performance. Similarly, Zawacki-Richter et al. (2021) concluded that AI applications in education contribute positively to student learning outcomes, particularly when integrated within well-designed pedagogical frameworks.

AI and Mathematics Education

Mathematics education has emerged as one of the primary domains benefiting from AI integration. AI-powered mathematics learning platforms provide personalized problem sets, adaptive assessments, automated feedback, and diagnostic evaluations. These features enable students to practice mathematical concepts at appropriate difficulty levels while receiving guidance tailored to their individual learning needs.

Research conducted by García-Martínez et al. (2022) demonstrated that students who utilized adaptive mathematics platforms achieved significantly higher scores than those receiving conventional instruction. The study attributed these improvements to increased engagement, individualized pacing, and immediate corrective feedback. Similarly, Kim et al (2023) reported that AI-based mathematics tutoring systems improved conceptual understanding and mathematical reasoning skills among secondary school students.

Within African educational contexts, emerging evidence suggests that AI-supported mathematics instruction can address persistent challenges associated with large class sizes and limited instructional resources. By providing individualized support, AI systems help bridge learning gaps and facilitate mastery of complex mathematical concepts.

AI and Physics Education

Physics education often presents unique instructional challenges due to the abstract nature of many scientific concepts. AI-assisted learning technologies offer opportunities to enhance conceptual understanding through simulations, virtual laboratories, intelligent tutoring systems, and adaptive instructional resources. These tools allow students to visualize scientific phenomena, conduct virtual experiments, and receive immediate feedback on problem-solving activities.

Research by Wang et al. (2022) found that students exposed to AI-supported physics instruction demonstrated significantly higher conceptual understanding than those taught using traditional methods. Similarly, Ahmed and Ibrahim (2024) reported improvements in problem-solving abilities, scientific reasoning, and academic achievement among students utilizing AI-enhanced physics learning platforms.

The application of AI in physics education is particularly valuable because it enables learners to engage with interactive representations of complex concepts that may be difficult to demonstrate in conventional classroom settings. Consequently, AI technologies contribute to improved comprehension, motivation, and academic performance.

Theoretical Framework

This study is anchored on Constructivist Learning Theory and the Technology Acceptance Model (TAM). Constructivist Learning Theory, advanced by Piaget and Vygotsky, emphasizes that

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learners actively construct knowledge through interaction with learning environments. AI-assisted learning platforms align with constructivist principles by providing opportunities for exploration, experimentation, feedback, and self-regulated learning. Students actively engage with content and receive personalized support that facilitates knowledge construction.

Empirical Review

Recent empirical studies have consistently reported positive effects of AI-assisted learning on academic achievement. Alenezi (2023) found that adaptive learning technologies significantly improved mathematics achievement among secondary school students. Similarly, Johnson et al (2024) reported enhanced science achievement among learners exposed to AI-supported instructional systems.

In Nigeria, emerging studies indicate growing interest in AI integration within education. Akinola et al (2024) reported positive relationships between AI-assisted learning and mathematics performance among secondary school students. Likewise, Okeke et al. (2024) found that AI-supported instructional interventions improved physics achievement and learner engagement.

Despite these promising findings, empirical evidence remains limited within the Nigerian secondary education context. Additional studies are required to establish the effectiveness of AI-assisted learning across different subject areas and educational settings. The present study contributes to addressing this gap by examining the effects of AI-assisted learning platforms on Mathematics and Physics achievement among Nigerian secondary school students.

Methodology

Research Design

This study adopted a quasi-experimental pretest-posttest control group design to investigate the effects of AI-assisted learning platforms on secondary school students' achievement in Mathematics and Physics in Nigeria.

Population and Sample of the Study

The target population consisted of all Senior Secondary School Two (SS II) Mathematics and Physics students enrolled in public secondary schools within three South western states of Nigeria. Ogun, Oyo and Lagos states in Nigeria. A sample of 300 students was selected using a multistage sampling technique. This comprise of three states from South western states of Nigeria, Ogun, Oyo and Lagos states in Nigeria. Two local governments each were considered with two schools from each local government. Fifty (50) SS II students were chosen from each school, to make three hundred students. Stage One involved purposive selection of six secondary schools with adequate digital infrastructure. Stage Two involved random selection of participating students.

The sample comprised: Experimental Group = 150 students and Control Group = 150 students. Gender distribution included: Male = 162 (54%) and Female = 138 (46%).

Instrument for Data Collection

Two researcher-developed instruments were utilized.

Mathematics Achievement Test (MAT)

The MAT consisted of 40 multiple-choice questions covering: Algebra, Geometry, Trigonometry, Statistics, and Probability. Maximum obtainable score = 100 marks.

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Physics Achievement Test (PAT)
The PAT consisted of 40 multiple-choice questions covering: Mechanics, Electricity, Waves, Heat Energy and Modern Physics. Maximum obtainable score = 100 marks.

Validity of the Instruments
Content validity was established through expert review by three specialists in Mathematics Education, Physics Education, and Educational Measurement and Evaluation. Their observations guided revisions of the instruments.

Reliability of the Instruments
A pilot study involving 40 students was conducted.
Cronbach Alpha coefficients obtained were:

Instrument	Reliability
MAT	0.87
PAT	0.84

These values indicate acceptable internal consistency.

Treatment Procedure
The intervention lasted eight weeks. Students in the experimental group utilized AI-assisted learning platforms featuring: Adaptive learning algorithms, Intelligent tutoring systems, Automated assessment, Personalized feedback and Learning analytics.
Students completed learning activities both during classroom sessions and independently.
The control group received instruction through conventional lecture and discussion methods.

Method of Data Analysis
Data were analyzed using Mean and Standard Deviation, Independent Samples t-test, and Linear Regression Analysis. All hypotheses were tested at 0.05 significance level.

Results
Mathematics Achievement Comparison
Hypothesis One
There is no significant difference in Mathematics achievement between students exposed to AI-assisted learning and those taught conventionally.

Table 1a: Descriptive Statistics for Mathematics Achievement

Group	N	Mean	SD	MSD	t	df	p-value
Experimental	150	78.40	8.50				
Control	150	65.10	9.20	13.30	12.14	298	.000

SD = Standard Deviation, t = t-test, df = degree of freedom, MSD = Mean Score Difference
Source: Fieldwork, 2026
The results indicate that students exposed to AI-assisted learning achieved a higher mean score (M = 78.40) than students taught conventionally (M = 65.10). Since $p < .05$, the null hypothesis was rejected.

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The result indicates a statistically significant difference in Mathematics achievement in favour of students exposed to AI-assisted learning.

Table 1b: Model Summary of simple linear regression analysis for effects of AI on academic achievement in Mathematics

Model	R	R^2	Adjusted R^2	Std Error of the Estimate
1	.566	.320	.317	6.842

Table 1b showed the Model Summary of Simple Linear Regression analysis conducted to determine the effect of AI-assisted learning platform usage has a moderate positive relationship with students' academic achievement (R = .566). The coefficient of determination (R^2 = .320) indicates that approximately 32.0% of the variation in students' achievement is explained by AI-assisted learning platform usage, while the remaining 68.0% may be attributed to other factors not included in the model.

Table 1c: ANOVA results of simple linear regression analysis for Mathematics student's achievement using AI-assisted learning platform

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	**6584.421**	**1**	**6584.421**	**140.681**	**0.000**
Residual	**13954.876**	**298**	**46.828**		
Total	**20539.297**	**299**			

Table 1c showed the ANOVA results of AI- Assisted learning platform indicating that the regression model is statistically significant, F(1, 298) = 140.681, p < .05, demonstrating that the predictor variable significantly explains variation in academic achievement.

Physics Achievement Comparison

Hypothesis Two

There is no significant difference in Physics achievement between students exposed to AI-assisted learning and those taught conventionally.

Table 2: Descriptive Statistics for Physics Achievement

Group	N	Mean	SD	MSD	t	Df	p-value
Experimental	150	76.20	7.90				
Control	150	63.40	8.70	12.80	11.27	298	.000

SD = Standard Deviation, t = t-test, df = degree of freedom, MSD = Mean Score Difference
Source: Fieldwork, 2026

Students in the experimental group achieved higher Physics scores than students in the control group.

Since p < .05, the null hypothesis was rejected.

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The findings indicate a statistically significant difference in Physics achievement in favour of the experimental group.

Hypothesis Three

AI-assisted learning platform usage does not significantly predict students' academic achievement in Mathematics and Physics

Table 3a: Multiple Regression Analysis

Predictor	B	T	P
AI Usage	0.57	9.82	.000

Table 3b: Model Summary

R	R^2	Adjusted R^2
0.566	.320	.317

The model indicates that AI usage explained approximately 32% of the variation in Mathematics achievement.

Table 3c: Coefficients of simple linear regression analysis for students' academic achievement from AI-Assisted Learning Platform

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
Constant	42.316	2.784		15.199	.000
AI-Assisted Learning Platform Usage	0.547	0.046	.566	11.861	.000

Table 3c reveals that AI-assisted learning platform usage significantly predicts academic achievement **(**$\beta = .566$, $t = 11.861$, $p < .001$**)**. The positive beta coefficient suggests that increased utilization of AI-assisted learning platforms is associated with higher academic achievement among secondary school students. Thus, the null hypothesis stating that AI-assisted learning platform usage does not significantly predict students' academic achievement is rejected.

Effect size of AI Usage on Physics and Mathematics academic Achievement

Table 4: Effect Size Analysis of AI Usage on Physics and Mathematics academic Achievement

Cohen's d values were computed to determine practical significance.

Variable	Cohen's d
Mathematics	1.5
Physics	1.42

According to Cohen (1988), both values represent large effect sizes, suggesting substantial educational impact.

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Discussion of Findings

The study revealed that students who utilized AI-assisted learning platforms achieved significantly higher scores in Mathematics than students who received conventional instruction. This finding suggests that adaptive learning systems can facilitate deeper understanding of mathematical concepts through individualized support and continuous feedback mechanisms. The result corroborates the findings of Chen et al (2020), who reported that AI-powered instructional systems improve academic performance by adapting content to learners' needs.

The significant improvement observed in Physics achievement further demonstrates the effectiveness of AI-supported learning environments. Physics concepts are often abstract and difficult for students to comprehend through traditional methods alone. AI-assisted platforms provide interactive simulations, adaptive exercises, and immediate corrective feedback, which contribute to enhanced conceptual understanding. This finding aligns with Wang et al (2022), who found that AI-enhanced instructional tools significantly improved students' understanding of scientific concepts.

The regression analysis revealed that AI usage significantly predicted students' academic achievement. Approximately 32% of the variation in achievement was explained by the level of AI utilization. This suggests that AI-assisted learning is not merely an instructional supplement but a meaningful predictor of educational outcomes.

The large effect sizes obtained for Mathematics and Physics achievement indicate that the intervention produced substantial educational benefits. These findings support Constructivist Learning Theory, which emphasizes active engagement, interaction, and feedback in knowledge construction. Students using AI-assisted platforms interacted more frequently with instructional content and received personalized guidance, thereby facilitating deeper learning experiences.

The results are also consistent with UNESCO's (2023) position that AI technologies can contribute to more inclusive, effective, and personalized educational experiences. Through adaptive content delivery and learning analytics, AI systems address learner diversity more effectively than many conventional instructional approaches.

Conclusion

This study investigated the effects of AI-assisted learning platforms on secondary school students' achievement in Mathematics and Physics in Nigeria. The findings demonstrated that students who were exposed to AI-supported instructional environments achieved significantly higher academic outcomes than their counterparts who received conventional classroom instruction. The results revealed substantial improvements in both Mathematics and Physics achievement among students in the experimental group, indicating that AI-assisted learning platforms have considerable potential to enhance STEM education within the Nigerian secondary school system.

The positive outcomes observed in this study may be attributed to the adaptive and personalized nature of AI-assisted learning systems. These platforms provide individualized learning pathways, instant feedback, continuous assessment, and targeted remediation, thereby enabling students to learn at their own pace while addressing specific learning difficulties. Such features contribute to increased learner engagement, improved conceptual understanding, and enhanced academic performance.

Furthermore, the findings established that AI utilization significantly predicted students' academic achievement, suggesting that effective integration of AI technologies can serve as an important

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determinant of educational success. The large effect sizes obtained for both Mathematics and Physics achievement indicate that AI-assisted learning is not only statistically significant but also educationally meaningful. Consequently, AI-supported instructional approaches represent a viable strategy for addressing persistent challenges associated with poor achievement in STEM subjects. The study therefore concludes that AI-assisted learning platforms constitute an innovative and effective instructional intervention capable of improving students' academic performance in Mathematics and Physics. As educational systems continue to undergo digital transformation, the strategic integration of AI technologies into teaching and learning processes may contribute significantly to improving educational quality, promoting learner-centered instruction, and advancing national STEM education goals.

Recommendations

Based on the findings and conclusions of this study, the following recommendations are made:

1. Integration of AI Technologies into Secondary Education: Educational authorities should develop policies that support the systematic integration of AI-assisted learning platforms into Mathematics and Physics instruction in secondary schools.
2. Provision of Digital Infrastructure: Federal and state governments should invest in reliable internet connectivity, computer laboratories, smart classrooms, and other digital resources necessary for effective implementation of AI-supported learning.
3. Teacher Professional Development: Continuous training programmes should be organized to equip teachers with the knowledge and competencies required to effectively utilize AI-assisted instructional tools in classroom practice.

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